

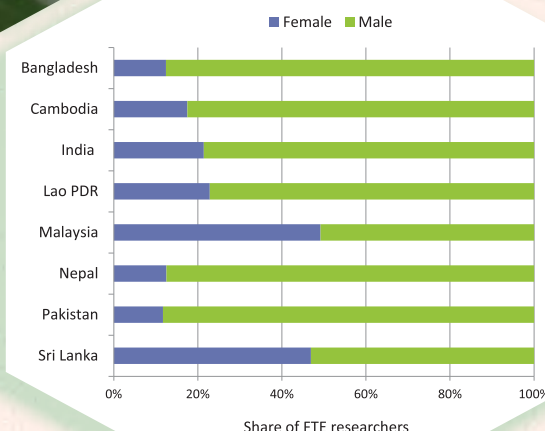
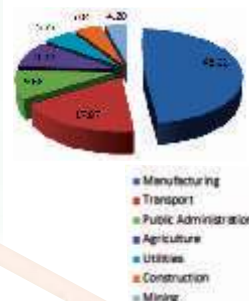


Investment in Agricultural Research for Sustainable Development in Asia and the Pacific

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**Asia-Pacific Association of Agricultural Research
Institutions (APAARI)**

2017



Investment in Agricultural Research for Sustainable Development in Asia and the Pacific

COUNTRY STATUS REPORTS

Editors

Bhag Mal, Shyam Sunder Singh and Raghunath Ghodake

Asia-Pacific Association of Agricultural Research Institutions (APAARI)

2017

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Contents

Preface	v
Acronyms & Abbreviations	vii
1. A Synthesis of the Status of Agricultural Research and Investment to Support Sustainable Development in Countries of Asia and the Pacific – Asia-Pacific Association of Agricultural Research Institutions (APAARI) <i>Mohammad A. Jabbar, Bhag Mal and Raghunath Ghodake</i>	1
2. Country Status Report: Afghanistan – Agriculture Research Institute of Afghanistan (ARIA) <i>Qudratullah Soofizada</i>	37
3. Country Status Report: Australia – Australian Centre for International Agricultural Research (ACIAR) <i>Nick Austin and David Shearer</i>	44
4. Country Status Report: Bangladesh – Bangladesh Agricultural Research Council (BARC) <i>Abul Kalam Azad and Md Abul Awal</i>	56
5. Country Status Report: Bhutan – Department of Agriculture (DoA) <i>Lhap Dorji</i>	66
6. Country Status Report: Cambodia – Cambodian Agricultural Research and Development Institute (CARDI) <i>Ouk Makara</i>	78
7. Country Status Report: China – Institute of Agricultural Economics and Development, Chinese Academy of Agricultural Sciences (CAAS) <i>Li Ninghui</i>	84
8. Country Status Report: Fiji – Ministry of Agriculture (MoA) <i>Apaitia Macanawai</i>	96
9. Country Status Report: India – Indian Council of Agricultural Research (ICAR) <i>S. Ayyappan, A.K. Vasisht and A.K. Bawa</i>	101
10. Country Status Report: Iran – Agricultural Research, Education and Extension Organization (AREEO) <i>Javad Mozafari</i>	109
11. Country Status Report: Japan – Japanese International Research Center for Agricultural Sciences (JIRCAS) <i>Sakiko Shiratori, Tomohide Sugino Naruo, Matsumoto and Masa Iwanaga</i>	122

12. Country Status Report: Laos – National Agriculture & Forestry Research Institute (NAFRI) <i>Bounthong Bouahom</i>	130
13. Country Status Report: Malaysia – Malaysian Agricultural Research and Development Institute (MARDI) <i>Sharif Haron, Tapsir Serin, Nik Rozana Nik Mohd Masdek, Amanah Mustakimah Siraj, Mohammad Fauzy Tambi, Siti Shurazizah Sukhur and Allicia Jack</i>	138
14. Country Status Report: Nepal – Nepal Agricultural Research Council (NARC) <i>Y.R. Pandey and U.K. Acharya</i>	148
15. Country Status Report: New Caledonia – Institut Agronomique Neo-Caledonien (IAC), Centre de Cooperation, Internationale en Recherche Agronomique Pour le developpement, Paita Nouvelle - Caledonie <i>Laurent Lhuillier</i>	159
16. Country Status Report: Pakistan – Pakistan Agricultural Research Council (PARC) <i>Nadeem Amjad</i>	164
17. Country Status Report: The Philippines – Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) <i>Reynaldo V. Ebor, Leah J. Buendia, Maria Theresa, T. Bautista and Katrina Kae S. Principe</i>	173
18. Country Status Report: Papua New Guinea – National Agricultural Research Institute (NARI) <i>Sergie Kopen Bang</i>	182
19. Country Status Report: Republic of Korea – International Organization Cooperation Team, International Technology Cooperation Center, 300 Nongsaengmyeong-ro, Wansan-gu, Jeonju-si, Jeollabuk-do <i>Cho Myoung-rae and Yi Jeong-heon</i>	200
20. Country Status Report: Sri Lanka – Sri Lanka Council for Agricultural Research Policy (SLCARP) <i>A.R. Ariyaratne, N.S. Jayasekera, P.C. Giritagama and D.D.S.S. Dissanayake</i>	211
21. Country Status Report: Taiwan – Taiwan Agricultural Research Institute (TARI) <i>Junne-Jih Chen</i>	225
22. Country Status Report: Thailand – National Economic and Social Development Board, Department of Agriculture (DOA) <i>Alongkorn Korntong and Margaret C. Yoovatana</i>	234
23. Country Status Report: Vietnam – Vietnam Academy of Agricultural Sciences (VAAS) <i>Trinh Khac Quang</i>	245
List of Authors	257

Preface

The Asia-Pacific Association of Agricultural Research Institutions (APAARI) in collaboration with the Australian Centre for International Agricultural Research (ACIAR), Department of Agriculture (DOA), Thailand, Food and Agricultural Organization of the United Nations – Regional Office for Asia and the Pacific (FAO RAP), Global Forum on Agricultural Research (GFAR) and International Food Policy Research Institute (IFPRI) organized a High Level Policy Dialogue on Investment in Agricultural Research for Sustainable Development in Asia and the Pacific at Bangkok on 8-9 December 2015. One of the objectives of the Policy Dialogue was to assess the current capacities, disparities and levels and trends of investment in agricultural research and innovation to support agricultural development and hence sustainable development in countries of Asia and the Pacific. In order to facilitate the dialogue in this specific focus area, an effort was made to gather key basic information on selected aspects of agricultural research and innovation from the countries of the Asia-Pacific region. The specific aspects covered were: the current policies, strategies, priorities, institutional roles, responsibilities and partnerships, major challenges and opportunities, infrastructure and financial investments, as well as current capacities and trends of investment in agricultural research and innovations.

A structured outline/questionnaire was sent to 25 countries of the region, of which 22 countries provided very useful and relevant information in the form of country status reports. This compilation includes systematically organized and edited country status reports and a synthesis paper based on in-depth analysis of the information contained in these country reports. The synthesis paper was presented in the High Level Policy Dialogue.

Based on GDP per capita at current prices in 2014, five countries were classified as high income, seven as medium income and 10 as low income countries. Responses revealed that major policies that have implications for agricultural research in these countries include food security/food supply, productivity improvement, sustainable natural resources management, sustainable development or sustainability, competitiveness and market development, rural development, rural income generation and livelihood. The implications of these vary across income groups and countries. There are also significant differences between countries and income groups in terms of specific strategies adopted.

Among the main focus and priority areas for research and development, top on the list are broad areas encompassing global warming/climate change/natural resources management/environment. Other areas include frontline research and innovation, strengthening market/value chain/competitiveness, stability of food supply/commodity supply, establishment of advanced facilities/services/infrastructure, problems of producers/industry. The synthesis categorically suggests that agricultural research is under-funded and under-invested. Climate change, environmental problems and their consequences are perceived as the most important challenges facing the countries. Other perceived challenges are: i) technology for productivity improvement and market development, and ii) research staff, facilities and laboratories.

We are grateful to the Heads of National Agricultural Research Systems (NARS) and all the authors of these country reports for providing valuable information on the status of investments in agricultural research in their respective countries, which resulted in this important and comprehensive compilation. We also express our most sincere thanks to Drs Raj Paroda, Mohammad Jabbar, Jawahir Karihaloo and Sudhir Kochhar for their valuable contributions and support in various ways in bringing out this important publication.

We are sure that this compilation will be extremely useful to the policy planners, research managers, donors, researchers, students, farmers and others concerned and involved in enhancing and improving investment in agricultural research and innovation for sustainable development in Asia and the Pacific.

Editors

Acronyms & Abbreviations

AAEP	Afghanistan Agriculture Extension Project
AAIP	Afghanistan Agriculture Input Project
AANR	Agriculture, Aquatic and Natural Resources
AARI	Ayub Agricultural Research Institute
ABSP	Agricultural Biotechnology Support Project
ACI	Advanced Chemical Industries
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
ADD	Agricultural Development Domain
ADECAL	Agency for Economic Development of New Caledonia
ADS	Agriculture Development Strategy
AEC	Asian Economic Community
AFACI	Asian Food and Agriculture Cooperation Initiative
AFNR	Agriculture, Forestry and Natural Resources
AFRS	Agriculture and Forestry Research Strategy
AFU	Agricultural and Forestry University
AGDP	Agricultural Gross Domestic Product
AKF	Australian Koala Foundation
AKIS	Agricultural Knowledge and Information Systems
AICRP	All India Coordinated Research Project
ALP	Alternative Livelihood Programme
ANDS	Afghanistan National Development Strategy
ANHDO	Afghanistan National Horticulture Development Organization
ANNGO	Afghanistan National Nursery Growers Organization
APAARI	Asia-Pacific Association of Agricultural Research Institutions
APC	Agricultural Price Commission
APEC	Asia-Pacific Economic Cooperation
APP	Agriculture Production and Productivity Programme
AR4D	Agricultural Research for Development
ARDA	Agriculture Research Development Agency
AREEO	Agricultural Research, Education and Extension Organization
ARI4D	Agricultural Research and Innovations for Development
ARIA	Agricultural Research Institute of Afghanistan

ARIT	Agricultural Research Institute Tandojam
ASEAN	Association of South East Asian Nations
ATI	Agricultural Training Institute
ATMA	Agricultural Technology Management Agency
AVRDC	Asian Vegetable Research and Development Centre
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BCS	Bogia Coconut Syndrome
BFRI	Bangladesh Fisheries Research Institute
BFRI	Bangladesh Forest Research Institute
BI	Bioversity International
BI-APO	Bioversity International- Asia Pacific Organization
BINA	Bangladesh Institute of Nuclear Agriculture
BJRI	Bangladesh Jute Research Institute
BLRI	Bangladesh Livestock Research Institute
BNF	Biological Nitrogen Fixation
BPH	Brown Plant Hopper
BRAC	Bangladesh Rural Advancement Committee
BRRI	Bangladesh Rice Research Institute
BSRI	Bangladesh Sugarcane Research Institute
BSRTI	Bangladesh Sericulture Research and Training Institute
BTRI	Bangladesh Tea Research Institute
CAAS	Chinese Academy of Agricultural Science
CARDI	Cambodian Agricultural Research and Development Institute
CAS	Certified Agricultural Standards
CC	Climate Change
CCI	Cocoa and Coconut Institute
CDB	Cotton Development Board
CDF	Commodity Development Framework
CDRI	Cambodian Development and Research Institute
CEAL	Community Extension Agents for Livestock
CEO	Chief Executive Officer
CGIAR	Consultative Group on International Agricultural Research
CGRFA	Commission on Genetic Resources for Food and Agriculture
CHED	Commission on Higher Education
CIC	Coffee Industry Cooperation
CIFE	Central Institute of Fisheries Education

CIG	Common Interest Group
CIMMYT	Centro Internacional Mejoramiento de Maize y Trigo
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Centre
CIRAD	Centre de Coopération Internationale en Recherche Agronomique Pour le Développement
CIRAD	French Agricultural Research Centre for International Development
CLAP	Community Livestock and Agriculture Project
CNRS	Centre National de la Recherche Scientifique
CNRS	National Center for Scientific Research
COA	Council of Agriculture
COMSTE	Congressional Commission on Science and Technology and Engineering
CorPlan	Corporate Plan
CoRRB	Council of RNR Research of Bhutan
CPC	Central Party Committee
CRESICA	Consortium for Research, Higher Education, Innovation in New Caledonia
CSC	Community Service Centers
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organization
CSO	Civil Society Organization
CWANA	Central Asia, West Asia and North Africa
DA	Department of Agriculture
DAL	Department of Agriculture and Livestock
DBT	Department of Biotechnology
DDA	Demand Driven Approach
DENR	Department of Environment and Natural Resources
DFAT	Department of Foreign Affairs and Trade
DFRS	Department of Forest Research System
DNPM	Department of National Planning and Monitoring
DOA	Department of Agriculture
DOST	Department of Science & Technology
DPTFRI	Date Palm and Tropical Fruit Research Institute
DSP	Development Strategic Plan
DST	Department of Science and Technology
EO	Executive Order
EDC	Economic Development Clusters
EDP	Economic Development Policy
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria

ENBP	East New Britain Province
ENSO	El Niño-Southern Oscillation
ERDB	Ecosystems Research and Development Bureau
EU	European Union
FAO	Food and Agriculture Organization
FAS	Farming Assistance Programme
FCB	Food Cooperation of Bhutan
FCP	French Cooperation Project
FFS	Farmers Field School
FIAC	Farmer's Information and Advice Centre
FJD	Fijian Dollar
FoA	Faculty of Agriculture
FoF	Faculty of Forestry
FORWARD	Foundation for Women's Health Research and Development
FO	Farmer's Organization
FPDA	Fresh Produce Development Agencies
FRA	Fisheries Research Agency
FRIEND	Foundation for Rural Integrated Enterprises & Development
FTA	Free Trade Agreement
FTE	Full Time Equivalent
FYP	Five Year Plan
GAIN	Global Agricultural Information Network
GAP	Good Agricultural Practices
GC	Governing Council
GDA	General Directorate of Agriculture
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GM	Genetically Modified
GMP	Good Manufacturing Practice
GOI	Government of India
HACCP	Hazard Analysis and Critical Control Point
HDI	Human Development Index
HR	Human Resource
HRD	Human Resource Development
HSRI	Health Systems Research Institute
IAC	Institut Agronomique néo-Calédonien

IARI	Indian Agricultural Research Institute
IATTC	Inter-American Tropical Tuna Commission
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in Dry Areas
ICIMOD	International Center for Integrated Mountain Development
ICM	Integrated Crop Management
ICRAF	International Center for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information Communication Technology
ICT/MIS	International Communication Technology/Management Information Systems
IFAD	International Fund for Agriculture Development
IFARD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IFREMER	French Research Institute for Exploitation of the Sea
IIT	Indian Institute of Technology
ILRI	International Livestock Research Institute
INRA	National Institute of Agronomic Research
IOCs	Industry-Owned Companies
IoT	Internet of Things
IP	Intellectual Property
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management
IPR	Intellectual Property Right
IRD	Inland Revenue Department
IRRI	International Rice Research Institute
ISP	Industry Strategic S&T Programme
ITC	Innovation Technology Center
ITP	Industrial Tree Plantation
ITPGRFA	International Treaty of Plant Genetic Resources for Food and Agriculture
IVRI	Indian Veterinary Research Institute
IWMI	International Water Management Institute
JICA	Japanese International Cooperation Agency
JICA/CDIS	Japan International Cooperation Agency/Capacity Development and Institutional Strengthening
JICA/RIPA	Japan International Cooperation Agency/Rice-based Agriculture Development in Afghanistan
JICA/SATREPS	Japan International Cooperation Agency/Science and Technology Research Partnership for Sustainable Development

JIRCAS	Japanese International Research Center for Agricultural Sciences
KAFACI	Korean-Africa Food and Agriculture Cooperation Initiative
KCNSA	Kampong Cham National School of Agriculture
KOLFACI	Korea-Latin America Food and Agriculture Cooperation Initiative
KOPIA	Korea Project on International Agriculture
KOPIA	Korean Project for International Agriculture
KPK	Khyber Pakhtunkhwa
KRA	Key Result Area
KU	Kathmandu University
KVK	Krishi Vigyan Kendra
LDC	Livestock Development Corporation
LEAF	Local Extension Agents for Fisheries
LGU	Local Government Unit
LI-BIRD	Local Initiative for Biodiversity Research and Development
LNG	Liquefied Natural Gas
LOHAS	Lifestyles of Health and Sustainability
MAFF	Ministry of Agriculture, Forestry and Fisheries
MAIL	Ministry of Agriculture, Irrigation and Livestock
MARD	Ministry of Agriculture and Rural Development
MARDI	Malaysian Agricultural Research and Development Institute
MAS	Marker Assisted Selection
MEF	Ministry of Economic and Finance
MEs	Medium Enterprises
MFPI	Ministry of Food Processing Industries
MIS	Management Information System
MNFSR	Ministry of National Food Security and Research
MoA	Ministry of Agriculture
MOAC	Ministry of Agriculture and Cooperatives
MoAF	Ministry of Agriculture and Forests
MoEF	Ministry of Environment and Forests
MoES	Ministry of Earth Sciences
MOF	Ministry of Finance
MoST	Ministry of Science and Technology
MSU	Mindanao State University
MT	Metric Tonnes
MTDP	Medium Term Development Plan
NAARRDN	National Agriculture, Aquatic and Resources Research and Development Network

NAARRDS	National Agriculture, Aquatic and Resources Research and Development System
NAAS	National Institute of Agricultural Science
NABP	National Agro-Biodiversity Programme
NADF	National Agricultural Development Framework
NAFRI	National Agriculture & Forestry Research Institute
NAP	National Agricultural Policy
NAP4	National Agro-Food Policy
NAQIA	National Agriculture Quarantine and Inspection Authority
NARC	National Agricultural Research Center
NARC	Nepal Agricultural Research Council
NARES	National Agricultural Research & Education System
NARI	National Agricultural Research Institute
NARO	National Agriculture Research Organization
NARPOL	National Agriculture Research Policy
NARS	National Agricultural Research System
NAST	Nepal Academy of Science and Technology
NBN	National Broadband Network
NCRP	National Coordinated Research Programme
NDAL	National Department of Agriculture and Livestock
NDRC	National Development and Reform Commission
NDRI	National Dairy Research Institute
NEC	National Executive Council
NEI	Nutrition and Education International
NESDP	National Economic and Social Development Plan
NGO	Non Government Organization
NGP	National Greening Programme
NIA	Nuclear Institute for Agriculture
NIAB	Nuclear Institute for Agriculture and Biology
NIAES	National Institute for Agro-Environmental Sciences
NIAS	National Institute of Agricultural Sciences
NIAS	National Institute of Animal Science
NIBGE	National Institute for Biotechnology and Genetic Engineering
NICS	National Institute of Crop Science
NIFA	Nuclear Institute for Food and Agriculture
NIHH	National Institute of Horticulture and Herbs
NKRA	National Key Result Areas
NOAP	National Organic Agriculture Programme

NORAD	Norwegian Aid for Research and Development
NRC	National Research Council
NRCT	National Research Council of Thailand
NRM	Natural Resource Management
NSF	National Science Foundation
NSTDA	National Science and Technology Development Agency
NTFP	Non-Timber Forest Product
NUoL	National University of Laos
NWC	Natures Way Cooperative
NWFP	Non-Wood Forest Product
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OGTP	One Geog-block Three Products
OHEC	Office of the Higher Education Commission
OPRA	Oil Palm Research Association
OPV	Open Pollinated Varieties
PA	Philippine Agriculture
PARB	Punjab Agricultural Research Board
PARC	Pakistan Agricultural Research Council
PC	Plant Clinics
PCAARRD	Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development
PCAMRD	Philippine Council for Aquatic and Marine Research and Development
PCC	Philippine Carabao Center
PCST	Pakistan Council for Science and Technology
PDAL	Provincial Divisions of Agriculture & Livestock
PDP	Philippine Development Plan
PHDC	Perennial Horticulture Development Centre
PHDP	Perennial Horticulture Development Project
PhilMech	Philippine Center for Postharvest Development and Mechanization
PhilRice	Philippine Rice Research Institute
PLNSA	Prek Leap National School of Agriculture
PNG	Papua New Guinea
PPD	Policy and Planning Division
PRIMAFF	Policy Research Institute of the Ministry of Agriculture, Forestry and Fisheries
PSF	Pinoy S&T Services for Farmers and Entrepreneurs
R&D	Research and Development

RDA	Rural Development Administration
RD&E	Rural Research, Development and Extension
RDC	Rural Research and Development Corporation
RIARC	Regional Integrated Agricultural Research Center
RNR	Renewable Natural Resources
RTF	Research Trust Fund
RUA	Royal University of Agriculture
S&T	Science & Technology
SAARC	South Asian Association for Regional Cooperation
SAUs	State Agricultural Universities
SIDA	Swedish International Cooperation Development Agency
SIP	Strategic Innovation Promotion Programme
SKRAs	Sectoral Key Result Areas
SKSV	The Sultan Kudarat State University
SLCARP	Sri Lanka Council for Agricultural Research Policy
SLM	Sustainable Land Management
SME	Small and Medium Enterprise
SNV	Foundation of Netherlands Volunteers
SO	Strategic Objective
SPA	Strategic Plan of Action
SPRFMO	South Pacific Regional Fisheries Management Organization
SPS	Sanitary and Phytosanitary
SRDI	Soil Resource Development Institute
SRF	Strategy and Results Framework
SSL	Self-Sufficiency Level
ST	Strategic Thrusts
STI	National Science Technology and Innovation Policy Office
SUCs	State Universities and Collages
TAP	Traceable Agriculture Product
TARI	Taiwan Agricultural Research Institute
TFP	Total Factor Productivity
TGP	Techno Gabay Programme
TSP	Telmo Gabay Programme
TGAP	Taiwan Good Agriculture Practice
TRF	Thailand Research Fund
TRON	Thailand Research Organization Network
TTT	Tei Tei Taveuni

TU	Tribhuvan University
UAF	University of Agriculture, Faisalabad
UGC	University Grant Commission
UN	United Nation
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNITECH	University of Technology
UNRE	University of Natural Resources and Environment
USDA/ARS	United States Department of Agriculture/Agricultural Research Services
USG	Urea Super Granule
VAAS	Vietnam Academy of Agricultural Sciences
VND	Viet Nam Dollar
VSU	Visayas State University
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WNBP	West New Britain Province
WTO	World Trade Organization
WUR	Wageningen University Research Institute
WWF	World Wildlife Fund
UPOV	International Union for the Protection of New Varieties of Plants

1. A Synthesis of the Status of Agricultural Research and Investment to Support Sustainable Development in Countries of Asia and the Pacific

Mohammad A. Jabbar, Bhag Mal and Raghunath Ghodake

Asia-Pacific Association of Agricultural Research Institutions (APAARI), Bangkok

ABSTRACT

In order to provide background information about the current policies, strategies, priorities as well as current capacities and trends of investment in agricultural research and innovation to support sustainable development in countries of Asia and the Pacific, a structured questionnaire was sent to 25 countries seeking a brief status report. Twenty two countries responded of which, based on GDP per capita at current prices in 2014, five were classified as high income, seven as medium income and 10 as low income countries.

Responses revealed that major policies that have implications for agricultural research in these countries include food security/food supply, productivity improvement, sustainable natural resources management, sustainable development or sustainability, competitiveness and market development, rural development, rural income generation and livelihood. Specific meaning and implication of each of the above policies vary across income groups and countries. Among the strategies adopted to implement the policies include two broad categories: one is related to research and technology transfer and the other is related to building organization, market development, and regulations. There are differences between countries and income groups in terms of specific strategies adopted.

Among the main focus and priority areas for research and development, top on the list is a broad area encompassing global warming/climate change/natural resources management/environment, which is common across income groups. Other areas include frontline research and innovation, strengthening market/value chain/competitiveness, stability of food supply/commodity supply, establishment of advanced facilities/services/infrastructure, problems of producers/industry. There are differences between income groups in terms of importance of focus areas. Agricultural research and innovation is primarily a public sector activity in nearly all the countries; in high income countries, private sector, NGOs and farmer associations also play some role. Precise information on levels of investment and their sources were not available. However, available cursory information suggests that agricultural research is under-funded and under-invested. Climate change, environmental problems and their consequences are perceived as the most important challenges facing the countries across all income groups. Other perceived challenges fall into two broad categories - technology for productivity improvement and market development, and research staff, facilities and laboratories. All the countries have ongoing plans built on past achievements to address future challenges.

It is recommended that during the discussion on future agenda and priorities, in addition to the above issues, consideration should be given to alignment with sustainable development goals agenda, the increasing importance of livestock sub-sector in the region, the need for strengthening research-policy-end user partnerships and interactions, and the need for stronger collaboration within regional bodies like the ASEAN and SAARC.

Keywords: Agricultural research; Objectives and strategies; Investment; Sustainable development, Asia-Pacific, APAARI

Background and Objectives

Over the last few decades, world agriculture produced remarkable results. The availability of food supplies has outpaced the growth in population which enabled millions of people to get out of poverty, hunger and malnutrition. However, continued prevalence of poverty, hunger and malnutrition, especially in parts of the Asia-Pacific region, pose new challenges for agriculture. Even though the number of hungry people decreased by 43 per cent since 1990-92, the region still contains over 642 million poor and hungry people representing two-third of the world's total poor and hungry. During 2011-13, nearly 1/8th of the population in the region did not have enough food to meet their daily minimum dietary energy needs (FAO 2014). A significant proportion of the people in the region are also suffering from hidden hunger or deficiency in micro-nutrients. In 2013, globally 161 million children below the age of five suffered from chronic malnutrition (UNICEF 2015). Among them about two third are located in the Asia-Pacific region. In some countries, incidence of child under-nutrition is over 40 per cent. Paradoxically, overconsumption, especially of some livestock products, among a section of the rich population leading to obesity and other related health hazards are also emerging as new problems in more advanced countries in the region as elsewhere.

Addressing these problems in the future will be doubly challenging because of a number of reasons. The successes in the past have been achieved at great cost to natural resources. Excessive pressure on land and water resources resulted in their degradation; drive towards higher productivity, standardization and uniformity of output resulted in enormous loss of biodiversity in both plant and animal populations. Application of inappropriate production practices led to increased global warming and damage to ecosystems creating new problems for both human and ecosystem health (FAO 2014). These problems are likely to aggravate in the future because estimates suggest that by 2050, the region will add one billion more people; rapid economic growth in some countries will increase income levels significantly and nearly two third of the population will live in urban areas compared with about 42 per cent in 2010.

Meeting the food demands of this larger, more urban and more prosperous population will require doubling the availability of food of both crop and animal origin in the region. Both production and trade will play key roles in future food supplies. Given the scarcity of arable land in the region, much of the increased food needs have to be produced through improving productivity - both specific factor productivity as well as total factor productivity - giving particular attention to improving the livelihoods of the poor and maintaining the integrity and resilience of natural resources. But scientific breakthroughs in agriculture in the region have become fewer in recent years indicating a sign of stagnation. So there is no alternative but to revitalize science, technology and innovation in agriculture to address the emerging challenges.

Designing future plans and actions in science and technology for agriculture and rural development will require an understanding of past trends in investment, development and achievement and the current situation. It is generally known that the countries in the region are diverse in terms of level of development, resource endowment, especially man-land ratio, level of investment and advancement in technology, research and innovation capacity, and importance of trade in national income. So they may have non-equivalent perspectives and policy objectives for the future. But, comprehensive information and systematic assessment about the past achievements and the current situation for the countries in the region is not readily available.

One of the objectives of the High Level Policy Dialogue was to assess current capacities, disparities and levels and trends of investment in agricultural research and innovation to support agricultural development and hence sustainable development in countries of Asia and the Pacific. In order to facilitate the dialogue, an effort was made to gather some basic information on selected aspects of agricultural research and innovation from the APAARI member countries by using a standard questionnaire. In this paper, the methodology used in information collection and a synthesis of key findings are presented to help discussion to identifying priority areas of action to promote and improve investment, policy support and institution building in agricultural research and innovations for sustainable development at both the national levels and in the Asia-Pacific region as a whole.

Methodology

A structured questionnaire was prepared by the APAARI Secretariat covering the following aspects: current policies and strategies on agricultural research for development; focus areas and priorities for agricultural research and innovations; institutional roles, responsibilities and partnerships; infrastructure and financial investment; major challenges and opportunities ahead; and short to medium-term plans. Broad scope for each topic/theme was described in the questionnaire. The questionnaire was sent to the Heads of NARS of 25 countries requesting each to send a 10-15 page report. A deadline for response was given with encouragement for seeking clarification on any topic, if required. Subsequently, further clarifications and amendments were circulated to eliminate any scope for different interpretation of the information sought under a topic.

Out of 25 countries, responses from 22 were received. This high response rate indicated seriousness of the countries invited to participate in the dialogue to share their information and ideas with peers to hold a fruitful discussion on the basis of facts and evidence. The high response rate also indicated that though the responding countries differ in many ways and may have non-equivalent perspectives about various aspects of agriculture, in the increasingly globalized market economy situation, they value the need for cooperation and partnership as essential means to address the problems and challenges facing them by learning from each other's experiences.

Given that the countries in the region are diverse in several ways, grouping them into fairly similar categories was considered useful for meaningful comparison of the responses. For this purpose, two options were considered – geographic (South Asia, Southeast Asia and the Pacific) and level of income as a proxy for economic development. However, the geographic approach appeared less useful because within each sub-region there are significant variations, especially in terms of level of income or development. In the questionnaire, information on national total GDP and agricultural GDP were included and in the responses these data have been provided. However, some countries reported GDP for 2014 using different base years according to their national accounts. Moreover, data on population was not sought hoping to get it from a secondary source. But depending on the source, the population estimate might differ. Taken these deficiencies or discrepancies together, information in the questionnaire appeared inadequate to estimate per capita GDP for grouping the countries.

An alternative source was World Development Indicators (WDI) for individual countries which are generated by the World Bank using a standard approach across countries. WDIs for a

country may differ from its national statistics, so choice of WDIs as a data source may carry some sensitivity but these are widely used indicators for international comparison of trends. Moreover, the indicators are regularly updated and amended based on the latest information so figures may change from one date to another, so they are taken as trends, and not as absolutely accurate values. They remain comparable because of the uniform standard approach applied.

Hence, GDP per capita in 2014 at current prices derived from World Development Indicators was used to divide 22 responding countries into three income groups (Table 1). Per capita GDP above USD 20,000 was considered high income, between USD 2,500 and 20,000 as medium income and below USD 2,500 was considered low income. These definitions are not exactly the same as that of World Bank classification of high, medium and low income countries¹. Information on a number of other parameters for 2014 such as PPP GNI per capita, share of agriculture in GDP, share of livestock in agricultural GDP and share of rural population are also presented in table 1 as complementary to GDP per capita as a basis for grouping the countries.

Out of the 22 responding countries, five are classified as high income, seven as medium income and 10 as low income. Some important features emerge from the table.

First, relative rank of a country remains fairly similar under both GDP and PPP GNI except minor variation in a few cases. For Australia, GNI is equivalent to about 70 per cent of GDP, and for all other countries, GNI is higher than GDP by different extent: 1.05 times in case of Japan to 3.83 times in case of Pakistan. In general, GNI/GDP ratios are lower for the high income countries and higher for the low income countries, so inequality between countries is less if PPP GNI is used as the indicator of income or economic development.

Second, except a few outliers, there is an inverse relationship between level of income and share of agriculture in GDP and share of population living in rural areas. On the other hand, there is a positive relationship between level of income and share of livestock in agricultural GDP. These trends are consistent with historical experiences in advanced countries. As economies develop, agriculture and rural population decline in importance but livestock become more important within agriculture because of changes in people's consumption behaviour propelled by income growth and urbanization.

The relative importance of agriculture, livestock and rural population in countries with different income levels or levels of development has different implication for policies and strategies for agriculture, livestock and rural development. The analysis showed whether and how these characteristics are reflected in the country reports on policies for agricultural research and innovation for development.

Key Findings

Before presenting the results of the analysis of the responses in the country reports, some general remarks about the nature of the responses are necessary. It appears that there are significant

¹As of 1 July 2015, low-income economies are defined as those with a GNI per capita, calculated using the World Bank Atlas method of USD 1,045 or less in 2014; middle-income economies are those with a GNI per capita of more than USD 1,045 but less than USD 12,736; high-income economies are those with a GNI per capita of USD 12,736 or more. Lower-middle-income and upper-middle-income economies are separated at a GNI per capita of USD 4,125 (World Bank 2015).

Table 1. Selected attributes of some countries in the Asia-Pacific region

Income level and Country	GDP/ capita at current prices, USD	PPP GNI/ capita at current Int. USD	GNI/ GDP ratio	% GDP from agriculture	% AgGDP from livestock	Rural population (%)
	2014	2014		2014	2013	2014
High income						
Australia	61887	42886	0.69	2.5	47.0	10.7
Japan	36194	37920	1.05	1.2*	16.9	7.0
Korea, Rep.	27971	34620	1.24	1.2	59.1	17.6
Taiwan	NA	NA	NA	1.9*	NA	NA
New Caledonia	NA	NA	NA	1.5*	NA	30.0
Middle income						
Malaysia	10934	24080	2.20	9.1	21.6	26.0
China	7594	13130	1.72	9.2	32.0	46.0
Thailand	5519	13840	2.51	11.6	22.4	50.8
Iran, Islamic Rep.	5315	16140	3.04	8.8*	23.2	27.1
Fiji	4546	8030	1.77	9.0*	41.4	46.6
Sri Lanka	3631	10270	2.82	9.9	12.2	81.7
Philippines	2871	8380	2.92	11.3	33.0	55.5
Low income						
Bhutan	2381	7570	3.18	17.1	6.0	62.1
Papua New Guinea	2108**	2510**	1.19	27.6*	NA	87.0
Vietnam	2052	5350	2.60	18.1	28.6	67.0
Lao PDR	1760	5060	2.87	24.8*	18.3	62.0
India	1596	5640	3.54	17.0	20.5	67.6
Pakistan	1334	5110	3.83	25.1	28.0	61.7
Bangladesh	1093	3330	3.04	15.9	13.0	66.5
Cambodia	1091	3100	2.84	28.7*	10.0	79.0
Nepal	697	2420	3.47	34.3	26.8	81.8
Afghanistan	659	1960	2.97	20.0*	NA	74.0

Note : PPP GNI (formerly PPP GNP) is gross national income (GNI) converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GNI as US dollar has in the USA

NA denotes that data are not available

Source: World Bank 2015; For livestock share of AgGDP, (FAO 2015) <http://faostat3.fao.org/download/Q/QV/E>, accessed on 13 November 2015. *Reported in Country Reports for APAARI High Level Policy Dialogue and included in this proceedings. **Reference year 2013

differences in form, content and quality of information provided in the country reports. A combination of three possible sources may explain this variation. First, in spite of definition of 'broad scope' and additional clarification on various topics, it appears that the questionnaire was not adequately or sufficiently clear about the exact type of information sought under various topics. Perhaps there were still ambiguities. Second, the countries might have interpreted the information needs in their own way to suit their available information rather than tailor information to fit the questionnaire. Third, which is a corollary of the second, the country reports have been prepared on the basis of existing national policy, planning and strategy documents of one kind or another. Based on national situation and preferences, each country may have used unique concepts, narrative and vocabulary in those documents, which were also reflected in the country reports. Therefore, a particular aspect might have been described somewhat differently in different country reports.

The objective of the synthesis was to identify key issues and their patterns across three income groups to see if there are significant similarities and differences. Then explain possible reasons behind the differences to help identify possible options to address them under comparable or similar situations. In order to do so, differently expressed responses on any specific topic were carefully interpreted and sorted using subjective judgment for purposes of grouping. In this process, it has been possible to classify and sort most responses into one or the other category. Some country specific responses might have been left out of the classification exercise if they did not fit any category but have been mentioned in the text if it has special importance for that country or for the region.

Main Current Policies

Information on current policies that have implications on agricultural research and innovation for development was sought. In responding to this question, some interpreted this as agricultural policies having implication for agricultural research while some others interpreted it as agricultural research policies *per se*. Major responses are summarized in table 2. It appears that food security/food supply, productivity improvement, sustainable natural resources management (NRM), sustainable development or sustainability, competitiveness and market development, rural development in its various facets are principal policies/policy objectives in the responding countries.

Food security/food supply for the nation is the paramount policy objective for 20 out of the 22 countries. However, the issue has somewhat different connotation in high income compared to medium and low income countries. For example, for Japan and Taiwan, the primary concern is to assure adequate food supply for the citizens. Both the countries depend on imports for a significant share of food supply, so for them the policy objectives are to maintain the share of domestic food supply. For the low and medium income countries, food security refers to the widely used FAO definition of food security with its four dimensions – availability, access, utilization and quality.

Sustainable natural resources management has been reported as the objective by 14 countries with additional five countries reporting sustainable development or sustainability as the objective. These two policy objectives are grouped separately because conceptually there are some basic differences between the two. While the aim of sustainable NRM is to maintain

Table 2. Main agricultural policies and/or policy objectives having implications for R&D in countries in Asia and the Pacific by income level

Policy/policy objective	Number of countries responding by income level			
	High n = 5	Medium n = 7	Low n = 10	All N=22
Food security/food supply	3	7	10	20
Productivity improvement	1	5	7	13
Sustainable natural resource management	2	5	7	14
Sustainable development/sustainability	2	2	1	5
Competitiveness/market development	3	3	1	7
Poverty alleviation/inclusive growth	–	3	4	7
Increase rural income/promote viability of farming/protection of smallholders	1	3	3	7
Rural development/rural economic growth	2	1	–	3
Promotion of agricultural industry/rural industry for economic development	3	1	1	5
Employment generation	–	1	2	3

Source: Appendix A1. (Because of multiple responses by each country, column totals will not be equal to n or N in this and subsequent tables)

long-term productivity, integrity and resilience of natural resources, sustainable development or sustainability refers to a much wider agenda encompassing natural, economic and social dimensions of development in a society or country. While sustainable NRM as an objective has been mentioned by countries across income groups, few countries that mentioned sustainable development/sustainability as an objective belong mostly to high and medium income groups. This pattern of response is probably an indication that there may be different levels or degrees of understanding or appreciation of the issues surrounding sustainability with higher income countries having a more wider perspective than lower income countries. In reality, lower income resource scarce countries probably need to appreciate the wider perspective of sustainable development as much as the high income countries.

Productivity improvement has been mentioned as the objective by 13 countries mostly belonging to medium and low income groups. This is understandable because in such countries productivity is lower than in the high income countries and productivity improvement is a key pathway to assure food security, increase income and reduce poverty.

Competitiveness and market development have been grouped together because these are related. Well-developed markets facilitate and promote competitiveness. This objective has been mentioned by seven countries, mostly belonging to high and medium income groups perhaps because market and trade, especially international trade in a globalized environment, play key roles in their national economies.

Poverty alleviation, inclusive growth, rural income generation, improving farm income, viability of farming and protection of smallholders have been mentioned as objectives by 14 countries

belonging to medium and low income groups with some overlap in a few cases. Though expressed in different ways, these objectives are fairly overlapping focused on improving income and living standard of rural people. On the other hand, eight countries, five belonging to high income group, mentioned rural development, rural economic growth, promotion of agricultural industry and rural industry for economic development as important objectives. These objectives are of a different nature than the objectives of rural development and rural livelihood in lower income countries. In the high income countries, in order to encourage the small number of rural population to stay in the countryside, they need to be supported with appropriate industries and infrastructure to enjoy a reasonable standard of living. On the other hand, in the low income countries, a significant share of the population still live in rural areas, many of them are poor and small farmers, and agriculture sector still plays a major role in the economy especially in the rural economy (Table 1). So, for such countries, the objective of rural development is to create opportunities for rural people, especially the poor engaged in smallholder farming or other occupations, to get out of poverty. Therefore, different strategies will be required to achieve rural development objectives under high and low income countries.

Only three countries belonging to low and medium income groups mentioned employment generation as a policy objective. In theory this objective could be merged with other objectives focused on rural income generation and rural development but there is some merit in keeping it separate as remunerative employment - irrespective of location or sector - is usually a pathway to get out of poverty.

Major Strategies Adopted for Implementing Policies

The nature of responses varied widely between countries. Some responses were clearly stated and included a few items while some other responses indicated that there was some confusion about the meaning of policy, strategy and tools or instruments for policy. In the latter cases, some listed items would qualify more as tools/instruments/activities rather than as strategies. In any case, efforts were made to aggregate all provided information into meaningful groups. It appeared that the strategies pursued to implement adopted policies/policy objectives could be divided into two broad groups: one related to research and technology transfer and the other related to building organization, market development, and regulations (Table 3). Within the research and technology transfer group, there are several sub-categories. Innovation in technology transfer and support services has been the most widely used strategy in all income groups even though it can be reasonably assumed that the mechanisms applied might be different across the groups because of differences in the level of development, institutional and technological capacity and the structure of the agriculture sector with smallholder dominance in low income countries and large scale enterprises in high income countries. For example, for productivity improvement and solving problem of labour shortage due to aging of farmers, Japan is considering the use of robotics while low income countries are considering reduction of yield gap and improvement of factor productivity perhaps through conventional means of technology transfer.

Alongside innovation in transfer of existing knowledge and technology, research and development for generation of new knowledge has also been widely used as a strategy, especially in the medium and low income countries. Some countries belonging to medium and low income groups mentioned using multi-disciplinary/multi-institutional/systems research as a strategy while

Table 3. Main strategies adopted for implementing agricultural policies/policy objectives in countries in Asia and the Pacific by income level

Strategies	Number of countries responding by income level			
	High N = 5	Medium N = 7	Low N = 10	All N = 22
Innovation in technology transfer/support services	5	6	4	15
Research and development, generation of new knowledge	2	5	7	14
Multidisciplinary/multi-institutional/integrated systems research	–	3	3	6
Need based/demand driven research	2	1	1	4
Strengthen climate risk management/NRM capacity	4	1	6	11
Develop infrastructure/organization	4	3	3	10
Develop agri-food industry/value chain/market	2	2	5	9
Create fairer farm business/competitiveness	2	–	1	3
Strong IPR/regulatory science/policy advocacy	1	3	1	5
Link urban and rural development/promote land management	1	1	2	4

Source: Appendix A2

a few others, half of them in high income group, mentioned using need based or demand driven research that reflected the priorities of farmers, industries and consumers.

Strengthening capacity for climate risk management and natural resource management has been used by 11 countries mostly belonging to high and low income groups. However, actual implementation of this strategy might take different forms in high vs low income countries because of differences in the nature of problems. For example, it is generally well known that nutrient loading, water pollution and high level of greenhouse gas emission are some of the major problems in high income countries while soil degradation, loss of vegetation and water pollution are some of the major problems in the low income countries. So different strategies and tools and relevant capacities are required to deal with these problems in different contexts.

Ten countries mentioned infrastructure and organizational development as strategies, 12 countries mentioned development of market, value chain and steps for fairer competition as strategies and five countries mentioned strong intellectual property rights, regulatory measures and policy advocacy as strategies. Together these strategies were frequently mentioned by high and low income countries and somewhat less frequently by medium income countries. Four countries, two of them in low income group, mentioned linking urban and rural development, and promotion of land management as adopted strategies.

Specific Focus

It was expected that in order to answer this question, the respondents would consider all the four domains (commodities, enterprises, systems and research approaches), then identify focus areas covering one or more or all domains. Essentially, a short rather than a long list of areas

of focus was expected. But responses were variable – some countries provided a short list which was self-explanatory, others provided a longer list, indicating that perhaps there were really no focus areas.

Aggregation of all information suggested that the most frequently mentioned focus area is global warming/ climate change/ natural resources management/ environment (Table 4). Fourteen countries that reported these areas mentioned either one or more of these related areas and they are evenly distributed across income groups indicating that these are truly common problems in the region, though the actual form and intensity of the problems may differ between countries, between income levels and ecologies. Other focus areas mentioned in descending order of importance include frontline research and innovation, strengthening market/value chain/competitiveness, stability of food supply/commodity supply, establishment of advanced facilities/services/infrastructure, problems of producers/industry, and policy/governance/advocacy. Countries that mentioned these focus areas are fairly evenly distributed across the income groups indicating that at the theoretical or thematic level, there is some degree of convergence of areas of policy and research focus among the countries in the region across income levels though actual nature of the problems and the way they are being addressed may vary across countries and income groups.

It needs to be mentioned that in the country responses, a specific focus area may have been described in more precise or specific manner reflecting country specific situation. For example, Japan mentioned ‘R&D for promptly solving problems faced by the producers’ as a focus area in which strong industry-academia-government collaboration is promoted to link seeds for cutting-edge technologies, such as information communication technology (ICT) and robot technologies, to the value chain of domestic agricultural, forestry and fisheries products. Another focus area is aging and decrease in number of workers in rural areas, leading to weakening of the production base of agriculture, forestry and fisheries industries. Hence, the plan is to transform these industries into the advanced ‘knowledge and information industries’ and make

Table 4. Specific focus areas covering commodities, enterprises, systems, and research approaches in countries in Asia and the Pacific by income level

Specific focus areas	Number of countries responding by income level			
	High n = 5	Medium n = 7	Low n = 10	All N = 22
Global warming/climate change/NRM/environment	3	4	7	14
Frontline research and innovation	3	4	5	12
Strengthen market/value chain/competitiveness	3	2	6	11
Stable food supply/commodity supply	1	4	5	10
Advanced facilities/services/infrastructure	1	3	4	8
Problems of producers/industry	2	4	2	8
Policy/governance/advocacy	2	2	2	6

Source: Appendix A3

them more attractive to young people. This would lead to continued stable supply of quality food while improving the food self-sufficiency ratio. Taiwan also mentioned similar problems due to ageing of rural farming population.

Major Priority Areas of Agricultural Research and Innovation for Development

Two major priority areas of agricultural research and innovation for development across income groups are sustainability/natural resources management/climate change and new technology/improved productivity mentioned by 19 and 17 countries, respectively (Table 5). Within the broad sustainability/NRM/climate change area, a range of issues have been mentioned - soil fertility, soil erosion, soil degradation in general, soil salinity and acidity, draught and soil moisture stress, flood, sea level/water level rise, water pollution, water scarcity and efficiency in use, loss of biomass and vegetation, loss of biodiversity, incidence of weather induced pests and diseases of plants and animals, degradation of ecosystems in general. Among these, specific priority areas vary between countries and income groups - some having a few of them, others having several or many. Moreover, different countries facing these problems may adopt different research strategies to address them. For example, Bangladesh is conducting research to develop salinity tolerant rice varieties for coastal areas prone to sea water intrusion and submergence tolerant rice varieties for flood prone areas.

Among the other less frequently mentioned major priority areas, only medium and low income countries mentioned market/value chain development and socioeconomics/policy/market research while some high income countries mentioned food supply for citizens/food safety, cost cutting innovations/competitiveness, technology for rural industries/rural R&D/farmer need based research,

Table 5. Major priority areas of agricultural research and innovation for development in countries in Asia and the Pacific by income level

Priority areas of research and innovation	Number of countries responding by income level			
	High n = 5	Medium n = 7	Low n = 10	All N = 22
Sustainability/NRM/climate change	4	6	9	19
New technology/improved productivity	2	6	9	17
Market/value chain development	–	3	4	7
Socioeconomics/policy/market research	–	1	3	4
Food supply for citizens/food safety	2	1	1	4
Technology for rural industries/rural R&D/farmer need based research	3	–	1	4
Cost cutting innovations/competitiveness	2	1	–	3
Innovation in use of research output/technology	1	2	–	3
Contribution to global issues such as climate change/more effective aid investment in agriculture	3	–	–	3

Source: Appendix A4

innovation in the use of research output/technology, and contribution to global issues such as climate change. Under each of the above broad categories individual responding countries mentioned a few to a large number of specific areas reflecting local situations, which are widely different. However, a fairly clear distinction between high vs low and medium income country priority research areas emerge. While productivity improvement, market/value chain development and associated socioeconomic/policy/market research are high priorities in low and medium income countries, innovation in the application of knowledge/technology, innovation for cutting cost to enhance competitiveness and innovations for rural industries and farmer needs are major priorities in high income countries.

Major targets set to be addressed through agricultural development

In the questionnaire, targets set to be addressed directly or indirectly through agricultural development were illustrated with the following examples:

- Food and nutritional security (by increased agricultural productivity and production; genetic enhancement, and/or value-added processing of foods to mitigate malnutrition and under-nutrition)
- Poverty reduction (by enhancing farmers' income)
- Reduced environmental degradation (by adopting measures such as biocontrol, bioenergy, conservation agriculture, biosafety and other environmental safeguards/applications)
- Any other major target for inclusive growth and development

Further, it was clarified that target is a time bound number or figure or rate to be achieved. However, most respondents reported target in terms of issues/problems/areas without any time bound number perhaps because no time frame or date was mentioned for reporting target numbers. Eighteen, 17 and 12 countries mentioned three broad target areas, which are stable food supply/food security/food safety, sustainable development/natural resources management, and generation of new technology/improvement of productivity, respectively (Table 6). These three types of targets were mentioned evenly by three income groups. Nine countries, all belonging to medium and low income groups, mentioned poverty reduction/rural income generation as the target area. Only a few countries, mostly in high income group, mentioned competitiveness of agriculture/market performance, funding priority for rural R&D/improvement of R&D capacity, and improvement of aid effectiveness as targets.

Within each of the above target areas, responding countries listed various specific targets numbering a few to many. The actual meaning or implication of a specific target area may be different in different income groups or countries. Some examples are given for illustration.

Japan mentioned that its plan is to lower her food self-sufficiency target to a more attainable ratio and establish a new indicator, 'food self-sufficiency potential (*Shokuryo Jiky uRyoku*)' to evaluate latent food production capability. The new target for the calorie-based food self-sufficiency ratio has been lowered from the previous 50 per cent by 2020 to 45 per cent by 2025 (actual: 39% in 2013). Japan also mentioned that in its research plan, there are 21 key targets set for realizing models of efficient and stable farming and for promptly solving production and distribution problems in different fields.

Table 6. Major targets set to be addressed directly or indirectly through agricultural development in countries in Asia and the Pacific by income level

Targets set to be addressed through agricultural development	Number of countries responding by income level			
	High n = 5	Medium n = 7	Low n = 10	All N = 22
Stable food supply/food security/food safety	4	5	9	18
Sustainable development/NRM	3	6	8	17
Generate and use new technology/improve productivity	2	4	6	12
Poverty reduction/rural income generation	–	4	5	9
Competitiveness of agriculture sector/market performance	2	1	2	5
Funding priority for rural R&D/improve R&D capacity	3	–	–	3
Improve aid effectiveness	1	–	–	1

Source: Appendix A5

Australia mentioned several specific target areas under strengthening rural R&D, and another set of specific targets for improving aid effectiveness to create impact both on the aid beneficiary countries as well as domestic agriculture.

Thailand mentioned 10 specific target areas most of which have been included in the three top groups mentioned above. However, no specific number or figure or rate against any target area has been mentioned. Vietnam mentioned that the strategy is to develop science and technology in agriculture and rural development as a key driving force for industrialization and modernization of agriculture and rural development; raising contribution to the value-added agriculture from 40 per cent in 2015 to 50 per cent in 2020; contribution of high technology products in agriculture rising from 15 per cent in 2015 to 35 per cent by 2020. Then several more specific targets to achieve the above have been mentioned.

India reported that there are various projections of increase in demand for food commodities in the country. One scenario suggests seven per cent growth rate in national GDP, though the demand for food grains will only grow by about 50 per cent, and the rise in demand for fruits, vegetables and animal products will be more spectacular, the range being 100-300 per cent. Achieving these will require high productivity increase, especially total factor productivity (TFP), and one-third of TFP must contribute to the agricultural growth. Food safety is an integral part of food security. Twelve specific target areas have been mentioned by India to achieve food security and safety without mentioning any number or figure or rate.

Nepal has mentioned targets with number or figure or rate on several policy goals like food self-sufficiency ratio, poverty incidence, land and labour productivity, soil degradation, agribusiness share in Ag GDP and a number of others. Bangladesh mentioned several broad target areas and specific target areas under each but without any time bound number or figure or rate. On the other hand, Bhutan mentioned targets in terms of area, yield and output of different enterprises and also target in terms of number of technologies/innovations to be delivered or released. Similar examples can be given with respect to other countries.

Thus, it appears that information provided under this topic is generally complementary or consistent with information provided on policy objectives, specific focus areas and priority research areas in so far as topics/themes/issues are concerned though the specific priority problem/area within a broad theme may differ between countries and income groups. And most did not mention about quantification to indicate the target.

Institutional Roles, Responsibilities and Partnerships

The type of information expected on this topic included types of agencies/organizations doing different kinds of research and kind of partnership/collaboration that has been adopted. Types of agencies/organizations could be public sector (state/province/central), private sector, Civil Society Organizations, Farmers' Organizations, regional and international programmes.

The responses show that all the countries have national level research institutions, and most also have provincial or local government level institutions (Table 7). It is not clear whether in some cases local/provincial branches of any national institution have been treated in the same way as autonomous local/provincial institutions. Fourteen countries reported having universities and agricultural colleges doing research. There may be under reporting in this regard as apparently in some countries universities are not included in the definition of NARS, hence they have been left out even though they undertake important research.

Only eight countries, mostly in high and medium income groups, reported that private industries undertake agricultural research and innovation activities. On the other hand, 10 countries, also mostly in high and medium income groups, reported having NGOs/farmer associations/collectives doing agricultural research and innovation activities. This pattern seems reasonable because, in low income countries, large scale agricultural production and processing industries may be only a few and they are not matured enough to undertake or sponsor significant research and innovation activities. A few NGOs/collectives and farmer associations in low income countries may be involved in research activities *per se* other than routine development and knowledge dissemination activities.

Table 7. Types of institutions for agricultural research and innovation for development in countries in Asia and the Pacific by income level

Types of research institutions	Number of countries responding by income level			
	High n = 5	Medium n = 7	Low n = 10	All N=22
National research institutions	5	7	10	22
Provincial/local government research institutions	4	5	8	17
Universities/colleges	3	4	7	14
Private industry	4	3	1	8
NGO/farmer associations/collectives	4	4	2	10

Source: Appendix A6

On partnership, the questionnaire basically sought information on the nature of inter-institutional partnership. The responses are of varied nature and not precise enough to undertake any quantitative aggregation. However, based on the narratives and specific information in some country reports (Appendix A6), a few general observations on the nature of partnership can be made.

First, inter-institutional partnership appeared to be strong in the high income countries, emerging or medium in medium income countries and low in low income countries. Such a pattern seems consistent with reported strategies for implementation of adopted policies discussed earlier. The high income countries reported strategies that are more focused on addressing problems and needs of the farmers, consumers and industry based on consultation with those stakeholders, while the strategies reported by low and medium income countries for implementing their policies appeared to be more generic and supply driven in nature.

Second, only six countries - two from high income, one from medium income and three from low income groups - reported having good or strong connection with policy in designing and implementing research and innovation. In reality, such linkage of varying degrees may exist in other countries but did not come through explicitly in the responses.

Third, all the high income countries except New Caledonia are international donors of varying degrees. Each has partnership with several medium and low income countries in the region and elsewhere through technical aid projects. New Caledonia is a beneficiary of French support. It has been mentioned earlier that one of the focus target areas of Australia is to improve its aid effectiveness through making better impact on the recipient country as well as make it beneficial for domestic economy. On the other hand, nearly all the medium and low income countries have bilateral and/or multilateral aid funded projects of one kind or another.

Fourth, in addition to bilateral/multilateral partnership, link and partnership with centres of the Consultative Group on International Agricultural Research (CGIAR) system has special significance. For over the last five decades, the system has played a key role in addressing problems of poverty, hunger, malnutrition, and aspects of natural resources and ecosystems management in the developing countries through technology, institutional and policy research. The system is mandated to generate global public goods for the benefit of the poor in the developing countries. Out of the five high income countries in the Asia-Pacific region, Australia, Japan and Korea are donors to the system and Taiwan hosts the headquarters (HQs) of The World Vegetable Centre (AVRDC). Among the medium and low income countries, Philippines, Malaysia, India and Sri Lanka hosts the HQs of International Rice Research Institute (IRRI), World Fish, International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) and International Water Management Institute (IWMI), respectively. China, Thailand, India, Bangladesh and Iran are donors to the system. And nearly all the medium and low income countries, including those with HQs of a centre, have collaborative projects with one or more CG Centres (Appendix A6).

Financial Investments and Infrastructure

This question was expected to generate brief information on level of investment, important infrastructure related to research institutions and agricultural universities, and available human resources. Responses to these questions were highly incomplete and inadequate for aggregation

for any meaningful analysis. However, based on some preliminary information that is summarized in appendix A7, a few observations can be made.

First, with the exception of Australia, the government seems to be the primary source of funding for agricultural research and innovation in all the countries. Information on the share of government in total expenditure on research and innovation is not available. Only one or two countries provided some general information. In China, 90 per cent of research expenditure comes from the government - both central and provincial governments. Remaining 10 per cent comes from collectives, and more recently from private industries. In India, agriculture is a state government subject so major share of the research budget comes from the state governments but the central government has many countrywide projects and also supports state governments on priority issues and projects. Some large NGOs have research programmes. In Bhutan, 63 per cent of research budget comes from the government, the rest through donor projects.

In recent times, Australia has developed a unique funding mechanism for agriculture and rural development. It is implemented through a partnership between the government, the industry and producers through the Rural Research and Development Corporation (RDC). The RDCs are funded primarily by statutory R&D levies (or charges) on various commodities, with matching funding from the Australian Government. To expand Australia's rural R&D efforts, the government matches expenditure on eligible R&D, generally up to 0.5 per cent of the determined industry gross value of production. RDCs are accountable to both industry and government. Funding is allocated on the basis of performance and accountability. Also, aid-for-trade is a major criterion for research budget allocation - any research that has potential to increase trade is supported.

However, overall, the lack of detailed information on funding allocation and investment may be partly explained by problems in defining what constitutes investment in research and innovation. Different countries may define this differently in their national budgets. Some countries may also include expenditure on extension/dissemination in research and innovation budget, others may not.

Secondly, only China, Bangladesh and Papua New Guinea provided the information that their agricultural research expenditure is equivalent to 0.5-0.6 per cent, 0.67 per cent and 0.60 per cent of agricultural GDP, respectively against two per cent of AgGDP recommended for developing countries. Out of China's agricultural research budget, 50 per cent is allocated to crops, and six per cent to livestock. Nepal reported that spending on research as a share of the agriculture sector budget has declined from 10-12 per cent in the past to about eight per cent at present. Generally speaking, agriculture research and innovation is under invested in the low and medium income countries.

Third, several countries have reported the number of scientists engaged in agricultural research and innovation (Appendix A8). But, these are possibly incomplete and underestimates because some countries mentioned only staff employed by government institutions leaving out universities/colleges, NGOs and private sector, even if they may be small in number. Because of differences in size of the country, the economy, and level of development, these absolute numbers are also not directly comparable without some common denominator.

However, there are a few important observations about the quality of the research staff in some of the reporting countries. In Korea, Taiwan and Japan, 72, > 40 and 38 per cent of research staff, respectively, have Ph.D. degrees compared to less than 10 per cent in most low income countries. In Pakistan, only 18 per cent of staff in government research institutions are Ph.Ds. compared to over 45 per cent in universities. Nepal reported that Ph.D. degree has no additional value in the system in terms of salary or promotion criteria, so there is either lack of interest in higher degrees or if the degree is acquired, it is difficult to retain the Ph.D. holders as they usually leave to join better paid NGOs/development agencies. China reported that about 50 per cent of all research staff in the country is employed in the agriculture sector. Some countries mentioned that they do not have adequate personnel in terms of number and types of skill required, though no actual figures were provided. Some mentioned that staff are aging as training for replacement is inadequate. In Japan about 15 per cent of research personnel are woman. No other country has provided this information.

Thus, the preliminary information available suggests that agriculture research and innovation is heavily under budgeted and under-invested, and the number of available personnel is inadequate in many low and middle income countries and those available are not adequately skilled or qualified.

Major Challenges and Opportunities

Responses on perceived major challenges and opportunities are summarized in table 8. It appears that climate change, environmental problems and their consequences are perceived

Table 8. Major challenges and opportunities facing the countries in Asia and the Pacific by income level

Major challenges and opportunities	Number of countries responding by income level			
	High n = 5	Medium n = 7	Low n = 10	All N = 22
Climate change/environmental problems	2	6	5	13
Aging/declining rural population/rural transformation	3	1	–	4
ICT/biotechnology/other advanced technology	2	1	1	4
Food supply/security	2	2	–	4
Food safety	2	1	–	3
Maintain farm income	1	1	–	2
Poverty/hunger/malnutrition	1	2	–	3
Productivity improvement/value addition	1	2	3	6
Yield gap/use of knowledge	–	1	3	4
Market development/competitiveness	1	2	4	7
Inadequate/aging research staff	1	2	6	9
Inadequate/reduced funding for research	–	2	5	7
Inadequate/aging labs/facilities for research	–	2	4	6

Source: Appendix A7

as the major challenge by 13 countries spread evenly across income groups. In reality, the exact nature of the challenges may vary between countries. Other perceived challenges are of a varied nature and only a few countries mentioned each of these. The challenges can be divided into two broad categories - one related to technology for productivity improvement and market development, the other related to research staff, facilities and laboratories.

However, there is a general pattern of the responses. It appears that for some high and medium income countries, the main perceived challenges are aging and declining rural population, generation of ICT/biotechnology and other advanced technology to deal with productivity and other problems, food supply, food security and food safety, and maintenance of farm income to retain agriculture as an attractive occupation. It is interesting to note that some high income countries also perceive poverty, hunger, malnutrition as challenges. For example, Australia's perception of the challenges has a domestic as well as an international dimension as below:

“Agricultural productivity must increase if the world is to continue to feed, clothe and support a growing population from fixed or shrinking land and water resources. Research is an essential driver of productivity growth in agriculture, and well-managed agricultural research can deliver innovative, lasting solutions that bring sustainable change to those who need it most. Research also provides new knowledge, technologies, capacities and policies to deal with rapidly changing contexts, such as increased globalization of the agriculture and food-sector markets, new and emerging food safety and quality issues, changing diets, and the rapid rise of supermarkets and consolidation within food supply chains.

Investment in agricultural research for development is a highly effective option for reducing poverty for a relatively large beneficiary population: net sellers of food receive greater income through increased production, while net buyers have greater access to, and possibly pay lower prices for, food. This aligns with and supports Australia's foreign policy objectives—regional prosperity and security, global peace and an open international economic system.

The inseparable challenges of poverty, malnutrition and hunger remain among the world's greatest challenges. Australia, as a wealthy nation with a strong heritage of agricultural innovation, has an active role to play in overcoming these challenges by building mutually beneficial agricultural partnerships with developing countries.”

It is in the above context that problems of poverty, hunger, malnutrition, gender equality feature as challenges in Australia's perspective.

Paradoxically, the above challenges are either not mentioned by low income countries or mentioned very infrequently perhaps because poverty, hunger, malnutrition and gender inequality are part of their life, so for them the challenges are rather to find ways to overcome them. Hence, for some medium and low income countries, the main perceived challenges are productivity improvement and value addition, reducing yield gap and use of knowledge for that purpose, market development and improvement of competitiveness, inadequate and aging research staff, inadequate and reduced funding for research, inadequate and aging facilities and laboratories.

Beyond this general classification of challenges, some countries mentioned specific challenges facing them. For example, Japan mentioned post-earthquake rehabilitation in northern Japan as a major challenge. Nepal mentioned, balanced budget allocation between sectors and regions as a challenge perhaps because of the newly adopted constitution with provisions for decentralization of governance. Some countries mentioned land scarcity and loss of land to urban development as a major challenge.

Few countries mentioned specific opportunities perhaps because the identified challenges implicitly indicate opportunities for development as well as potential for cooperation and partnership, especially on those challenges which are broad and common to several countries, if not all. Some countries mentioned specific opportunities, for example, Bhutan intends to develop organic farming as a mechanism to promote trade given its natural and until now undisturbed pristine environment.

Looking Ahead (short and medium-term)

The responses to this question indicate that all the countries have ongoing plans and programmes built on past achievements to address future challenges (Table 9). There is no general pattern of the plans - some are operating within the framework of five year plans or on longer term strategic plans or on indicative plans operationalized through annual budgets or a combination of the above. Some countries emphasized more stakeholder engagement in future planning, some mentioned specific issues for focus such as agriculture and human health and agriculture and mining, some mentioned more collaboration with CG centres while others expected more

Table 9. Looking ahead - short and medium-term plans

Level of income and country	Short and medium-term plan in view
High income	
Australia	More effective monitoring and emphasis on agriculture and human health and agriculture and mining
Japan	Existing road map to be updated with stakeholder consultation i.e. government, industry, academia
Korea, Republic of	Several specific plans are in action
Taiwan	Usually research and development are planned in 2-6 year cycles
New Caledonia	A stakeholder consultation based problem identification and plan is underway
Medium income	
Malaysia	Tenth Malaysia Plan period (2010-2015) will continue to implement the National Agrofood Policy (NAP4), 2011-2020
China	Both short and long-term projects that address priority national or local government issues are funded through annual budget mechanism
Thailand	More proactive engagement with ASEAN for AEC is envisaged
Islamic Rep. of Iran	The national research system will be reformed to adopt a more holistic approach to research for development during 6th plan 2016-20

Contd...

Table 9 (Contd.)

Level of income and country	Short and medium-term plan in view
Fiji	Fiji 2020 Agriculture Sector Policy Agenda Modernizing Agriculture prepared in 2014
Sri Lanka	No formal road map, R&D guided by 2016-18 production plan with national policy goals stated earlier
Philippines	Will continue to implement industry specific S&T programme as R&D is vital for development
Low income	
Bhutan	Progress is mostly on target, short-term goal is to implement current plan activities, long-term is to reprioritize based on experience
Papua New Guinea	Implementation of current strategy and projects and efforts to increase funding planned
Vietnam	Agriculture sector restructuring plan to 2020 is underway to make research more systematic and effective, and increase level of investment
Lao PDR	Recognize need to mobilize more funds, increase research collaboration with domestic and outside partners
India	Continue implementing current plans and strategy and strive to increase level of investment in agricultural research
Pakistan	More effective participation of stakeholders and increase in funding level envisaged.
Bangladesh	Implementation of current strategies planned within the framework of 7th five year plan and country investment plan adopted earlier
Cambodia	Recognize need to develop national agricultural research plan
Nepal	More collaboration with CG centres planned with possibility to increase outside funding
Afghanistan	No formal road map but intends to build research capacity in its various dimensions

Source: Country reports for APAARI High Level Policy Dialogue

interaction within regional bodies such as Association of South East Asian Nations (ASEAN), and some envisaged restructuring national research system. This information is to some extent helpful to understand priorities and current thinking about preparedness and gaps to address ensuing challenges.

Summary and Recommendations

Summary of findings

Analysis of the information received from the 22 countries having revealed that major policies that have implications for agricultural research in these countries include food security/food supply, productivity improvement, sustainable natural resources management, sustainable

development or sustainability, competitiveness and market development, rural development, generation of income and rural livelihood in its various facets. However, specific meaning and implication of each of the above policy/policy objective vary across income groups and countries.

Among the strategies adopted to implement the policies/policy objectives include two broad categories: one is related to research and technology transfer and the other is related to building organization, market development, and regulations. Within the research and technology transfer related strategies, there are several sub-categories such as innovation in technology transfer and support services, research and development for generation of new knowledge, multi-disciplinary/multi-institutional/systems research, need based or demand driven research that reflect the priorities of farmers, industries and consumers, and strengthening capacity for climate risk management and natural resource management. There are differences between countries and income groups in terms of the strategies adopted.

Among the main focus areas for research and development reported, top on the list is a broad area encompassing global warming/climate change/natural resources management/environment which is common across income groups. Other focus areas include frontline research and innovation, strengthening market/value chain/competitiveness, stability of food supply/commodity supply, establishment of advanced facilities/services/infrastructure, problems of producers/industry, and policy/governance/advocacy. There are differences between income groups in terms of importance of different focus areas.

Among the main priority research areas, sustainability/natural resources management/climate change and new technology/improved productivity are the most frequently mentioned areas across all three income groups. Among the other less frequently mentioned major priority areas, only medium and low income countries mentioned market/value chain development and socioeconomics/policy/market research, while some high income countries mentioned food supply for citizens/food safety, cost cutting innovations/competitiveness, technology for rural industries/rural R&D/farmer need based research, innovation in the use of research output/technology, and contribution to global issues such as climate change. Within each of the above priority areas, there are more specific areas and their nature varies across income groups and countries.

Agricultural research and innovation is primarily a public sector activity in nearly all the countries; in high income countries, private sector, NGOs and farmer associations also play some role. Precise information on levels of investment and their sources were not available. However, available information suggests that agricultural research is under-funded and under-invested in relation to its potential contribution to the economies. In the low income countries, laboratories, facilities and personnel are inadequate, of poor quality and aging.

Among the major challenges facing the countries in the region, climate change, environmental problems and their consequences is perceived as the most important area across all income groups. Other perceived challenges fall into two broad categories - one includes technology for productivity improvement and market development, the other includes research staff, facilities and laboratories. However, there is a general pattern of the responses. For some high and medium income countries, the main perceived challenges are aging and declining rural population,

generation of ICT/biotechnology and other advanced technologies to deal with productivity and other problems, food supply, food security and food safety, and maintenance of farm income to retain agriculture as an attractive occupation. On the other hand, for some medium and low income countries, the main perceived challenges are productivity improvement and value addition, reducing yield gap and use of knowledge for that purpose, market development and improvement of competitiveness, inadequate and aging research staff, inadequate and reduced funding for research, inadequate and aging facilities and laboratories.

All the countries have ongoing plans and programmes built on past achievements to address future challenges. There is no general pattern of the plans - some are operating within the framework of five year plans or on longer term strategic plans or on indicative plans operationalized through annual budgets or a combination of the above. Some countries emphasized specific areas of action in the future e.g. more stakeholder engagement in future planning, restructuring national research system, more collaboration with CG centres or within regional bodies such as ASEAN.

Some issues deserving strong consideration

Because of the design of the questionnaire, some issues perhaps did not come through or did not come through as strongly as they deserved to be considered. A brief account of some such issues is given below:

- Alignment with the sustainable development goals (SDG) agenda
- Structural change in the agriculture sector in the region
- More investment but where and how?
- Collaboration within regional bodies

Alignment with the sustainable development goals (SDG) agenda

The SDGs have been adopted at the United Nations General Assembly only recently and all the member countries are committed to the agenda (United Nations 2015). Among the eight Millennium Development Goals (MDGs) that preceded SDGs, only Goal 1 (eradication of extreme poverty and hunger), and Goal 7 (ensure environmental sustainability) had implications for the agriculture sector, especially for R&D. The set targets and indicators for Goal 1 indicated that the linkage with agriculture was somewhat indirect. The targets and indicators for Goal 7 indicated that awareness building and appreciation about climate change was the main objective. Goal 3 (promote gender equality and empower women) was primarily focused on equality in school enrolment, wage employment and political representation. Even then, as time passed, the potential role of agriculture in addressing MDG Goals 1, 7 as well as 3 increasingly, came to the forefront of discussion, which partly contributed to the shape of the SDG agenda.

The SDG agenda is a plan of action for people, planet, dignity and prosperity and there is also expectation to strengthen universal peace and larger freedom. Among 17 SDG Goals, the following have direct and indirect implications for agriculture, climate change and the environment:

Goal 1 : End poverty in all its forms everywhere

Goal 2 : End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 5 : Achieve gender equality and empower all women and girls

Goal 6 : Ensure availability and sustainable management of water and sanitation for all

Goal 8 : Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 12 : Ensure sustainable consumption and production patterns

Goal 13 : Take urgent action to combat climate change and its impacts

Goal 14 : Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15 : Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 17 : Strengthen the means of implementation and revitalize the global partnership for sustainable development

It is recognized that implementation of the agenda will require resources, investment, technology, infrastructure and institutions including rules and regulations, partnerships - local, regional and global - and coordination and harmonization. It is recognized that each country has primary responsibility for its own economic and social development and that the role of national policies and development strategies cannot be imposed from outside. At the same time, national development efforts need to be supported by an enabling international economic environment.

In that context, it is important that national agricultural research and development plans consider the importance of alignment with the SDG agenda. From the perusal of country reports, it appears that the major policies, strategies, focus areas and priority research areas contain elements that are consistent with the SDG agenda. But, they are not well-expressed and some aspects may be missing. So, more systematic alignment needs to be made.

One possible approach to deal with this is to take the relevant SDG goals, associated targets and indicators, and see how current national agricultural policies, strategies, priorities fit the SDG framework, what elements are missing and then see how missing elements can be addressed. If all individual countries adopt the same approach, a coherent bigger picture will automatically emerge.

Prospective structural change in the agriculture sector in the region

It was mentioned in the introduction that as economies develop, agriculture and rural populations decline in importance but livestock become more important because of changes in people's consumption behaviour propelled by income growth and urbanization. This is reflected in falling share of rural population, falling share of agriculture in GDP and rising share of livestock in

agricultural GDP. The relative importance of agriculture, livestock and rural population in countries with different income levels or levels of development has different implication for policies and strategies for agriculture, livestock and rural development.

The present livestock agenda for the rich and poor nations are polarized and quite different. In the developed countries, demand for livestock products, especially for meat, has levelled off, there is substantial efficiency gains in production due to advances in technology, major infectious diseases have been progressively controlled and food safety are major concerns. There is increased sensitivity to natural resources management and there is progressive improvement in management of antimicrobial use. On the other hand, in the poorer countries, demand for livestock products is growing rapidly, and livestock can be a pathway to improve nutrition, reduce poverty and contribute to development. But for that to happen, many challenges relating to genetics, feed, disease management and market development need to be addressed.

Globally, out of top ten agricultural commodities in value terms, half are livestock commodities like milk, chicken, pork, beef. Among the top ten commodities, maize and soybean are important crops and a significant portion of these are used as animal feed - hence connected to livestock. In various sub-regions of Asia, of the top five agricultural commodities, 2-3 are livestock commodities though the rank of a specific livestock commodity differs between the sub-regions. For example, in South Asia, milk is the top most commodity in value terms among all agricultural commodities, while in East Asia it is pork (Figure 1). So the historical pattern can also be observed in the sub-regions reflecting different levels of development. Among the high income countries, Australia is a major net exporter of livestock products. Among medium and low income countries in the region, only Thailand and India are net exporters of meat;

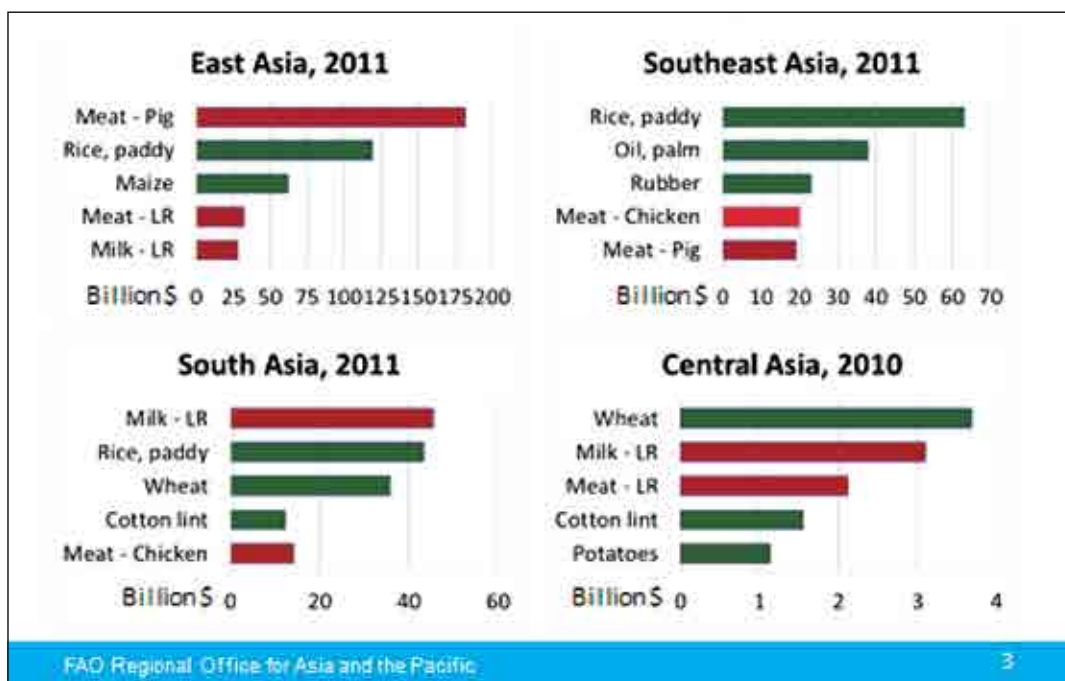


Figure 1. Top 5 agricultural commodities in value terms in all Asian sub-regions
(Source: Vinod Ahuja, personal communication)

all others are net importers of meat and milk. Various projections indicate that net import will increase if investment in livestock sector is not given due attention.

Although in some country reports, livestock has been included as a priority research focus area the significance and implication of the prospective structural change in the agriculture sector in the region with livestock becoming a more important activity in value terms in many countries has not been adequately captured. So this deficiency should be corrected and proper attention be given to the livestock sub-sector within broad agriculture sector to address SDGs.

More investment but where and how?

Though statistics on investment in R&D in agriculture and rural development was scanty in the country reports, it is recognized that the current level of investment is low and needs to be enhanced significantly. Rationale for increased investment in research is well known. Many studies have shown that rates of return on research expenditure are higher than returns in other fields of expenditure. Results of a more recent comprehensive study are reported by Yu *et al.* (2013). The authors have also studied impact of public expenditure on agriculture in China, Indonesia, Thailand and Uganda and found that expenditure on R&D has the highest impact followed by expenditure on roads, education, irrigation, extension, electricity, soil-water and health (Table 10).

However, high level of investment *per se* may not lead to high impact. Scientists involved in basic research may not embark on research with ‘application in mind’ or under the ‘nagging opportunities of need and use’². But at the end, knowledge generated by basic research is eventually applied for the welfare of people and society. For much of downstream adaptive and applied research, logic of uninhibited basic research just for generating knowledge does

Table 10. Rank of the impact of public spending on agriculture

Expenditure domain	China	Thailand	Indonesia	India	Uganda
R&D	1	1	1	1	1
Education	2	3	–	3	–
Roads	3	–	–	2	–
Telecommunication	4	–	–	–	–
Irrigation	5	4	2	4	2
Extension	–	–	3	–	3
Electricity	6	2	–	8	–
Rural development	–	–	–	5	–
Soil and water	–	–	–	6	–
Health	–	–	–	7	–

Source: Yu *et al.* (2013)

²See the following two statements quoted in Perry (2015) :‘Science can flourish only in an atmosphere of complete freedom, protected from the nagging importunities of need and use, because the scientist must travel where his imagination leads him’. Peter Medawar, Nobel Prize in Physiology or Medicine, 1960. ‘We do science best when we don’t have an application in mind’. Thomas Südhof, Nobel Prize for Medicine, 2013.

not apply. Many low income countries may have to prioritize where and how their limited research resources should be allocated to make impact and earn best possible returns for tax payers' resources.

Development is an outcome of the interplay of ideas, institutions and beneficiaries (Figure 2). Science and research fall in the idea category, institutions are primarily represented by policy and beneficiaries are represented by producers, consumers and industries who are end users of science and policy. If science and research community are to influence the course of development, they must be aware of its dynamics. Identifying emerging issues is a critical role for science in informing policy based on needs and demands of the end users. In the literature on science-policy-industry interface, there are several models of how researchers interact with policy and beneficiaries or end users to influence the pathways for development.³

There may not be any ideal model for demand-led teaching and research but the bottom line is that if researchers and teachers want to influence the policy and development process, they need to understand and respond to what is going on in the 'institutions' and 'beneficiaries' domains (right half in Figure 2). If the actors in the three domains remain in their silos and act without adequate interaction with each other (left half in Figure 2), every domain will end up using society's resources inefficiently or sub-optimally.

Donors to the CGIAR system now-a-days demand science quality, impact and innovation simultaneously, and also quickly. The CGIAR works in partnership with governments and institutions in medium and low income countries, institutions in high income donor countries

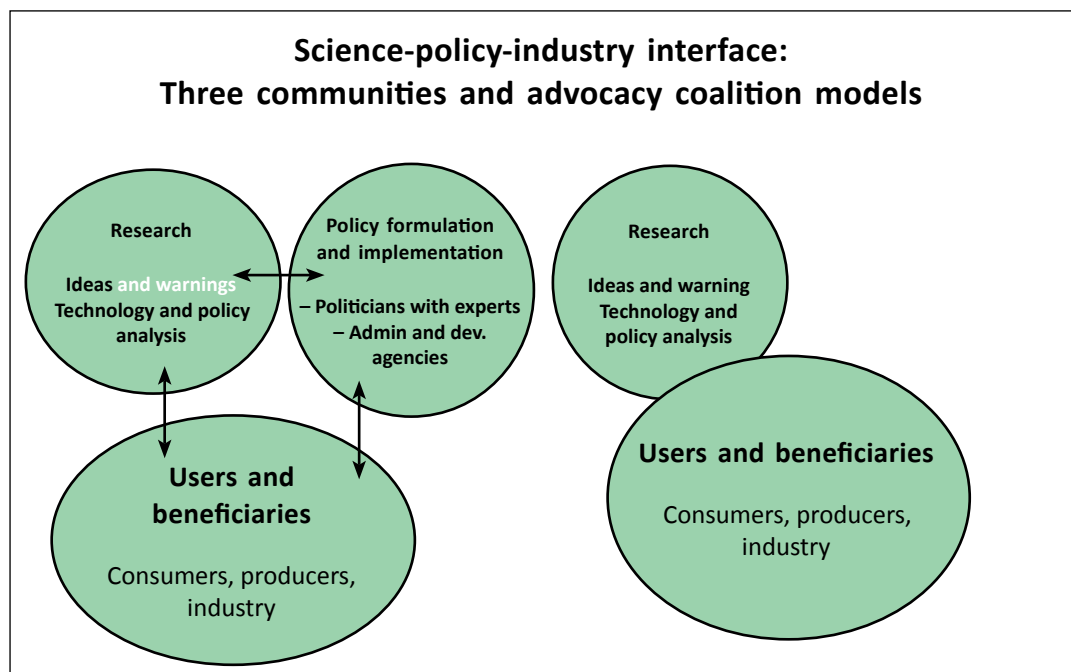


Figure 2. Science-policy-industry interface

³Based on a series of lectures by Mohammad A. Jabbar given at a FAO RAP sponsored training course on Building Policy Capacity Towards Sustainable Livestock Sector Development in Asia, held in Bangkok, Thailand on 26-30 July, in Vientiane, Lao PDR on 2-6 November, 2015 and in Bogor, Indonesia on 9-13 November, 2015.

and with other international organizations. Therefore, the responsibility for delivery of output is quite diffused and complex with problems of attribution. Yet without demand for quality and impact, the system would be less successful than it has been.

Donor demand for science quality, impact and innovation in bilateral technical aid projects implemented in low and medium income countries is less effective because in such countries national research systems often work under an environment of weak partnership and interaction between science, policy and end users. So, national research systems deliver less than their potential output and impact. There are enough knowledge and technologies on the shelf in low and medium income countries that can be packaged and put into use to solve existing problems while undertaking new research to generate new knowledge and technology. Overall impact can be enhanced in such countries if more expenditure on R&D is accompanied by more demand for performance, accountability and effectiveness of the expenditure. More effective interaction among science, policy and interests is likely to increase effectiveness and accountability of R&D expenditure. Such an approach will induce a change from a dominantly disciplinary structure of science and research to problem and results oriented multi- and interdisciplinary approaches to research and development.

Collaboration within regional fora

The ASEAN and the South Asian Association for Regional Cooperation (SAARC) are two major sub-regional bodies. The ASEAN Economic Community Blueprint (ASEAN 2013) envisaged a major role for the agriculture sector for creation of a single market and production base which is regionally and globally competitive. Among three strategic objectives for the Food, Agriculture and Forestry Sector to achieve ASEAN Economic Community (AEC) goals, the second one is 'to promote cooperation, joint approaches and technology transfer among ASEAN Member Countries and international, regional organizations and private sector'. A review of achievements up to 2014 showed that many activities have been successfully completed and others are in progress but there are a few, if any, inter-country collaborations in agricultural research that have been initiated and funded by the ASEAN. Only in donor funded multi-country projects, there is collaboration. Among the ASEAN Member states that sent country reports, only Thailand mentioned intention for more inter-country collaboration within ASEAN in the future.

SAARC agreement also envisages strong inter-country collaboration in science and technology, especially in the agricultural sector. But in reality not much progress has been made.

Both the bodies should consider possibilities of stronger inter-country collaboration in agricultural research and technology transfer to reduce cost by avoiding duplication, by achieving economies of scale in handling bigger issues by pooling together financial and human resources rather than trying to do bits and pieces individually due to inadequate scientific and financial resources.

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Appendix A1. Main agricultural policies and/or policy objectives having implications for R&D in countries in Asia and the Pacific

Income level and country	Food security/food supply	Sustainable development/sustainability	Sustainable NRM	Productivity improvement	Competitiveness/market development	Agric. industry/rural industry for economic development	Rural income/viability of farming/protect smallholders	Rural development/rural economic growth	Poverty alleviation/inclusive growth	Employment generation
High income										
Australia		✓		✓	✓	✓				
Japan	✓	✓				✓		✓		
Korea, Republic of				✓	✓		✓	✓		
Taiwan	✓		✓			✓				
New Caledonia	✓		✓	✓						
Medium income										
Malaysia	✓	✓	✓	✓	✓	✓	✓		✓	
China	✓			✓			✓	✓		
Thailand	✓	✓		✓	✓					✓
Islamic Rep. of Iran	✓		✓	✓			✓			
Fiji	✓		✓						✓	
Sri Lanka	✓		✓	✓						
Philippines	✓		✓		✓				✓	
Low income										
Bhutan	✓	✓	✓						✓	
Papua New Guinea	✓		✓	✓			✓			
Vietnam	✓			✓	✓	✓				
Lao PDR	✓		✓				✓		✓	
India	?		✓				✓		✓	
Pakistan	✓			✓					✓	✓
Bangladesh	✓		✓	✓						✓
Cambodia	✓		✓	✓						
Nepal	✓			✓						
Afghanistan	✓		✓	✓						

Source: Country reports for APAARI High Level Policy Dialogue

Appendix A2. Main strategies adopted for implementing agricultural policies/policy objectives in countries Asia and the Pacific

Income level and country	Need based/demand-led research	R&D/ generation of new knowledge	Innovation in technology transfer/ support services	Multi-disciplinary/ multi-institutional/ integrated systems research	Strong IPR/ regulatory science/ policy advocacy	Develop infrastructure/ organization	Create fairer farm business/ competitiveness	Strengthen climate risk/NRM capacity	Develop agro-food industry/ value chain/ market	Promote land management/ link urban-rural development
High income										
Australia		✓	✓			✓	✓	✓		
Japan	✓	✓	✓		✓	✓				
Rep. of Korea	✓		✓			✓		✓		
Taiwan			✓			✓	✓	✓		
New Caledonia			✓					✓		✓
Medium income										
Malaysia		✓	✓			✓			✓	
China		✓	✓					✓		✓
Thailand			✓	✓	✓					
Islamic Rep. of Iran		✓	✓	✓		✓				
Fiji			✓	✓					✓	
Sri Lanka	✓	✓			✓					
Philippines		✓	✓		✓	✓				
Low income										
Bhutan			✓			✓			✓	
Papua New Guinea			✓			✓			✓	
Vietnam								✓	✓	✓
Lao PDR		✓						✓		
India		✓		✓	✓			✓		
Pakistan		✓	✓	✓		✓				
Bangladesh		✓						✓		✓
Cambodia		✓							✓	
Nepal	✓			✓			✓			
Afghanistan		✓	✓					✓	✓	

Source: Country reports for APAARI High Level Policy Dialogue

Appendix A3. Specific focus areas covering commodities, enterprises, systems and research approaches in countries in Asia and the Pacific

Level of income and country	Problems of producers/industry	Global warming/ climate change/NRM/ environment	Strengthen market/ value chain/ competitiveness	Frontline research and innovation	Policy/ governance/ advocacy	Stable food/ commodity supply	Advanced facilities/ services/ infrastructure
High income							
Australia		✓	✓	✓	✓		
Japan	✓ Aging	✓					
Rep. of Korea			✓	✓		✓	
Taiwan			✓	✓			✓
New Caledonia	✓	✓			✓		
Medium income							
Malaysia			✓	✓		✓	✓
China		✓				✓	
Thailand	✓	✓	✓	✓			
Islamic Rep. of Iran	✓			✓		✓	
Fiji		✓				✓	✓
Sri Lanka	✓	✓			✓		
Philippines	✓			✓	✓		✓
Low income							
Bhutan							✓
Papua New Guinea			✓		✓	✓	
Vietnam		✓	✓	✓			✓
Lao PDR		✓	✓			✓	
India		✓	✓	✓	✓		✓
Pakistan		✓				✓	
Bangladesh		✓		✓			
Cambodia			✓	✓			✓
Nepal	✓	✓	✓	✓			
Afghanistan		✓				✓	

Source: Country reports for APAARI High Level Policy Dialogue

Appendix A4. Major priority areas for agricultural research and innovation for development in countries in Asia and the Pacific

Level of income and country	Food supply/food safety	Cost cutting innovations/competitiveness	Technology for rural industries/ farmer need based research	New technology/ improved productivity	Market/ value chain dev	Socio-economics/ policy/ market research	Innovation in use of research output/ technology	Sustainability/ NRM/climate change	Global issues/ effective aid investment
High income									
Australia			✓						✓
Japan	✓	✓	✓	✓				✓	✓
Rep. of Korea	✓	✓						✓	✓
Taiwan				✓			✓	✓	
New Caledonia			✓					✓	
Medium income									
Malaysia				✓			✓		
China	✓			✓	✓		✓	✓	
Thailand		✓			✓			✓	
Islamic Rep. of Iran				✓				✓	
Fiji				✓				✓	
Sri Lanka				✓		✓		✓	
Philippines				✓	✓			✓	
Low income									
Bhutan			✓	✓	✓			✓	
PNG					✓			✓	
Vietnam				✓	✓				
Lao PDR				✓				✓	
India				✓				✓	
Pakistan				✓				✓	
Bangladesh				✓		✓		✓	
Cambodia				✓	✓	✓		✓	
Nepal				✓		✓		✓	
Afghanistan	✓			✓					

Source: Country reports for APAARI High Level Policy Dialogue

Appendix A5. Major targets set to be addressed directly or indirectly through agricultural development in countries in Asia and the Pacific

Level of income and country	Stable food supply/food security/safety	Funding priority for rural R&D/improve R&D capacity	Poverty reduction/ rural income	Generate & use new technology/improve productivity	Competitiveness of agric. sector/ market development	Sustainable development/ NRM	Monitor aid effectiveness
High income							
Australia		✓					✓
Japan	✓			✓			
Rep. of Korea	✓			✓	✓	✓	
Taiwan	✓	✓			✓	✓	
New Caledonia	✓	✓				✓	
Medium income							
Malaysia	✓						
China				✓	✓	✓	
Thailand	✓		✓	✓		✓	
Islamic Rep. of Iran	✓			✓		✓	
Fiji			✓	✓		✓	
Sri Lanka	✓		✓			✓	
Philippines	✓		✓			✓	
Low income							
Bhutan	✓			✓			
Papua New Guinea	✓		✓			✓	
Vietnam	✓		✓		✓	✓	
Lao PDR	✓				✓	✓	
India	✓			✓			
Pakistan	✓			✓		✓	
Bangladesh	✓		✓	✓		✓	
Cambodia	✓		✓			✓	
Nepal	✓		✓	✓		✓	
Afghanistan				✓		✓	

Source: Country reports for APAARI High Level Policy Dialogue

Appendix A6. Types of institutions and their roles, responsibilities and nature of partnership for agricultural research and innovation for development in countries in Asia and the Pacific

Level of income and country	National research institutions	Provincial/ Local research institutions	Universities/ colleges	Private industry	NGO/farmer associations/ collectives	Stakeholder partnership strength	Good Link with policy	International aid/ partnership	CGIAR connection
High income									
Australia	✓	✓	✓	✓	✓	Strong	✓	Supplier	Donor
Japan	✓	✓	✓	✓	Minor	Strong	✓	Supplier	Donor
Rep. of Korea	✓					Strong		Supplier	Donor
Taiwan	✓	✓	✓	✓	✓	Strong		Supplier	AVRDC HQs
New Caledonia	✓	✓		✓	✓	?		French Support	
Medium income									
Malaysia	✓		✓	✓		Emerging		Anticipated	World Fish HQs
China	✓	✓	✓	✓	✓	Medium	✓	Beneficiary	Donor, CG projects
Thailand	✓	✓		✓	✓	High		Beneficiary	Donor, CG projects/AIT HQs
Islamic Rep. of Iran	✓	✓	✓	Anticipated	✓			Beneficiary	Donor, CG projects
Fiji	✓								
Sri Lanka	✓	✓						Beneficiary	IWMI HQs
Philippines	✓	✓	✓		✓	Medium		Beneficiary	IRRI HQs
Low income									
Bhutan	✓	✓	✓					Beneficiary	?
Papua New Guinea	✓	✓	✓			Anticipated		Beneficiary	?
Vietnam	✓	✓				Medium	✓	Beneficiary	CG projects
Lao PDR	✓		✓			Low		Beneficiary	CG projects
India	✓	✓	✓			Medium		Beneficiary	Donor, ICRISAT HQs
Pakistan	✓	✓	✓			Low		Beneficiary	CG projects
Bangladesh	✓	✓		✓	✓	Low		Beneficiary	Donor, CG projects
Cambodia	✓		✓			Low	✓	Beneficiary	?
Nepal	✓	✓	✓		✓	Low	✓	Beneficiary	CG projects
Afghanistan	✓	✓				Low		Beneficiary	CG projects

Source: Country reports for APAARI High Level Policy Dialogue. For CGIAR donor information <http://www.cgiar.org/who-we-are/cgiar-fund/fund-donors-2/>

Appendix A7. Major challenges and opportunities facing the countries in Asia and the Pacific

Level of income and country	Climate change & environment	Productivity & improvement/ value addition	Food supply/ food security	Food safety	Fill yield gap/use of knowledge	Poverty/ hunger/ malnutrition	Aging/ declining farming population/ rural transformation	Inadequate/ reduced funding	Inadequate/ aging labs/ facilities	Inadequate/ aging staff	ICT/ biotech/ other techs	Market/ Competitiveness	Maintain farm income
High income													
Australia		✓	✓			✓							
Japan	✓						✓				✓	✓	
Rep. of Korea				✓			✓						✓
Taiwan	✓		✓	✓			✓				✓		
New Caledonia										✓			
Medium income													
Malaysia	✓	✓	✓	✓									✓
China	✓						✓						
Thailand	✓										✓	✓	
Islamic of Rep. Iran.	✓							✓	✓				
Fiji									✓	✓			
Sri Lanka	✓	✓	✓			✓							
Philippines	✓				✓	✓		✓		✓		✓	
Low income													
Bhutan								✓	✓			✓	
PNG					✓			✓				✓	
Vietnam		✓						✓					
Lao PDR	✓								✓	✓			
India	✓				✓							✓	
Pakistan	✓	✓									✓		
Bangladesh	✓	✓			✓								
Cambodia								✓	✓	✓			
Nepal								✓		✓			
Afghanistan	✓							✓	✓	✓		✓	

Source: Country reports for APAARI High Level Policy Dialogue

Appendix A8. Sources and level of investment and human resources

Level of income and country	Government	Others	Investment as % of AgGDP	Number of researchers	Number with PhD
High income					
Australia		Govt-industry			
Japan	Primary	Minor industry		8425	3096
Rep. of Korea	Primary	Minor industry		1165	837
Taiwan	Primary	Minor industry		200*	>40%
New Caledonia	Major plus French			70	12
Medium income					
Malaysia	Primary				
China	Primary 90%	Coops/industry	0.5-0.6	52240	
Thailand	Primary				
Islamic Rep. of Iran	Primary	Donor		5000	
Fiji	Primary			49	1
Sri Lanka	Primary			519	
Philippines	Primary				
Low income					
Bhutan	Primary 63%	Donor 37%			
Papua New Guinea	Primary		0.60		
Vietnam	Primary	Donor		10895	600
Lao PDR	Primary			256	22
India	Primary	Coops/NGOs		25000	
Pakistan	Primary			3500	18%, 46% in university
Bangladesh	Primary	Donor	0.67	Inadequate	
Cambodia	Primary			312	14
Nepal	Primary	Donor	<10% of ag sector budget	412	88
Afghanistan	Primary	Donor		120	1

Source: Country reports for APAARI High Level Policy Dialogue *at the Taiwan Agricultural Research Institute only

2. Country Status Report: Afghanistan

Qudratullah Soofizada

Agriculture Research Institute of Afghanistan (ARIA), Kabul, Afghanistan

Basic Information

Indicator	Particulars
1. Name of the Country	Afghanistan
2. Reporting Agency	ARIA
3. Value of GDP in Local Currency (billion AFs)*	1,250.40
4. Value of GDP (2014) in billions USD*	20,84.00
5. Value of Ag. GDP in Local Currency (billion AFs)*	250.08
6. Value of Ag. GDP in billions USD*	4.17
7. Ag. GDP as % of GDP*	20.00

**Agriculture Sector Review 2014, World Bank Report*

Summary of Agriculture Sector in Afghanistan

There is a compelling case for investing in agriculture in Afghanistan. Agriculture (excluding opium poppy) accounts for about one quarter of national GDP and is the second largest sector after services. More than 80 per cent of the population and nearly 90 per cent of the poor live in rural areas, and agriculture plays an important role in their livelihoods. About half of all households derive at least part of their income from agriculture, which employs about 40 per cent of the national workforce.

Agriculture and minerals are the two sectors with the greatest potential to drive economic growth in the foreseeable future, and to generate the foreign exchange and government revenue needed to help offset projected reductions in foreign aid. But of the two, agriculture offers significantly greater potential for creating jobs. It also has prospects for raising labour productivity, benefiting women and other disadvantaged groups (the poor, landless, and nomads), and reducing poverty and food insecurity in rural areas. Given the country's high population growth rate, simulations with an economy-wide model show that agriculture will need to grow by at least six per cent per year if rural incomes are to increase. This is nearly twice as fast as the average growth rate over the past decade. Achieving it will be challenging but possible: fortunately, there are many catch-up opportunities-from revamping the rural institutions, infrastructure, and technology destroyed.

Climate is arid continental. South-west and South regions are arid and other regions are semi-arid. Annual precipitation is around 300 mm in average and is obtained in the form of snow and rain during October to April.

Current Policies

The Afghanistan National Development Strategy (ANDS) and the relevant agricultural sector plans, e.g. the National Agricultural Development Framework (NADF) and the Agriculture Production and Productivity Programme (APP) emphasize achieving self-sufficiency in food as the most important agricultural development goal. While there are several projects and programmes that address selected farming problems, a coherent value chain-oriented approach, based on a solid need analysis is still missing.

In order to enhance agricultural potential there is a need for improvement in three inter-related, mutually reinforcing areas: managing our natural resources upon which agriculture is dependent, increasing agricultural productivity, and food processing and marketing that bring added value. The complementarities in these agricultural sub-sectors can ensure national success economically and environmentally while contributing to food and livelihood security.

The forests and grazing land, soil and water resources are each needed for agricultural strength. In some cases, we can be satisfied by sustainability, but others demand expanding and then protecting the natural heritage. Deforestation must be reversed, not accepted as a fact of life. Water needs to be better harnessed and more efficiently provided for irrigation. Grazing lands and crop lands can each become more fertile and productive. The natural resources management is the base of the triangle, a foundation for agricultural productivity.

Modern techniques have already begun to make traditional farming more efficient. Proven to boost family incomes, these need to be expanded geographically and transformed into modern agricultural traditions. Rich wool from Ghazni and elsewhere, woven into sumptuous carpets, underscores the economic importance of modern animal husbandry. Better production of wheat and rice provides food security while fruit-growing builds a future for exports.

The third side of the triangle makes farm produce more valuable through processing or marketing. Once fruit becomes jam, or grapes become raisins, export markets can be developed and a whole new tier of economic activity emerges. This creates jobs off the farm, but can still employ poor families with farms too small for self-sufficiency. Improved storage extends the life of produce and increases its value, while access to credit encourages expansion.

For achieving self-sufficiency in food production, there is an urgent need to have a clear cut guiding policy and strategy.

Strategies

Production and productivity

Increasing production and productivity of crops and livestock production, through provision of better research and extension services and enhanced use of inputs. The goals are to move Afghanistan closer to self-sufficiency in field crops, expand production of cash crops to meet domestic and export demands, and improve the supply of animal products for food and handicrafts. The Government's framework therefore focuses on cereals and industrial crops, horticulture, livestock, irrigation, and support for nomadic livestock production. It seeks to get more farmers

out of subsistence farming into semi-specialized and/or semi-intensive market-based production systems, while maintaining diversification for risk reduction and food security.

Economic regeneration through development of value chains

i) The economic regeneration needs to be addressed through the development of value chains keeping in view the following factors: support to producer, retailer, and trader organizations; ii) financial services for agricultural development; iii) value addition; iv) quality control and safety of agricultural inputs and products; v) marketing and market linkages; and vi) agricultural land leasing. Each of these subcomponents includes actions that should be taken solely by MAIL, and others that should be taken by MAIL in coordination with external support.

Natural resource management

For natural resource management, the following aspects need to be addressed: i) Natural resource surveillance, planning, and regulation; ii) protection and conservation; and iii) community management of natural resources.

Change management

‘To create a dynamic, well-functioning, competent, and effective institution through a process of reform and structural adjustment, prepared to meet the challenges of the 21st century and responding to the needs and demands of the agriculture sector.’ Potential targets for change may include leadership practices, communication practices, organization design, lines of business and activities performed, performance management, incentive and compensation strategies, culture change, policies and procedures, and process re-engineering and outsourcing.

Specific Focus

- Development of improved varieties of field crops and livestock breeds using innovative breeding techniques
- Conservation and utilization of diverse genetic resources for crop improvement programmes
- Promotion of efficient management of livestock and forestry
- Developing the integrated production and protection technologies of field crops for different geographical regions
- Increasing the overall production, productivity and profitability of field crops, livestock and forestry
- Effective and efficient transfer of integrated production technologies to the target groups
- Soil improvement and soil fertility
- Effective and efficient utilization of inputs for productivity enhancement in field crops through integrated management
- Strengthen of coordination and collaboration with national and international stakeholders

Priorities for Agricultural Research and Innovations for Development (ARI4D)

To improve crop and animal husbandry coupled with genetic improvement of livestock, plant varieties, and rootstocks. Suboptimal crop and soil management limits agricultural productivity in Afghanistan. Likewise, inferior and unsuitable livestock species, cultivars, and rootstocks that are susceptible to diseases and drought are a key factor in the low quality and yields of Afghanistan's agricultural products. Agriculture research can mitigate these factors in Afghanistan. Such research is best conducted both on research stations and on farmers' fields. Research stations are vital assets because they provide hubs from which research priorities are established and conducted. The farm community is a vital element in the research process. Linkages and continual communication among extension, research, and the farm community are key elements of effective agricultural research.

The government of the Islamic Republic of Afghanistan's most priority focus is achieving national food security. The government is committed to halving the number of hungry people by 2020. Therefore, the government is putting more emphasis on gain in agricultural productivity, production and capacity building in all of their research and development oriented policies and strategies. The proposed project will undoubtedly help the government to move forward in this endeavour.

Targets

To develop and promote the innovative agricultural research production technologies which are resource sustainable, economically viable, environmentally safe, contribute for prudent natural resources management, and promote the development of local markets for the improvement of the food and nutritional security in Afghanistan.

Institutional Roles, Responsibilities and Partnerships

- **FAO:** Active collaboration existed between FAO and ARIA on policy issues and research activities.
- **CIMMYT:** Active collaboration existed between CIMMYT and ARIA on supply of new advanced lines and research material of wheat, maize and barley crops.
- **ICARDA:** Active collaboration existed between ICARDA and ARIA on supply of new advanced lines and research material of wheat, industrial crops, legumes, vegetables and fodder crops.
- **AKF:** To support ARIA to develop new improved potato and forest trees varieties including pistachio.
- **NEI:** Help ARIA to develop and introduce new improved soybean varieties.
- **JICA:** As three project mentioned above (SATRIP, RIPA, CDIS Output 3) contribute for the development of new improved varieties of rice, wheat, vegetable crops; providing support on germplasm and capacity building.
- **French Cooperation Project (FCP):** Providing support under NEASP project to equip and construct the Poza-e-Shan farm station and also help ARIA to develop and introduce wheat and cotton varieties.

- Afghanistan Agriculture Input Project (AAIP): A constructive and positive support like capacity development of scientific staff, infrastructure development to research farms, and technical support to researchers is provided by AAIP to ARIA for the development and strengthening of ongoing research programmes. Thus, active collaboration existed between AAIP and ARIA on financial, technical, quality seed production, infrastructure developmental and capacity building support.
- Community Livestock and Agriculture Project (CLAP): CLAP through ICARDA supports ARIA in fast-track release of 6 new draught resistance and high-yielding varieties of food, fodder and vegetables crops through adaptive research, production of high quality certified seeds through village based seed enterprises and establishment of participatory demo plots for extension purposes. In addition, CLAP is also involved in building capacity of ARIA's staff and refurbishment of ARIA research centers.
- Japan International Cooperation Agency/Capacity Development and Institutional Strengthening (JICA/CDIS) output 3: Support ARIA intend to develop and introduce vegetable, wheat new improved varieties along capacity building.
- Japan International Cooperation Agency/Rice-based Agriculture Development in Afghanistan (JICA/RIPA): Support ARIA intend to develop and introduce new improve variety of rice.
- Japan International Cooperation Agency/Science and Technology Research Partnership for Sustainable Development (JICA/SATREPS): Support ARIA for reinforcement of cereal germplasm and capacity building.
- Afghanistan Agriculture Extension Project (AAEP): Support ARIA for introducing and transferring of best agronomical approaches and production technology and collaboration for transfer of production technology to the formers.
- European Union/Parrenial Horticulture Development Project II (EU/PHDP II): Provide support to ARIA for the transition process or take over the six Perennial Horticulture Development Centres (PHDCs) which include (i) the national collection of fruit and nuts (ii) provision of mother plants to private sector nurseries (ANHDO) and development of public-private partnership for traceability system for planting material (iii) adaptive research (i.e. breeding lines of almond apricot), (iv) pomology laboratories and post-harvest activities, (v) training centres.
- Afghanistan National Horticulture Development Organization (ANHDO) partner with the ARIA-PHDCs in adaptive research and post-harvest activities.
- Afghanistan National Nursery Growers Organization (ANNGO) partner with ARIA-PHDCs for the certification system of fruit saplings (mother plants for multiplication from the National Collection managed by ARIA to the private ANNGO Mother Stock Nurseries).

Infrastructure and Financial Investments

Agricultural Research Institute of Afghanistan (ARIA) was established on 1959. ARIA was formed with clear purpose and mandate to fulfil the economic and social aspirations of the farming communities of this country. The focused strategies were placed on the development of diversified agricultural production technologies for the sustainable agriculture production

system at village levels in Afghanistan. Keeping in view, the urban and rural socioeconomic situations diversified agricultural research programmes were identified, established, promoted and implemented by ARIA to sustain the economy, food security and livelihood at district and village levels.

Thus, a comprehensive infrastructure was started/developed at national and regional levels with the establishment of 17 regional research stations under different agro-ecological regions. At ARIA, three research directorates covering field crops, soil science, livestock and forestry were established to develop agricultural production technologies including new varieties and products through innovative research approaches. Interestingly, ARIA initiated diversified research programmes on various field crops like cereal crops (wheat, barley, rice, maize), horticultural and vegetable crops, legume crops, oilseed crops, industrial crops, production technologies, soil management, plant protection, livestock improvement and management and forestry management. Presently, more than 120 scientific staffs (one Ph.D., 20 M.Sc., 81 B.Sc. and 12 high school) are working on various research programmes throughout country and contributing directly in the development of indigenous production technologies in the field of agricultural research. However, to feed the need of this country, ARIA is not fully equipped with required infrastructure and working manpower.

Major Challenges

Afghanistan faces the following major challenges:

- Low human capacity
- Insufficient research infrastructure and machinery
- Water crisis
- Soil degradation
- Genetic erosion
- Biotic and abiotic pressures
- Post-harvest losses
- Energy management
- Access to markets and market uncertainties
- Knowledge and information gap
- Lack of policy support

Looking Ahead (short to medium-term)

The following major areas need to be addressed on priority:

- To provide leadership role in the development and promotion of production technologies and extension network for a sustainable agriculture production system in Afghanistan
- To develop human resources to enhance research capabilities

- Establishment and development of appropriate research programmes to fulfil the national requirement and address priorities
- To develop new varieties of various field crops and introduce new improved animal breeds to meet the needs of farming communities
- To produce sufficient nucleus and breeder seed of popular varieties of different field crops
- To conserve the fruit germplasm (national collection) and continue to produce healthy and true-to-type fruit saplings for the farmers through the partnership already established with the private sector (ANNGO) for production of certified true-to-type fruit saplings originated from the national collection
- To improve soil condition and soil fertility
- To develop and introduce new efficient production technologies of agriculture, livestock and forestry
- To transfer the best production technologies to the farmers and herders through collaborative approaches
- To establish and strengthen the Regional Research Stations for the development of regional production technologies

3. Country Status Report: Australia

Nick Austin and David Shearer

Australian Centre for International Agricultural Research (ACIAR), Canberra, Australia

Basic Information

Indicator	Particulars
1. Name of the Country	Australia
2. Reporting Agency	ACIAR
3. Value of GDP in Local Currency (specify)*	AUD1 595b ¹
4. Value of Ag. GDP in Local Currency (specify)*	AUD67.2b ²
5. Ag. GDP as % of GDP*	1.6 ³

Current Policies

Domestically, the Australian agriculture, farming and food sector is supported by the Department of Agriculture and Water Resources which develops policy and provides services to improve the productivity, competitiveness and sustainability of agriculture, fisheries, forestry and related industries. The Department supports farmers in times of hardship and assists with risk management and planning.

As agriculture has always played an important role in the success of Australia, and it touches all Australians, the Australian Government is committed to strengthening the sector and ensuring that it remains as competitive as possible, because stronger farmers mean a stronger Australian economy.

The Australian Government sees the opportunities for the sector as being enormous as Australia sits on the edge of the strongest growing region in the world, have a developed agriculture sector with world-class food safety systems. The outlook for the Australian primary industries sector is strong, with the world's demand for food rising, driven by population growth and calls for higher quality and greater variety of food.

For the past 18 months, the Government has listened to the challenges that farmers are facing and discussed what is required for them to be successful on the land. From this feedback, the Australian Government has developed the Agricultural Competitiveness White Paper.

¹From the Australian Bureau of Statistics (<http://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/1345.0?opendocument?opendocument#NationalAccounts>) for 2014-15.

²Compromises AUD 42.8b from Value of farm and fisheries food production and AUD 24.4b from Value added, food, beverage and tobacco processing. From Australian food statistics 2012-13, available at agriculture.gov.au, which is current as at June 2014.

³From Australian food statistics 2012-13, available at agriculture.gov.au, which is current as at June 2014.

The White Paper outlines the initiatives and commitments by the Australian Government for each of our five priority areas for action (outlined below). It is a AUD 4 billion investment in Australian farmers.

The vision of the White Paper is to build a more profitable, more resilient and more sustainable agriculture sector to help drive a stronger Australian economy.

In relationship to domestic research and innovation, Australia's primary industries have a strong tradition of being innovative and adaptive to new challenges. They have proven to be highly efficient and competitive in international markets.

Investment in research and development (R&D) and innovation is vital for ongoing growth and improvement in the productivity, profitability, competitiveness and sustainability of Australia's agriculture, fisheries, forestry and food industries.

The Australian Government is providing funding of AUD 100 million over four years from 2014-15, for a competitive grants programme to deliver cutting-edge technology and applied research, with an emphasis on making the results accessible to Australia's primary producers.

This new funding is in addition to the current government funding of around AUD 250 million per year for Rural Research and Development Corporations (RDCs), discussed below.

Government investment (both federal and state/territory) in primary industries' innovation:

- Recognizes that the large number of small producers could not gain an economic return from individual investment in R&D and that farm products are largely uniform and non-rival in nature.
- Acknowledges the significant intra- and inter-industry spillovers and regional and rural benefits that accrue from publicly supported R&D.
- Addresses important national development and sustainability objectives, such as biosecurity and natural resource management.

At the federal level, RDCs are the Australian Government's primary vehicle for funding rural innovation. RDCs are a partnership between the government and industry created to share the funding and strategic direction setting for primary industry R&D, investment in R&D and the subsequent adoption of R&D outputs. The RDCs commission and manage targeted investment in research, innovation, knowledge creation and extension.

While RDC investments service the identified needs of industry, they also address national R&D needs through the Rural R&D Priorities (the priorities). The priorities are intended to achieve a national understanding of current critical R&D investment needs and to better target agricultural, fisheries, forestry and food industry R&D efforts. A common understanding of rural research priorities will better position Australia's agricultural, fisheries, forestry and food industries to embrace innovations and adopt new technologies, to respond to market changes, to open up new markets and to maintain a competitive edge in the face of economic and climatic challenges.

Through the National Primary Industries Rural Research, Development and Extension (RD&E) Framework, the Australian Government works with the state and territory governments, the universities and the Commonwealth Scientific and Industrial Research Organization (CSIRO) to develop and implement a national approach for RD&E in Australia. The Research, Development and Innovation Committee of the Agriculture Senior Official Committee is charged with looking for improvements in the efficiency and effectiveness of rural RD&E, to maximise the contribution of RD&E to primary industries, rural and regional Australia and the wider community. The Committee is made up of representatives from the Australian, state and Northern Territory government departments responsible for primary industries, RDCs, CSIRO and universities.

The Australian Government's new development policy Australian aid: promoting prosperity, reducing poverty, enhancing stability and new performance framework Making Performance Count: enhancing the accountability and effectiveness of Australian aid introduce key shifts in our aid programme. The purpose of the aid programme is to promote Australia's national interests by contributing to sustainable economic growth and poverty reduction. Australia is pursuing this purpose by focusing on two development outcomes: supporting private sector development and strengthening human development. The Australian aid programme focuses on our Indo-Pacific region, with a sharper focus on Australia's immediate neighbourhood - this is where we can make the most difference.

The policy recognizes that the world has changed and understands that the Australian Government aid programme must change too. With many developing countries growing rapidly and aid representing an increasingly small proportion of development finance, Australia's aid programme needs to be more innovative and catalytic, leveraging other drivers for development, such as private sector investment and domestic finance.

There are four 'tests' that guide the strategic choices across the Australian aid programme, translating this new aid paradigm practice. They will ensure that Australian aid:

- Pursues Australia's national interest and extends Australia's influence
- Impacts on promoting growth and reducing poverty
- Reflects Australia's value-add and leverage
- Makes performance count.

There will also be significant improvements in the way Australia delivers aid, through:

- Greater innovation
- Strengthening our private sector focus
- Enhancing aid for trade
- Disability-inclusive development
- Economic diplomacy
- Working with the most effective partners
- Consolidating the aid programme

- Responsibly engaging with risk and applying safeguards
- Actively managing fraud and anti-corruption
- Following value for money principles
- Transparency

In relationship to agriculture, fisheries and water within the Australian Government's aid programme, Australia recognizes these sectors provide livelihoods for millions of workers, particularly in rural areas, and underpin food security and nutrition. Australia understands productivity will need to increase significantly to meet expanding global food demand, especially in the Indo-Pacific region. At the same time, water resources are coming under competing pressures from agriculture, industry, electricity generation, growing urban populations and the impacts of climate variability. Overfishing practices threaten the long-term sustainability and profitability of global and regional fisheries.

Optimizing the potential of agriculture, fisheries and water for economic development, while ensuring sustainable use of resources for long term prosperity, is one of the biggest challenges facing our region. Through Australia's aid programme, Australia is supporting agricultural productivity, sustainable fisheries management and water resource management, and is addressing impediments that prevent producers linking effectively into domestic and international markets.

Strategies

In Australia, the White Paper outlines five priorities for the Australian agriculture sector.

Priority 1. A fairer go for farm businesses, where:

- The Australian Government is helping farmers achieve a better return at the farm gate and fairer competition for farm produce
- The Australian Government is also committed to reducing red tape from the economy by AUD 1 billion a year. Less red tape makes business easier for farmers
- The Australian Government is also developing a better tax system for farm businesses

Priority 2. Building the infrastructure of the 21st century:

- The Australian Government is planning ahead and thinking innovatively when it comes to infrastructure
- The Government is already delivering on its commitment to invest AUD 50 billion for current and future infrastructure
- The Government is also already investing an additional AUD 60 million on top of the AUD 100 million Mobile Black Spot Programme to improve mobile coverage across regional Australia
- The Government is delivering on the AUD 29.5 billion National Broadband Network (NBN) rollout. Improved access to technology will give farmers more market options, and therefore a stronger position to negotiate on price

Priority 3. Strengthening our approach to drought and risk management:

- Drought is one of the biggest challenges farmers face and it has a significant impact on agricultural output, productivity and farm incomes.
- Farmers can use many of the new, practical White Paper initiatives not only in drought, but to manage the other risks they face.

Priority 4. Farming smarter:

- The agriculture sector needs access to the most advanced technologies and practices to continue to 'farm smarter'.

Priority 5. Accessing premium markets:

- Improving international trade will grow Australian farm businesses and increase financial returns for farmers.

The Strategy for Australia's aid investments in agriculture, fisheries and water (February 2015) outlines the overarching rationale, objectives and priorities for the Australian aid programme's investments in these sectors which, together, comprise one of the six priority areas outlined in Australia's development policy.

The Strategy applies to aid investments managed by Department of Foreign Affairs and Trade (DFAT), the Australian Centre for International Agricultural Research (ACIAR) and other Australian government agencies delivering Official Development Assistance (ODA) in the agriculture, fisheries and water sectors. It will help ensure the Government's aid investments in these sectors align with and support the Government's new aid paradigm and broader economic diplomacy efforts. Innovative and catalytic use of Australia's aid and expertise in agriculture, fisheries and water - particularly through leveraging private sector partnerships and investment - is a key focus of the Strategy.

Under the Strategy, Australia's aid investments in agriculture, fisheries and water will 'promote prosperity, reduce poverty and enhance stability' through contributions to both private sector development and human development. Aid investments will continue to be an appropriate mix of bilateral, regional and global investments. The Government's efforts in these sectors will seek to:

- Increase contributions to national economic output
- Increase incomes of poor people, and
- Enhance food, nutrition and water security

Specific Focus

Specifically related to research and innovation in Australia, the areas of focus covers a broad range of commodities, enterprises, systems and approaches (adaptive, applied, basic & strategic, anticipatory, etc.), with an understanding the agriculture sector needs access to the most advanced technologies and practices to continue to 'farm smarter'.

The Australian Government is helping farmers keep up-to-date with the latest research and technologies and new ways of improving business, such as:

- 100 million over four years to extend the Rural R&D for Profit Programme to 2021-22 to get research onto the farm
- AUD 1.4 million research boost to match industry levies and contributions in the export fodder and tea tree oil industries
- AUD 1.2 million allocation to the Rural Industries Research & Development Corporation for small industries
- New RD&E priorities to direct levy funds to areas that will improve farm gate returns
- Reduce Research and Development Corporations administration costs to leave more money for RD&E
- AUD 50 million to boost Australia's emergency pest and disease eradication capability
- AUD 50 million to give farmers better tools and control methods against pest animals and weeds

The Government is already helping farmers access skilled and reliable labour by:

- Focusing on better training through the AUD 664.1 million Industry Skills Fund
- Making visa programmes more flexible by expanding the Seasonal Worker Programme Australia-wide, and the Working Holiday Maker (417 and 462) visas in northern Australia
- Establishing a new Ministerial Advisory Council on Skilled Migration to review the list of occupations available for sponsorship under the 457 visa

The Government is also supporting farmers and other land managers to tackle practical environmental projects. This includes the AUD 1 billion National Landcare Programme, while the AUD 700 million commitment to the Green Army will provide training in conservation management.

To meet the core objectives of Australia's Strategy for Australia's aid investment in agriculture, fisheries and water, the Government will prioritize its efforts in three areas:

- Strengthening markets to help increase small-scale farmers and fishers' participation in markets and address constraints to agri-food business, including by leveraging private sector investment and innovation (with an emphasis on women's economic empowerment)
- Innovating for productivity and sustainable resource use to improve productivity along food and agriculture value chains and promote more efficient and sustainable use of natural resources, using international and Australian research and expertise
- Promoting effective policy, governance and reform to assist partner countries achieve more effective policy settings to promote sustainable and inclusive growth and open trade, and improve the enabling environment for business, investment and innovation

Priorities for Agricultural Research and Innovations for Development (ARI4D)

In Australia, the Rural Research and Development (R&D) for Profit programme implements a government election commitment to boost funding to RDCs and fund nationally coordinated, strategic research that delivers real outcomes for Australian producers. The Agricultural Competitiveness White Paper announced the government's decision to extend the programme for a further four financial years and provide an additional AUD 100 million in grant funding.

The total funding available for the programme has therefore been increased to AUD 200 million over eight years, ending on 30 June 2022.

The Rural R&D for Profit programme aims to improve farm-gate productivity and profitability and deliver real outcomes for Australian farmers.

To be eligible for grant funding, RDCs must partner with one or more researchers, research agencies, RDCs, funding bodies, businesses, producer groups or not-for-profit organizations, and the partnership must provide funding (cash or cash plus an in-kind contribution) at least equal to the requested Australian Government grant funding.

In Australia's Strategy for Australia's aid investment in agriculture, fisheries and water, the Australian Centre for International Agricultural Research (ACIAR) focusses on delivering the priorities for agricultural research and innovation. In relationship to these priorities, ACIAR will generate outputs across four areas from our research partnerships:

New technologies: ACIAR will help create new agricultural technologies and support their commercialisation and use in developing countries. The technologies will be demand-led, targeting food sufficiency, intensification, diversification and resilience of production systems; health and nutrition; and empowerment of women. They will reduce impediments to productivity and trade. ACIAR is continuing to ensure that the improvement of adoption rates is an ethos for the research partnerships supported and will facilitate this in various ways; for example, by adopting a more multidisciplinary approach to projects, involving businesses and non-government organizations in the design of projects and the implementation of project outcomes, and partnering with Consultative Group on International Agricultural Research (CGIAR) Centres.

New knowledge: ACIAR will help generate and deliver new scientific knowledge with and for developing countries. To do this, ACIAR will support, encourage, and build capability for, scientific excellence. As well as contributing to the global stock of knowledge, ACIAR's work will put findings from global research into local contexts, and will help to shape policy. ACIAR is placing particular emphasis on communicating the knowledge generated, to maximise its availability and impact.

Greater capability: ACIAR will build capability in partner countries to do and use research. ACIAR will pay particular attention to the countries and areas where skills gaps are the most pronounced. Capacity building of institutions and individuals is integral to all ACIAR-supported research, and significantly enhances the sustainability of research outcomes. ACIAR's research programmes bring Australian researchers together with developing-country researchers, primarily by short or extended visits, and all research is undertaken collaboratively in the laboratory or in the field. This informal training, through 'learning-by-doing', is augmented by two formal training programmes:

- i) the Australia Awards John Allwright Fellowship scheme, which supports Masters and Ph.D. programmes for overseas students at Australian universities
- ii) the Australia Awards John Dillon Fellowship programme, which supports between 10 and 15 mid-career scientists and science managers to undertake training and gain experience in science management through placement at Australian institutions.

Better decision-making: ACIAR will support better decision-making in two ways-through policy analysis that leads to improved policies and better regulation; and by helping to strengthen the evidence basis on which policy is formulated. We will seek to make existing information more accessible. ACIAR's programmes will seek to achieve earlier engagement with decision-makers, opinion-formers and practitioners, to maximise the likelihood of policy-relevant results and subsequent uptake.

Targets

In Australia, the Rural R&D for Profit programme aims to realize productivity and profitability improvements for primary producers through:

- Generating knowledge, technologies, products or processes that benefit primary producers
- Strengthening pathways to extend the results of rural R&D, including understanding the barriers to adoption
- Establishing and fostering industry and research collaborations that form the basis for ongoing innovation and growth of Australian agriculture

Research projects must address one or more of the new RD&E funding priorities announced in the Agricultural Competitiveness White Paper, which fall into four areas:

Advanced technology, to enhance innovation of products, processes and practices across the food and fibre supply chains through technologies such as robotics, digitisation, big data, genetics and precision agriculture

Biosecurity, to improve understanding and evidence of pest and disease pathways to help direct biosecurity resources to their best uses, minimizing biosecurity threats and improving market access for primary producers

Soil, water and managing natural resources, to manage soil health, improve water use efficiency and certainty of supply, sustainably develop new production areas and improve resilience to climate events and impacts; and

Adoption of R&D, focusing on flexible delivery of extension services that meet primary producers' needs and recognizing the growing role of private service delivery.

Within the Australian Government's aid programme related to agriculture, fisheries and water, DFAT, in coordination with ACIAR and other relevant Australian government agencies, will monitor the overall performance of the aid programme in maximizing development outcomes in agriculture, fisheries and water. The approach will be to assess the breadth, depth and effectiveness of the work in this priority area across the aid programme, identifying lessons

learned and examples of good practice. This assessment will be guided by the following key evaluative questions focusing on the extent to which the Government's aid investments in agriculture, fisheries and water:

- Have contributed to increased economic output in our partner countries
- Have increased the incomes and improved the livelihoods of poor women and men
- Have increased agricultural productivity and contributed to food, water and nutrition security
- Have contributed to the high-level targets in the aid programme's performance framework; and
- Are, at the individual programme level, being effectively and efficiently implemented and are achieving their intended impacts

ACIAR is driven by a focus on impacts and will continue to strive to understand the needs of next and end users of the research and to develop impact pathways that continually respond to the changing circumstances in which the outputs of research can best be utilized. ACIAR is also placing emphasis on building partnerships and processes that maximise the likelihood of impact.

ACIAR is focussed on impact pathways, particularly the role of women and, through partnerships with next and end users that will deliver:

- Increased availability of and access to meat, milk, grains, fruits and vegetables
- Greater product utilization and reduced postharvest losses
- Improved nutritional quality and diversity of diets
- New and diversified enterprise options
- Enhanced market chains for smallholder agriculture
- Increased productivity, quality and market access for agriculture, aquaculture and forestry products
- Greater resilience and diversity of production systems
- Strengthened plant and animal biosecurity

Institutional Roles, Responsibilities and Partnerships

In Australia, the RDCs are the main way the Australian government and primary producers co-invest in R&D for industry and community benefits.

There are currently 15 RDCs-five Commonwealth statutory bodies and 10 industry-owned companies (IOCs). All the RDCs manage R&D services, with most IOCs also providing other industry services, mainly marketing. Following legislative amendments in 2013, statutory RDCs are also able to undertake marketing activities at the request of industry, where supported by a statutory marketing levy.

In the Strategy for Australia's aid investments in agriculture, fisheries and water innovative and catalytic use of Australia's aid and expertise in agriculture, fisheries and water - particularly through leveraging private sector partnerships and investment - is a key focus.

ACIAR's role is to establish research priorities with partner countries and build relationships between Australian and developing country research institutions. This approach enables a strong influence on the development, commissioning, monitoring and evaluation of programmes carried out with ACIAR funding.

ACIAR's research programme managers are the first point of contact for scientists wishing to become involved in ACIAR projects. They will advise at the outset whether a particular line of research fits with regional and country priorities. They will also help with choice of partner institution, and advise on the potential for funding availability and the timeline for development and carrying out the research

The research partnerships supported by ACIAR representative a diverse range of research agencies within Australia, in our developing country partners NARS, with the CGIAR and other global and regional bodies.

Infrastructure and Financial Investments

Australia's RDCs invest in R&D and innovation to improve the profitability, productivity, competitiveness and long-term sustainability of Australia's primary industries. These include agricultural, fishing and forestry industries. Both industry and government recognise that creating and meeting demand for Australian produce is essential to the competitiveness and profitability of our primary industries and provides benefits for the whole Australian community. The government-industry partnership model that supports the RDCs has been operating successfully for over 25 years.

The RDCs are funded primarily by statutory R&D levies (or charges) on various commodities, with matching funding from the Australian Government. To expand Australia's rural R&D efforts, the government matches expenditure on eligible R&D, generally up to 0.5 per cent of the determined industry gross value of production. RDCs are accountable to both industry and government.

Levies for R&D and marketing are initiated at the request of industry and are collected and administered by the Department of Agriculture and Water Resources. These funds are distributed to the RDCs to undertake R&D and industry services.

The key performance and accountability framework for IOCs and statutory RDCs is set out in the funding agreements signed with the Commonwealth. These agreements are required to allow funds appropriated by Parliament to be spent by the RDCs and to ensure the funds are expended by the RDCs for the purposes for which they are appropriated, essentially for the delivery of R&D and marketing services.

Individual funding agreements with RDCs outline what is expected of them. This includes expectations of performance and transparency, as well as accountability to levy-payers, the government and the public. The funding agreements are renegotiated based on the performance of the RDC during the term of the funding agreement (usually four years). The performance review allows flexibility for parties to adapt to changing expectations and priorities for R&D.

Since 2005, Australia's aid expenditure on agriculture, fisheries, water resource management and rural development has averaged approximately 7 per cent of its ODA. In 2014-15, an estimated AUD 367.4 million in Australian aid was provided for agriculture, fisheries and water. The agriculture and fisheries sectors will contribute substantially to achieving the Government's 20 per cent aid-for-trade target by 2020, given investments in these sectors currently account for over a quarter of Australia's aid-for-trade expenditure. While most spending will continue to take place through bilateral programmes, Australia will also invest in regional and global initiatives to address the wider market, policy and trade environment, test innovative approaches and share lessons learned.

Under ACIAR's five-year Strategic Plan, ACIAR will invest around AUD 0.5 billion on agricultural research for development from 2014-18.

Major Challenges and Opportunities

Agricultural productivity must increase if the world is to continue to feed, clothe and support a growing population from fixed or shrinking land and water resources. Research is an essential driver of productivity growth in agriculture, and well-managed agricultural research can deliver innovative, lasting solutions that bring sustainable change to those who need it most. Research also provides new knowledge, technologies, capacities and policies to deal with rapidly changing contexts, such as increased globalization of the agriculture and food-sector markets, new and emerging food safety and quality issues, changing diets, and the rapid rise of supermarkets and consolidation within food supply chains.

Investment in agricultural research for development is a highly effective option for reducing poverty for a relatively large beneficiary population: net sellers of food receive greater income through increased production, while net buyers have greater access to, and possibly pay lower prices for, food. This aligns with and supports Australia's foreign policy objectives – regional prosperity and security, global peace and an open international economic system.

The inseparable challenges of poverty, malnutrition and hunger remain among the world's greatest challenges. Australia, as a wealthy nation with a strong heritage of agricultural innovation, has an active role to play in overcoming these challenges by building mutually beneficial agricultural partnerships with developing countries.

ACIAR will continue to put Australia's agricultural innovation system to work to reduce poverty and contribute to the long-term economic prosperity of developing countries. This work contributes to stronger economies and to poverty alleviation, which is central to Australia's aid agenda.

Stronger economies in our region will also assist Australian exporters and investors to access and profit from foreign markets. Support for more-productive, market-led agricultural systems that engage smallholders encourages developing countries to effectively tap into new opportunities. In these ways, ACIAR works towards a future of shared prosperity.

Through partnerships in science and technology, ACIAR continues fosters closer ties between Australia and the region and develops stronger people-to-people links. These are some of the

most effective ways of assisting other nations, and of creating real bridges between Australia and our counterparts.

ACIAR's five-year strategy, which responds to urgent global challenges, and sets out ACIAR's distinct contribution to the global research effort. ACIAR will, through international agricultural research partnerships, achieve more-productive and sustainable agricultural systems, for the benefit of developing countries and Australia.

One of the accomplishments of ACIAR's work, and a key global challenge, is improving gender equality. Women make a vital contribution to agriculture, and ACIAR's work is making a real difference to lives of women and girls around the world. ACIAR's approach recognizes the important role that women play in agriculture, and confirms ACIAR's commitment to tackling gender inequality, in the design, delivery and impact of its projects.

Another important part of ACIAR's approach is the introduction of rigorous benchmarks and strengthens performance measures. Measuring the performance of ACIAR will ensure that agriculture-sector research continues to impact on policy and practice in partner countries to contribute to economic growth and reduce poverty.

Looking Ahead (short to medium-term)

In the next five years, ACIAR will continue to work as part of Australia's aid programme, which plans, works and reports in a whole-of-government way. This will require ACIAR to become increasingly familiar with, and a part of, the global development debate. ACIAR continues to adapt and respond to emerging opportunities, including those at the interface between agriculture and human health, and agriculture and mining. We will continue to strive to better understand and enhance adoption processes.

4. Country Status Report: Bangladesh

Abul Kalam Azad and Md Abul Awal

Bangladesh Agricultural Research Council (BARC), Dhaka, Bangladesh

Basic Information

Indicator	Particulars	
	2012-13	2013-14
1. Name of the Country	Bangladesh	
2. Reporting Agency	BARC	
3. Value of GDP* in Local Currency (million taka)	7,298,965.00	7,741,361.00
4. Value of GDP* in USD (million)	91,317.00	99,606.00
5. Value of Ag. GDP* in Local Currency (million taka)	1,174,360.00	1,225,702.00
6. Value of Ag. GDP* in USD (million)	14,692.00	15,771.00
7. Ag. GDP as % of GDP*	16.78	16.50

* = GDP of Bangladesh at constant prices (Base: 2005-06); 1 USD = 79.93 Taka (2012-13) and 77.72 Taka (2013-14) Source: Bangladesh Bureau of Statistics (BBS) 2015

Current Policies

National Agricultural Policy-2013: The main objective of the National Agricultural Policy-2013 is to increase productivity with increased crop production and create employment opportunity through diversification in agricultural programmes to ensure food, nutrition and improved livelihood for all.

Sixth Five Year Plan (2011-2015): The Sixth Five Year Plan 2011-2015 provides strategy, framework and guidelines for reducing disparity, developing human capacity, managing land constraints, using natural resources, increasing agricultural productivity, household income and employment and ensuring food security.

Master Plan for Agricultural Development in the Southern Delta of Bangladesh: Master Plan for Agricultural Development in the Southern Delta of Bangladesh emphasizes to increase coverage and productivity with good management practices, production of high value crops in the homesteads as well as fallow lands, aforestation, shrimp farming, animal rearing, salinity management, water management etc.

Seed Policy of Bangladesh-2006: The overall purpose of this policy is to make the best quality seed of improved varieties of crops conveniently and efficiently available to farmers with a view to increase production, farmers' productivity, per capita farm income and export earnings.

National Fisheries Strategies-2006: Introduction of intensive shrimp farming and modern techniques of fishing in the coast and sea, community based fisheries management, restocking of open water fisheries and creation of new sanctuaries and strengthening of Department of Fisheries were identified as area of interventions for growth and development of this sub-sector.

National Forest Policy 1994: The Forest Policy, 1994 has clearly incorporated the participatory forestry concept. The policy endeavours to bring 20 per cent of the land area under forest to maintain the ecological balance and attain self-sufficiency in forest produce through joint venture between government and NGOs with people's participation.

National Livestock Development Policy 2007: The general objectives of this policy is to provide enabling environment, opening up opportunities, and reducing risk and vulnerability for harnessing the full potential of livestock sub-sector to accelerate economic growth for reduction of rural poverty with private sector as main actor and the public with a facilitating and supportive role.

Strategies

Major strategies adopted for implementing above policies are as follows:

National Agricultural Policy-2013

- Developing and harnessing improved crop varieties and production technologies through research and training
- Development of climate resilient crop varieties suitable for cultivation in the stress prone areas
- Development of early maturing varieties to increase cropping intensity
- Variety development with more nutritive value
- Promoting the use of surface water instead of underground water and improving soil health

Sixth Five Year Plan (2011-2015)

- Achieving self-sufficiency in food, in addition to rice, increased production of wheat will also be given priority. For increasing crop production, inter-cropping will be emphasized
- For crop intensification, the coastal zone, the Sylhet region and the char areas must receive priority in crop sector development plans
- Develop and deploy stress tolerant varieties (salt-tolerance, submergence tolerance, and drought tolerance for rice, and heat tolerance for wheat)
- In order to meet the growing demand of additional food for the increasing people of the country emphasis should be given on unutilized hoar land of the north-east part of Bangladesh.
- Strategy, policy and action should be formulated to convert the single crop land into double crop land, double crop land to triple crop land
- Ensure equal wage for equal work for women-men labour at agriculture
- Use of ICT in agriculture

Master plan for Agricultural Development in the Southern Delta of Bangladesh

- Development of saline tolerant crop varieties
- Soil salinity management by adopting mitigation technique
- Increasing cropping intensity by using fallow lands and producing double crops in the single-cropped areas
- Strengthening home gardening
- Solving urgent problems by short-term measures

Seed Policy of Bangladesh-2006

- Strengthen the institutional capability of the public and private sector entities engaged in the seed industry
- Evolve and/or adapt seed technology to meet the needs of high-input and high-output agriculture
- Promote balanced development of the seed sector by providing equitable opportunities to the public and private sector at all stages of the seed industry from breeding to marketing of seeds
- Simplify procedures for import of high quality seeds and planting materials, both by the public and private sectors to enable farmers to have access to the best quality planting materials available in the world
- Strengthen seed certification, quality control and testing facilities to ensure availability of quality seeds to farmers
- Simplify procedures for effective observance of plant quarantine

National Fisheries Strategies-2006

- Efficient use of marine/aquatic resources to contribute to the national economy, poverty alleviation and food security
- Augment the contribution of fisheries and aquaculture in generating socioeconomic benefits and improving the well being of the rural population;
- Improve the economic viability of the sector through diversification of production in accordance with market demand; and
- Increase the availability of high quality fishery products for the domestic market, including increased production of low price fish for popular consumption

National Forest Policy-1994

- Develop and implement a set of rules and procedures for forest management in concessions, including a logging code and a new forest concession contract that sets out requirements for the following: forest management plans; environmental impact assessment; legal and financial qualifications; and local participation in the sector

- Demarcate forest concession boundaries and implement a transparent and competitive concession allocation system
- Develop and implement an effective production monitoring system
- Develop and implement a mechanism to share the benefits from forest concession activities between the government, private sector and local communities
- Develop and implement procedures for awarding concessions or licences to local communities and local, small-scale enterprises

National Livestock Development Policy-2007

- Dairy development and meat production
- Poultry development
- Veterinary services and animal health
- Feeds and animal management
- Breeds development
- Hides and skins
- Marketing of livestock products
- International trade management
- Access to credit and insurance and
- Institutional development for research and extension

Specific Focus

The major focus on agricultural research and development comprise crops, livestock, fisheries and forestry. Rice, jute, wheat, potato, sugarcane, tea, pulses, oilseeds, fruits, vegetables, spices are the principal crops in Bangladesh. The crop sub-sector dominates the agriculture sector contributing 56.24 per cent of total production (BBS, 2015). Among the crops, rice is the principal food crop in Bangladesh. The country is now self-sufficient in rice production which is about 34.36 million tons (Bangladesh Economic Review, 2015) against 159 million people of the country (BBS, 2015). The increase in rice production has been possible owing largely to the adoption of modern varieties. There are apprehensions that the current growth momentum may not sustain long. The area of rice is found declining day by day. On the other hand, the rice lands are shifted to other crops which are more profitable. The pulses, oilseeds and vegetables are found deficit in production as per requirement. Areas under these crops are also showing declining trend. So, it creates a great challenge to become self-sufficient in pulses, oilseeds and vegetables. The cattle, poultry, and goats are also very important in the country. The production of meat, milk and eggs are not enough as per requirement. The major fish species are carp (rohu, catla), hilsa, tilapia, shrimp and some indigenous species which are going to extinct day by day. The government has taken initiative to conserve these endangered fish species. The forest area covers 17 per cent of the total area of Bangladesh which needs

to be increased up to 25 per cent. The increase the agricultural productivity and production approaches like applied, adaptive and basic/strategic researches are adopted in Bangladesh.

Basic Research: It is carried out to generate new knowledge, increase understanding of fundamental knowledge, concept and basic scientific principles. The end result of such research may not have direct or immediate commercial benefits, but may lead to major technological advancement. By nature, this type of research is of longer duration. Example: Genome sequencing of jute.

Strategic Research: It is mission-oriented with sharp focus on tangible outputs that could be achieved in short to medium time-span. It involves the application of established scientific knowledge and methods to broad economic or social objectives. This type of research is meant for upstream research in the strategic areas of national and long-term importance with opportunities for exploring development of cutting edge technologies and frontier sciences. Further, strategic research is to address areas of critical gap, cross-cutting over more than one area, inter-agency and interdisciplinary. Example: The incorporation of salt resistant genes into rice plants.

Applied Research: It is the application of the principles derived from basic/strategic research to address and is carried out to generate useful and transferable technologies. The outcomes of strategic research are used to design and produce prototype materials and methods that are suitable for testing and introduction under practical conditions. This type of research is always of short to medium term. This kind of research is conducted for client driven purpose. Example: Design of improved corn-sheller or Urea Super Granule (USG) applicator for paddy cultivation.

Adaptive Research: It is the replication of applied research under varied conditions for evaluation of its applicability at on-farm level. Adaptive research can generate feedback information for the use of the applied researchers to modify or further refinement of the technology. This type of research is particularly effective in evaluating and selecting new varieties and multiplying seed, enabling large numbers of farmers to access a new variety at low cost etc. Adaptive research is normally for a short period of time. Example: Evaluation of a new variety of salt-tolerant rice in the saline coastal region.

Priorities for Agricultural Research and Innovations for Development (ARI4D)

Major areas of ARI4D adopted in Bangladesh are as follows:

Varietal development:

- Development of short duration crop varieties (rice, oilseed crops, etc.)
- Development of varieties for favourable and stress prone areas (saline, drought, submergence, heat, etc.)
- Hybrid seed production and preservation
- Enhancing research on biotechnology, genetic engineering, market assisted molecular breeding (crops, livestock, fisheries, tea etc.)
- Conservation of endangered crop, livestock, fish and forest species

Management Practices:

- Development of appropriate technologies to mitigate salinity, drought, heat, flood, submergence, etc.
- Off-season production of different crops (summer tomato, summer onion, jackfruit, mango, etc.)
- Development of location specific improved cropping pattern
- Integrated crop management (ICM) for higher productivity in different ecosystems
- Intercropping in different crops

Crop Protection:

- Integrated pest management (IPM) for fruits and vegetables
- Appropriate management practice for major diseases and insects of different crops
- Development of new vaccine seed viruses against emerging viral diseases

Natural Resource Management (NRM):

- Strengthening soil fertility and fertilizer management research
- Integrated nutrient management for crops and cropping patterns
- Biological nitrogen fixation (BNF) in crops
- Strengthening research on soil degradation and problem soil management (erosion, salinity, slopping land agriculture, toxicity, drought etc.)
- Water saving technology in crop production
- Conservation agriculture with minimum tillage

Agricultural Engineering:

- Research to minimize post harvest and storage loss in different crops
- Development and promotion of agricultural machineries for agro-processing (crops/livestock/fisheries/forestry)
- Development of appropriate packaging and transportation system for local and international market
- Preparation of various food products for commercial use

ICT in Agriculture:

- GIS based information system on surface and ground water resources
- GIS based information system on plant/animal genetic resources
- Crop-zoning and land use planning

- Enhancing ICT/MIS in agricultural research and development
- Crop modelling
- Database for monitoring and evaluation

Policy and Planning:

- Policy investigation on price of inputs and outputs towards productivity and profitability
- Impact of research and development programmes/projects on productivity, profitability and environment

Targets

For agricultural development, the following targets are set:

Food and nutritional security: by increasing agricultural productivity and production through biotechnical approach, production of high value and nutritious crops, livestock and fish species etc.

Poverty reduction of rural people: by employing themselves in homestead gardening, agro-processing, livestock and fish culture. These activities will enhance their income and livelihoods.

Environmental safeguard: by practicing environment friendly crop production e.g. IPM, use of biopesticides in agriculture, conservation agriculture, appropriate dose of chemical use in ripening fruits and vegetables, use of balanced and appropriate dose of chemical fertilizers, reduction in soil erosion and water pollution, etc.

Nutrient rich rice varieties: with high Fe, Zn and Vitamin-A content.

Export purpose: Enhancing the production of fine grain and premium quality rice; high value vegetable crops and flowers for export purpose.

Best quality and high yielding jute varieties: Increased production of jute with best quality fibre by using genome sequencing.

Institutional Roles and Responsibilities and Partnerships

There are 13 institutions under National Agricultural Research System (NARS). The Bangladesh Agricultural Research Council (BARC) is the apex body of NARS. The main functions of BARC are to review, coordinate, priority setting, planning, monitoring and evaluation of research activities of other 12 NARS institutes. These institutes are as follows:

- Bangladesh Agricultural Research Institute (BARI)- conducts research on cereals (other than rice), pulses, oilseeds and horticultural crops
- Bangladesh Rice Research Institute (BRRI)- conducts research on rice
- Bangladesh Jute Research Institute (BJRI)- conducts research on jute production and utilization
- Bangladesh Sugarcane Research Institute (BSRI)- conducts research on sugarcane

- Bangladesh Institute of Nuclear Agriculture (BINA)- conducts research on use of nuclear technology in agriculture
- Bangladesh Livestock Research Institute (BLRI)- conducts research on cattle, buffalo, sheep, goat and poultry
- Bangladesh Fisheries Research Institute (BFRI)- conducts research on marine and fresh water fish species
- Bangladesh Forest Research Institute (BFRI)- conducts research on forestry and agroforestry
- Bangladesh Tea Research Institute (BTRI)- conducts research on tea
- Soil Resource Development Institute (SRDI)- conducts research on soil survey, soil classification and characterization
- Bangladesh Sericulture Research and Training Institute (BSRTI)- conducts research on sericulture
- Cotton Development Board (CDB)- conducts research on cotton

Some private organizations involved in agricultural research and development are:

- Bangladesh Rural Advancement Committee (BRAC): BRAC is a development organization dedicated to alleviating poverty by empowering the poor
- Lal Teer Seeds Ltd: This is the largest seed company in private sector of Bangladesh
- ACI: ACI is one of the largest Bangladeshi conglomerates. The company operates through three reportable segments: Pharmaceuticals, Consumer Brands and Agribusiness

The farmer organizations involved in agricultural development are:

- Integrated Pest Management (IPM) Club
- Farmer's Information and Advice Centre (FIAC)
- Common Interest Group (CIG)
- Local Extension Agents for Fisheries (LEAF)
- Community Extension Agents for Livestock (CEAL)

The regional and international organizations involved in agricultural research and development are:

- International Rice Research Institute (IRRI), the Philippines
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India
- Asian Food and Agriculture Cooperation Initiative (AFACI), South Korea
- Agricultural Biotechnology Support Project-II (ABSP II), USA
- International Potato Centre (CIP), Peru
- International Maize and Wheat Improvement Centre (CIMMYT), Mexico
- South Asian Association for Regional Cooperation (SAARC)
- World Fish, Malaysia
- International Food Policy Research Institute (IFPRI), USA

Infrastructure and Financial Investment

The infrastructural facilities are to be created such as greenhouses, tissue culture laboratories, biotechnology laboratories, and laboratory for molecular characterization, etc.

The human resources are inadequate in each institute/university to run the proposed laboratories. So, researchers in these disciplines are needed to be trained both within the country and abroad.

The investment in agricultural research is very low compared to AgGDP which is only 0.67 per cent in Bangladesh. It needs to be increased to a considerable level.

Major Challenges and Opportunities

Major Challenges

- Rapid shrinkage of agricultural land @ one per cent per year
- Population growth @1.47 per cent per annum
- Agricultural research and education (manpower shortage, updating course curriculum)
- Technology generation (needs expertise, time and money)
- Technology dissemination (needs expertise, time, logistics support)
- Inadequate value addition/food processing
- Climate change adaptation and mitigation
- Developing stress tolerant varieties
- Transferring updated information and technologies to the field
- Attaining irrigation efficiency
- Regaining soil fertility and natural ingredients
- Weak research-extension-farmer-market linkage
- Shortage of agricultural labour at peak seasons

Opportunities

- Modern technological know-how is available for dissemination
- Scope for expanding hybrid technology exists (10%)
- Prospects for adoption of advanced technology in agriculture are bright
- There is a great potential for proper utilization of agro-ecologically disadvantaged regions like hilly/coastal/harsh areas
- Export potentials exist for high-value crops
- Scope exists for crop diversification, intensification and value addition to agricultural produces

- Agriculture sector has capacity to absorb labour force and to generate income
- Scope for reducing yield gaps exists

Need and potential for future collaboration within and outside the country:

Exchange of ideas, collaborative research and capacity building programme may be undertaken with the international research and educational institutes in the areas like biotechnology, fruit and vegetable breeding, plant physiology, crop modelling, ICT in agriculture, molecular breeding, postharvest technology, farm mechanization, etc. are needed to be strengthened.

Looking Ahead (short to medium-term)

- Development of short-duration crop varieties
- Development of varieties for favourable and stress prone areas (salinity, drought, flood, submergence, heat, etc.)
- Conservation of threatened and endangered, crop, livestock and fish species
- Enhancing research on biotechnology, genetic engineering, marker-assisted molecular breeding (crops, livestock, fisheries, tea, etc.)
- ICT in Agriculture
- Yield gap minimization in different crops
- Development of low cost water saving technology
- Integrated management of major pests with special emphasis on biological agents
- Integrated nutrient management for major crops and cropping patterns
- Conservation agriculture
- Farm mechanization

5. Country Status Report: Bhutan

Lhap Dorji

Department of Agriculture (DoA), Thimpu, Bhutan

Basic Information

With a total of about 65 per cent of Bhutan's active rural households (age ranging from 15 to 64) engaged in farming, Agriculture continues to remain as an important sector to contribute to sustainable development in Bhutan. Agriculture (encompassing arable agriculture, livestock and forestry) contributes 16 per cent of the National GDP as shown in table 1.

The use of scientific knowledge in farming and development of technologies can play a major role in triggering development focus towards sustainable approaches. Realizing this, agriculture research in Bhutan started in 1965 with the creation of Agriculture Research Centres mainly to conduct adaptive and applied research in the fields of arable agriculture, horticulture, livestock, and forestry and farming systems. Currently, the adaptive and applied research is conducted by technical departments of agriculture, livestock and forestry with policy and strategic researches conducted by the Council of RNR Research of Bhutan (CoRRB) and the Policy and Planning Division (PPD) of the Ministry of Agriculture and Forests (MoAF).

Agriculture research and development is coordinated through the Department of Agriculture (DoA), Ministry of Agriculture and Forests (MoAF) through its three Regional Research and Development Centres (RDCs) in the country located in different agroecological regions. The Research and Development Centres are mandated to conduct agriculture research and

Table 1. Basic information

Indicator	Particulars
Name of the Country	Bhutan
Reporting Agency	RNR, RDC Wengkhari, DoA, MoAF
Value of GDP in Local Currency (Ngultrum – Nu. in millions)	104,378.10*
Value of Ag. GDP in Local Currency (Ngultrum – Nu. in millions)	16,700.50*
Value of Ag. GDP in USD in millions	253.42*
Ag. GDP as % of GDP	16.18*
Total Population (estimates 2014)	745,153.00*

*Source : GDP 2013 reported in Bhutan RNR Statistics 2015

initiate development programmes in promoting the technologies developed by the centres in collaboration with the National Extension System at District and Block levels. Further, a commodity programme approach is followed in which about seven different commodity programmes are identified, namely, rice, maize, fruits and nuts, vegetables, mushroom, medicinal and aromatic plants and organic farming implemented through the RDCs and the respective divisions under the DoA, MoAF with other support services in soil fertility, plant protection, post-harvest provided by the sector support agencies under the DoA, MoAF.

The respective RDCs lead a national mandate and regional mandates such as National Horticulture Research and Development Programme, National Rice Research and Development Programme, Sub-tropical Fruits and Nuts Research and Development Programme, National Maize Research and Development Programmes. The regional mandates mainly cover the research addressing the needs of specific regions and provide technical assistance to the clients in the respective regions.

In the last one year, the government initiated an organizational development, which further recommends streamlining of both research and development services and strengthening the RDCs to enhance delivery of research and development services in the region in order to bring services closer to farmers.

Current Policies in Agriculture Development

Policy objectives and over all development goals

The development of agriculture in Bhutan is guided by its overall goal to achieve a green economic growth, inclusive social development, poverty alleviation and climate smart sustainable management and utilization of natural resources through fulfilling the following objectives:

- Enhance food and nutrition security
- Enhance sustainable rural livelihood
- Accelerate RNR sector growth
- Promote sustainable management and utilization of natural resources

These objectives will be pursued through six Sectoral Key Result Areas (SKRAs) namely:

- Enhance food and nutrition security
- Generate employment opportunities and increase income
- Accelerate Renewable Natural Resources (RNR) sector growth
- Enhance sustainable forest, land, water and biodiversity resource management
- Enhance conservation of plant and animal genetic resources
- Enhance service delivery

Agriculture Development Policies

The current policies in Agriculture development in Bhutan summarized in the MoAFs 11th Five Year Plan (2013-2018) are presented in the following sections. The linkages of these policies to agriculture research are also indicated against each in this paper.

RNR research policy (2012): The RNR Research Policy of Bhutan responds to building a knowledge-based society and emerging challenge of transforming Bhutanese agriculture from subsistence to a commercial-based economy. To support this transition, the RNR Research Policy of Bhutan provides guidance on the conduct and management of RNR research in the country. The RNR Research Policy recognizes research as a driver in socio-economic development and strongly supports securing adequate funding for research from the government as well as creating a Research Trust Fund (RTF).

Economic development policy (2010): In order to encourage commercial farming, the Economic Development Policy (EDP) offers 10 years tax break to farmers or companies and an additional five years tax break for commercial organic farming. Sales tax and import duties are also exempted for farm machineries and agricultural inputs. The EDP, 2010 makes a clear mention of supports to research and development. It also identifies agro and forest based production as one of the priority areas for the role of research in the fields of developing technologies for horticulture crops, organic farming and floriculture. The policy is also in support of strengthening intellectual property rights (IPR) that can protect and support innovators and innovations which has a direct implication to research in agriculture as well.

Bhutan aims to establish Brand Bhutan products and one of the potential sectors for this is organic farming which require research to develop alternative farming practices and technologies suitable for organic farming. Commercialization of horticulture is identified to be a major source of making a change in agriculture and that is where role of agriculture research will come in to contribute in realizing economic growth.

National food and nutrition security policy of Bhutan (2014): This policy emphasizes sustaining availability, accessibility and utilization of food through production and imports. The policy implies an increased investment in commercialization of agriculture and specialization in horticulture export, Non-Wood Forest Products (NWFPs) and niche organic products. The increased investments in commercialization can have a direct linkage towards providing investments to Agriculture research in developing suitable technology options for enhancing food security and commercialization.

National land policy (2010): This provides an overall and consistent guiding policy framework for sustainable use of limited land and land-based resources for fulfilling the long-term aspirations and needs of all Bhutanese people while conserving the natural environment. Some of the key areas where agriculture research will have a major role is in conducting research on sustainable land management in an fragile environment.

Bhutan water policy (2003): The water policy recognizes the role of rivers as an aquatic habitat and as a source of food. It also recognizes individual right to safe, affordable and sufficient quantity of water for personal consumption and sanitation and that the best available water sources shall be allocated for drinking purposes. The policy calls for allocation of adequate water for sustainable agriculture for achieving overall national food security and that

higher efficiency for use of water should be achieved through adaptive and applied research. Agriculture research has a major role in developing appropriate water management technologies especially for irrigation in order to increase agriculture production and thus can be appropriately supported by this policy.

Bio-security policy (2008): Promulgates food safety for Bhutanese people; protection of human health from zoonotic and pest-borne diseases; sustainable use of natural resources; protection of agricultural production systems from pests and diseases; and facilitation of safe and sustainable trade and tourism.

National irrigation policy (2012): The policy provides direction in the irrigation sub-sector to address its current and future issues. It provides clear direction on the measures that need to be adopted to increase the irrigated area and to improve irrigation water management and optimal utilization of national water resources for crop production. Thus in addition to the water policy, agriculture research to improve the irrigation system through developing technologies is clearly identified in the National Irrigation Policy, 2012.

Foreign direct investment policy (2010): Promote private sector participation in RNR Sector to enhance investment, production, value addition and marketing.

Strategies in Agriculture Research and Development

In order to realize and translate the policies mentioned above, several strategic frameworks have been put in place. These are briefly mentioned in the following section. In order to focus on the agriculture sector, only strategies put in place to help realize those policy directly related to agriculture development is mentioned here.

Strategy for protection of agricultural areas, December 2009: The purpose of this strategy is to address the food security, which is in most critical threat. This is because of the indiscriminate use of agricultural land for non-agricultural purposes such as sprawling urban areas, acquisition of prime agricultural land haphazardly for the implementation of development activities in rural areas and the conversion of terraced paddy fields to other purposes, which results to the diminishing, or under-utilization of limited agricultural areas.

Land as the basis of production, the role of research is required in the fields of identifying options and innovations that could help protect land through reverting them into production and avoid loss of land to other uses.

Bhutan national human-wildlife conflict management strategy, 2008: The strategy document ensures to address and reduce human-wildlife conflicts to a manageable level in the country through a comprehensive consideration of social, economical and ecological factors to enhance the livelihoods of our farmers, and offset their losses from wildlife damages, for human welfare and poverty alleviation. Wild life damage to crops is one the major constraints faced by farmers and currently; the ministry of Agriculture is promoting the use of electric fence to ward off wild animals. Agriculture research centre's and the national plant protection centres developed low cost electric fence which has brought down cost of technology. The RDCs continue to spearhead the development and improvements' in the electric fence technology and also develop other alternatives to help reduce Human Wild Life Conflicts.

Commodities programme development strategies for 11th FYP: Every five year plan periods depending on the existing and new policies to help achieve development goals in agriculture, specific strategies are developed and used as guide in implementation. One such strategy currently guiding the implementation of agriculture development plans is the Commodity Programme Strategies which covers both research and development. The main commodity Programme Implementation Strategies are:

- National Horticulture Research and Development Programme Strategy
- National Fields Crops Research and Development Programme Strategy
- Farm Mechanization and Infrastructure – including irrigation, post-harvest, road access and market
- Organic Farming Strategy

These encompass separate Commodity Programme Strategies such as rice, maize, fruits and nuts, citrus, vegetables, spices and medicinal plants, potato, mushroom and organic programme strategy. The national programme strategies have set targets and resource allocations. Other cross cutting themes such as plant protection, soil fertility and post-harvest services equally contributes to the overall commodity programme.

Farm mechanization strategy: With increasing cost of farm labour, farm mechanization is given one of the highest priorities. The MoAF is enhancing the farm machinery support services (research on innovative technology, training to stakeholders and supply of subsidized machineries). Currently, the Ministry is rampantly going on establishing the Farm Machinery Hiring Service in all 205 blocks in the country covering all 20 districts. The hiring units provide machinery on hire and back-up services.

Agriculture marketing strategy: Bhutan agriculture development is not shifting its paradigm from production based to market based production. Access to market through network of farm roads has become another priority in development programmes. A new initiative which is under implementation currently is the creating of farm shops in every blocks in the country. The farm shops established through a collaboration of Agriculture Marketing and the Food Corporation of Bhutan, plays the role of a one stop shop for farmers from where they can buy essential commodities, tools, equipments, farm inputs and a buy back of farm produce by these shops is to begin soon. With the start of buy back, the farm shops becomes a market place for farmers to sell their farm produce. The farm shops can then bulk up the produces and market elsewhere.

Market outlets through establishment of market infrastructures are also supported by the government and area development projects under the MoAF. A new market support programme providing price support to farmers has also begun on a trial basis.

Commercialization and intensification of crops: Commodity development programmes have strongly emphasized on commercial level of farm production. Inputs supports such as greenhouses, tools and equipments, seeds are provided on a cost sharing basis. A winter crop intensification programme such as spring wheat, spring maize, oilseed cropping and winter cropping of vegetables have also started to ensure fields are effectively used without keeping it fallow. Hybrid maize is tested in selected potential areas and is currently under promotion.

- **Irrigation water management and infrastructure development:** Research in irrigation water management technologies and infrastructure development is to be enhanced by allocating adequate resources and targeting priority infrastructure development to accelerate rice production and winter cropping. More than 100 irrigation schemes are taken on board. New irrigation technologies contributing to effective utilization of water resources are to be promoted or developed through research and innovations.
- **Improvement of extension services:** Delivery of extension services are to be improved through adoption of focused approaches in extension services delivery rather than scattered delivery of services. Extension service centres are to be linked closer to regional research and development centres for technical assistance and collaborative programmes on technology dissemination.
- **Land development and consolidation:** Bhutan has very less arable land with almost 69 per cent under forest and protected area. Most parts of the country except for southern foothills and some parts in west central, agriculture farming is done on slopy lands. The DoA will be carrying out development and consolidation of land so that it is made suitable for mechanization. Appropriate sustainable land management options are also promoted to improve the land available for farming.

Approaches in Agriculture Development

The MoAF has adopted the Commodity approach for development in which support is provided to entire production and marketing chain. A concept of One Geog-block, Three Products (OGTP) guides development programmes to focus in generating a specific product for a particular block with adequate volume to market and bring benefit to farmers from farming.

Research Outreach - extending research support services beyond the research centre into the farmer's field is also emphasized strongly. Farm shops mentioned in previous section and credit facilities through the creation of the Business Opportunity Information Centre in the last few years are making progress enabling farmers to upscale production from small scale to commercial levels.

Farmer groups and cooperatives will be strengthened and link them with market. Private sector participation is also encouraged through promotion of Public Private Partnerships to enable private sector involvement in farming and enable commercialization of agriculture.

Specific Focus Areas in Agriculture Development

The MoAF focuses on agriculture marketing, farm roads, production input services, technical assistance, mechanization of agriculture, irrigation infrastructure and water management as key focus areas of development. A commodity based focused approach is given the highest priority and identified seven major crops - rice, maize, citrus, potato, apple, cardamom and vegetables to be focused. Improvement of market linkages and marketing system to initiate a market led production is currently explored through the involvement of corporate agency, Food Corporation of Bhutan (FCB) and linking them to farmers groups and cooperatives.

Priorities for Agriculture Research and Innovations

The Research and Development Centres (RDCs) are to be demand driven, market-oriented, innovation focused to ensure that the technologies generated through research serve the actual needs of the farmers and thus have prioritized developing suitable technology options appropriate for commercialization of agriculture and climate resilient. Innovation through crop selection, breeding, improving crop agronomy, plant protection - especially in reducing human wild life conflicts, soil fertility and irrigation technology have now become priorities. Innovations in improving the farming systems through integration of crops, development and promotion of integrated soil fertility and plant protection technologies through adaptive and action research are prioritized.

Development of climate resilient technologies through breeding, selection from traditional varieties, development of pest and disease tolerance and integration with traditional knowledge is also becoming important.

Targets

The agriculture development and research targets for the 11th Five Year Plan (FYP) (2013-2018) for some selected indicators are presented in tables 2 and 3.

Table 2. Annual targets for selected indicators at outcome level for 11th FYP

Key indicators	Baseline (2011)	Plan target (2018)
Vegetable production (mt)	35,777.00	63,456.00
Reduction of annual import of vegetables by 50% (mt)	6,793.00	3,369.00
Vegetable area under cultivation (acres)	28,255.00	42,382.00
Vegetable productivity (mt/acre)	1.302.00	1.85
Citrus production (mt)	60,993.00	67,273.00
Citrus- No of trees (bearing)	3,122,356.00	3,328,431.00
Citrus productivity (tons/acre)	35.00	41.00
Potato production (mt)	52,116.00	78,072.00
Potato productivity (tons/acre)	3.34	5.00
Fruits and nuts production (mt)	35,530.00	38,856.00
Fruits and nuts productivity (kg/tree)	22.00	30.00
Number of trees (bearing)	3,191,053.00	4,135,609.00
Spices and medicinal plants (mt)	4,500.00	5,400.00
Spices and medicinal plants area (acres)	6,938.00	8,326.00
Spices and medicinal plans productivity (kg/acre)	622.00	746.00
Mushroom production (mt)	89.00	119.00
Mushroom - No of farmer groups	18.00	70.00

Source: MoAF, 2014

Table 3. Selected list of research targets in the 11th Five Year Plan

Key indicators	Baseline (2013)	Plan target (2018)
Number of RNR technology available for use by the farmers	76	236
Number of technologies screened and climate smart technologies	22	40
Number of adoption & impact studies conducted (climate smart technologies)	1	11

Source: MoAF, 2014

The major institutions involved in the translation of agriculture policies into actions are those directly and indirectly associated with the whole value chain in agriculture production. A list of institutions, associated directly in agriculture development or in partnership, and their roles and responsibilities are given table 4.

Table 4. Institutional roles and responsibilities in agriculture development

Institutions/Agencies	Roles and responsibilities
Within the MoAF	
MoAF Secretariat, Policy and Planning, Administrative and Finance Divisions	Policy guidance and fund exploration; facilitate resources through area development projects; legal and policy frame work
Council for RNR Research	Policy research and research in cross cutting themes
Divisions	
Horticulture	Coordinate horticulture commodity development programme
Agriculture	Coordinate cereal crops development programme
Engineering	Provide engineering services (irrigation) and heavy machinery services
Agriculture Information Services	Coordinate extension services and information management
Central Programme Agencies	
Plant Protection Service Centre	Provide plant protection services
Soils Service Centre	Provide soil fertility and nutrient management services (nutrient analysis, land management, etc)
Post Harvest Centre	Provide post-harvest technologies and services
Agriculture Machinery	Provide farm mechanization services
National Seed Centre	Provide seeds and seedling services
Regional and District level	
Regional Research and Development Centre's	Develop suitable farming technology options and assist districts in promotion of technologies and technical assistance
District and Block Extension Services	Dissemination of technologies and technical assistance to farmers
Farmers/Groups, Cooperatives	Beneficiaries of agriculture development, producers

Contd...

Table 4 (Contd.)

Institutions/Agencies	Roles and responsibilities
Other Departments and Non Departmental	
Department of Agriculture Marketing and Cooperatives	Market information and linkages, conduct market research
Food Corporation of Bhutan	Facilitate marketing
Information and Communication Services	Provide information and communication services, publicity and information dissemination
National Biodiversity Centre	Provide plant genetic resources conservation services, financial resources in conservation initiatives
Bhutan Agriculture Food Regulatory Authority	Food regulatory services
Other Ministries and Autonomous Agencies	
Gross National Happiness Commission	Facilitate resource mobilization and planning guidance
Ministry of Finance	Provide financial resources
Rural Development Training Centre	Capacity development services for farmers
College of Natural Resources, Royal University of Bhutan	Capacity development services for agriculture staff
International/Government Agencies (Only few agencies associated in the last few years are mentioned here)	
Embassy of India, Govt. of India (GoI)	Technical support and fund support
UNDP	Technical assistance and fund support
JICA	Technical assistance and fund support, mechanization support
SNV	Technical assistance
Swiss International	Technical assistance and fund support
EU	Fund support
IFAD	Technical assistance and fund support
World Bank	Technical assistance and fund support
FAO	Technical assistance

Infrastructure and Financial Investments

Bhutan's Ministry of Agriculture in the current five year plan is allocated with a total of 4,856 million Ngultrums (about 74 million USD) as capital outlay. Of this, agriculture development has the highest allocation of 2,300 million Ngultrum (about 35 million USD) which accounts for 47 per cent of the total allocation with another 20 million Ngultrum (about 0.300 million USD) for Research. The agriculture infrastructure mainly for irrigation and farm mechanization is given the highest allocation of about 69 per cent and the remaining allocated for the commodity development programmes.

Based on the expenditures made in the first two years of the current plan, 63 per cent of the financial allocation is met from the Royal Government of Bhutan and 37 per cent through donor assistance (MoAF, 2015). The financial allocations to agriculture development are shown in table 5.

Table 5. Financial allocations to agriculture development in the 11th FYP (2013-2018)

Programme	Total outlay (million Nu.)	Total outlay (million USD)
National Field Crops Development Programme	430	6.60
National Horticulture Development Programme	230	3.50
Agriculture Infrastructure Development Programme	1600	24.60
National Organic Programme	40	0.61
Total	2300	35.38

Source: MoAF, 2014

There are no major investments in the current plan identified for infrastructures relating to institutions due to deficit. The existing institution with basic infrastructures is to be utilized except for few prioritized ones.

The agriculture development is implemented by a total Human Resource (HR) strength of 442 personnel including researchers. HR allocations in the agriculture levels and qualification are shown in table 6. Agriculture Department has 23 per cent total HR allocations, second highest in the Ministry. However, human resource especially at the professional and specialist level is still inadequate.

Table 6. Allocation of HR in agriculture development by level and qualification

Agency	Level					Total	% of MoAF
	Executive	Specialist	Professional/ mgt	Support/ Supervisory	Operational		
Department of Agriculture	1	8	370	333	107	819	23
	Qualification					Total	% of MoAF
	Ph.D.	Masters	Bachelors	PG Diploma	Diploma	Certificate	
	2	44	92	11	380	290	819

Major Challenges and Opportunities

Agriculture development is faced with the challenges of decreasing public investment, losing land to urban development, lack of infrastructure - irrigation and post harvest, low volume of production, human wild life conflicts and rural urban migration. The impacts of climate change in form of natural calamities and disasters are also increasingly becoming a major challenge. Inadequate financing will continue to be a challenge. The current five year plan has a resource gap of 33 per cent which can impact on achieving the targets.

However, opportunities from past development are to be explored such as connectivity of rural areas with farm roads and power tiller tracks (3,289 farm roads and 136 km of power tillers tracks) should be able to bring communities closer to market and thereby enhance

production. There is adequate policy and legal frameworks put in place as mentioned in previous sections which provide enabling policy environment to enhance agriculture development. Developments in information and communication technologies leading to e services such as Government to Citizen Initiatives could enhance service delivery that can also contribute to boosting production.

Bhutan's pristine environment suitable for clean agriculture practices provides opportunities to upscale organic production for niche crops both for domestic and export markets. As an importing country, its imbalance in trade capitalized to boost home production of agriculture produces for e.g., the vegetable self sufficiency programmes experienced in the last few years should further step up and move beyond vegetables into other farm produces.

The current efforts in mechanization, improvement in marketing and government's initiatives in providing credit facilities through Business Opportunities Information Centers should be captured to enhance production and entrepreneurship development in agriculture and contribute to commercialization of agriculture.

Looking Ahead (short to medium-term)

The mid-term evaluation of the agriculture development conducted recently showed that the development progress is on track. Out of 73 key performance indicators, nine have been achieved, 52 were on track and 12 at risk. Farm mechanization, vegetable production and maize production were highlighted to be key achievements (MoAF, 2015).

As an immediate short-term way forward will be to revisit the current agriculture development plan, reprioritize and move forward and see through completing the five year plan. The remaining part of the five year plan will have to focus on:

- Mobilizing fund deficits or reprioritize among programmes and reallocate resources
- Consolidation and enhance synergy of development programmes for effective utilization of available resources among the agriculture development implementing agencies and partner agencies
- Revisit targets set in the beginning and rework based on the available resources and capacity
- Follow up to the recent organizational development to allocate the adequate human resource allocations and management
- Streamline monitoring and evaluation - result based monitoring mechanism put in place and practiced and link up with the planning and budgeting systems

In the long run, MoAF will have to take stock of lessons learnt from the current plan and develop its next Five Year Plan which will have to focus on the following:

- Streamline research programmes to graduate into more advanced and systematic research in genetic conservation, biotechnology and breeding
- Institute consistent funding mechanism for agriculture research such as Research Trust Fund and client based research service delivery

- Economic advancement programmes targeting poverty prone areas
- Entrepreneurial development in agriculture to commercialize agriculture and make farming attractive to young farmers (engaging youth in farming)
- Agriculture input delivery mechanisms
- Agriculture market improvement
- Crop insurance schemes, agriculture subsidies and minimum price support for farmers
- Credit facilities and enhancing private sector in farming through public, private partnership programmes
- Climate change mitigation and climate smart technology development
- Development of commercially adaptable crop technologies
- Service delivery improvements
- Protection and development of agricultural land for commercial farming
- Crop intensification

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6. Country Status Report: Cambodia

Ouk Makara

Cambodian Agricultural Research and Development Institute (CARDI),
Pohnom Penh, Cambodia

Basic Information

Indicator	Particulars
1. Name of the Country	Cambodia
2. Reporting Agency	CARDI
3. Value of GDP in Local Currency (Riel in billion)*	60,920.00 billions
4. Value of GDP in USD*	15.23.00 billions
5. Value of Ag. GDP in Local Currency (Riel in billion)*	17,484.00 billions
6. Value of Ag. GDP in USD*	4.37 billions
7. Ag. GDP as % of GDP*	28.70

**World Bank statistics for the latest year during 2012-2014*

Rectangular Strategy Phase III

Rectangle I: Promotion of Agriculture Sector

Cambodia's agriculture continues to play an important role in supporting economic growth, ensuring equity, securing food security, and promoting development of the rural economy. The Royal Government's vision is to modernize Cambodia's agriculture (with maintaining the targeted agricultural growth of five per cent per annum), based on a new approach and with changed scope and pace, to transform this sector from extensive stage of development, i.e. primarily depending on expanded use of available resources (such as land and other natural resources) and traditional agricultural inputs, into an intensive stage of development that primarily depends on the application of techniques, new technologies, R&D, mechanization and increased capacity of irrigation to improve productivity, and diversify into high value crops and other agricultural products including livestock farming and aquaculture while taking into account the need to ensure efficient management of land and sustainability of environment and natural resources. Moreover, further promotion of commercialization and agro-industry development will increase added-value of agricultural products and income of people. In pursuance of this objective, the Royal Government focuses on:

- Further improving productivity, diversification and commercialization of rice and other crops by promoting R&D for productivity and quality improvement and adaptation to climate change

- Strengthening, expanding and ensuring the sustainability of extension services and market information
- Promotion of use of agricultural machinery with sustainable management of national resources.

Strategies

Major strategies adopted for implementing above policies

Agricultural Sector Strategic Development Plan 2014-2018 (ASSDP2014-2018)

In response to productivity, diversification and commercialization of agricultural crops, MAFF aims to increase the growth of all kind of crops production by 10 per cent per annum through enhancing agricultural research and extension aiming to increase crop yield, improve the product quality for market demand, and adaptation to climate change with sustainable agricultural land and water resource management.

National Strategic Development Plan 2014-2018 (NSDP2014-2018)

The enhancement of agricultural productivity, diversification and commercialization are the main strategic goals for promoting growth and reducing poverty in the agricultural sector. Productivity increases are needed to enable increased production by double cropping and crop intensification approach. Diversification will help farmers reduce risk and at the same time shift to the cultivation of crops with greater value-added. Poverty cannot be eliminated by improving subsistence alone, so commercialization is a necessary means of improving farm incomes and farmer welfare. At the same time, care must be taken to ensure that commercialization does not undermine food security.

Strategic Plan in Response to the Impact of Climate Change 2013-2018, MAFF (MAFF-SPIRICC 2013-2018)

To reach this objective, MAFF R&D will focus on the following strategic approaches: (i) strengthening capacity and facility of research and development that will continue to improve crop productivity and resilience to climate change and market demand; and (ii) promoting agricultural diversification through the creation of an enabling environment to increase the involvement of private sector in research to identify value added crops for diversification, adaptation to climate change and commercialization.

Specific Focus

Areas covering commodities, enterprises, systems, approaches (adaptive, applied, basic & strategic, anticipatory, etc.)

To achieve the above strategic objectives, NSDP2014-2018, ASSDP2014-2018 and SPIRICC2013-2018 outlines basic, strategic and adaptive R&D for rice and non rice crops with specific focus on:

- Continuing germplasm collection and evaluation and acceleration of their utilization

- Improvement of popular released rice varieties with commercial value grown in medium and lower toposequences of rainfed lowlands for tolerance to flood, drought and salinity, and resistance to bacterial leaf blight, rice blast and brown plant hopper (BPH)
- Development of less than 100 days maturity rice varieties suitable for dry and early wet season with resistance to BPH, rice blast and herbicide; tolerance to height temperature and salinity; and high water use efficiency
- Breeding to develop high-yielding open pollinated varieties (OPV) of legumes, maize, mango, and vegetables
- Development of market oriented and cost effective technology package for cropping systems in fully irrigation, rainfed lowlands, rainfed uplands and coastal areas
- Develop technologies for soil-water-crop management and integrated watershed management systems to mitigate green house gas and to improve productivity and sustainability promote best practices in the utilization of soil and water
- Assessing the effectiveness of introduced farm mechanization for direct seeding and crop intensification
- Developing technologies for pest management, including rats, golden apple snails, insects and weeds with particular focus on preventive strategies
- Identifying value chains for commercial crops
- Improving information communication technology (ICT), public awareness, training course, and knowledge transfer, to improving farmers' livelihoods

Priorities for Agricultural Research and Innovations for Development (ARI4D)

Major areas of ARI4D focus include:

- Conventional areas (breeding including quality and marker assisted selection (MAS), agronomy, crop protection, natural resource management (NRM), soil science, agricultural engineering)
- Other areas of development such as systems (farming, cropping, integrated), policy, value chains, agricultural business planning

Targets

Targets set to be addressed directly or indirectly through agricultural development.

- Food and nutritional security (by increased agricultural productivity and production; genetic enhancement, and/or value-added processing of foods to mitigate malnutrition and under-nutrition)
- Poverty reduction (by enhancing the farmers' incomes)
- Food safety and market orientation
- Reduced environmental degradation (by adopting measures such as biocontrol, bio-safety, soil erosion and mitigation of green house gas)

Institutional Roles, Responsibilities and Partnerships

Which agencies/organizations (including the state/province central), private sector, CSOs, FOs, regional and international programmes) doing what, and what kind of partnership/collaboration has been adopted.

The Cambodian Agricultural Research and Development Institute (CARDI). CARDI is a semi-autonomous, leading agricultural research institute under the jurisdiction of the Ministry of Agriculture, Forestry and Fisheries (MAFF) and Ministry of Economic and Finance (MEF). A core objective of CARDI is to improve the living standard of farmers through agricultural research, training and technology transfer. It is a multi-disciplinary research institute, focusing on rice, non-rice and rice-base farming systems in Cambodia. It is responsible for:

- Management and leadership of all research activities to enhance agricultural development
- Conducting applied research and transfer technologies, including agricultural economics
- Delivering services to support implementation and rehabilitation of agricultural development projects
- Development of human resources in the agricultural field and
- Cooperation with relevant research institutions, both national and international

Royal University of Agriculture (RUA) as the leading agricultural university in Cambodia, shall progressively achieve an international level of quality in education, research and extension of agriculture, related sectors and sustainable use of natural resources.

Prek Leap National School of Agriculture (PLNSA)

Kampong Cham National School of Agriculture (KCNSA)

General Directorate of Agriculture (GDA)

Cambodian Development and Research Institute (CDRI)

Infrastructure and Financial Investments

Brief information on important infrastructure relating to research institutions and agricultural universities, and available human resource be provided.

CARDI:

- 50 hectares of irrigated, rainfed and upland field experiments
- Genebank
- Grain quality, MAS and tissue culture laboratories
- Soil and water laboratories
- Plant protection laboratories

- Library
- 150 staff (50 government staff, 100 recruited staff) with six Ph.D., 16 M.Sc. and 34 B.Sc.
- Government budget=0.6 million USD, International research collaboration=0.25 million USD (2014)

RUA, Faculty of Agronomy:

- 0.8 hectare of field experiment
- Soil, entomology, plant disease, mushroom spawn and tissue culture laboratories
- 13 staff with four Ph.D. and seven M.Sc.

PLNSA, Department of Agriculture:

- 20 hectare of field research and demonstration,
- 10 staff with one Ph.D., four M.Sc. and five B.Sc.

GDA, Rice Crop Department:

- Four Development and Seed Centers
- 85 staff with one Ph.D., 10 M.Sc. and 30 B.Sc.

GDA, Department of Horticulture and Cash Crops:

- Three Development and Seed Centers,
- 54 staff with two Ph.D., five M.Sc. and 23 B.Sc.

Major Challenges and Opportunities

Major challenges

- Strong human resource competition by other agencies resulting in lack of HR
- Limited fund from both government and donors
- Limited functioning of research laboratories
- Poor coordination among research institutions

Opportunities

- Support from the government policies
- Market orientation research will encourage involvement of private sector
- Increase world demand for agricultural products

Need and potential for future collaboration (within and outside)

- Proper and effective coordination among national research institutions
- Participating in multi-national research projects
- Human resource development in agricultural research

Looking ahead (short to medium-term)

- What specific road map - both for short-term (five years) and medium-term (10 years) is envisaged?
- Need to develop national agricultural research road map for short, medium and long-term

7. Country Status Report: China

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Basic Information

It is well known that China's rapid economic development in the past three decades is unparalleled in recent world history. From 1978 to 2011, China's real average annual gross domestic product (GDP) growth rate was 9.92 per cent, making it one of the fastest growing economies in the world. In the recent years, the growth rate is going down, but it is still high in the world. Real GDP growth rate was: 7.7 per cent in 2012, 7.7 per cent in 2013, and 7.3 per cent in 2014. Real average agricultural GDP growth rate in 1978-2011 was 5.9 per cent. In 2012-2014, this rate was 4.9 per cent, 4.0 per cent, and 4.2 per cent, respectively.

The share of agriculture GDP in total GDP keeps going down from more than 40 per cent in 1980s to 16 per cent in recent years along with the development of whole economy (Table 1).

Table 1. Agriculture GDP and GDP of China

Year	Ag. GDP (billion Yuan)	Real growth rate (preceding year=100)	GDP (billion Yuan)	Real growth rate (preceding year=100)	Ag. GDP as % of GDP	Exchange rate (Yuan/ USD)
1978	13.97	108.1	36.50	111.6	38.27	
1979	16.98	107.5	40.68	107.6	41.74	
1980	19.23	101.4	45.52	107.9	42.25	
1981	21.81	105.8	48.98	105.1	44.53	1.7051
1982	24.83	111.3	53.33	109.0	46.56	1.8926
1983	27.50	107.8	59.76	110.8	46.02	1.9757
1984	32.15	112.3	72.26	115.2	44.49	2.3270
1985	36.19	103.4	90.40	113.5	40.03	2.9367
1986	40.13	103.4	103.09	108.9	38.93	3.4528
1987	46.76	105.8	121.02	111.7	38.64	3.7221
1988	58.65	103.9	151.01	111.3	38.84	3.7221
1989	65.35	103.1	170.90	104.2	38.24	3.7651
1990	76.62	107.6	187.74	103.9	40.81	4.7832

Contd...

Table 1 (Contd.)

Year	Ag. GDP (billion Yuan)	Real growth rate (preceding year=100)	GDP (billion Yuan)	Real growth rate (preceding year=100)	Ag. GDP as % of GDP	Exchange rate (Yuan/ USD)
1991	81.57	103.7	218.96	109.3	37.25	5.3233
1992	90.85	106.4	270.68	114.3	33.56	5.5146
1993	109.96	107.8	355.24	113.9	30.95	5.7620
1994	157.51	108.6	484.60	113.1	32.50	8.6187
1995	203.41	110.9	611.30	111.0	33.27	8.3510
1996	223.54	109.4	715.72	109.9	31.23	8.3142
1997	237.88	106.7	794.30	109.2	29.95	8.2898
1998	245.42	106.0	848.84	107.8	28.91	8.2791
1999	245.19	104.7	901.88	107.6	27.19	8.2783
2000	249.16	103.6	997.76	108.4	24.97	8.2784
2001	261.80	104.2	1102.70	108.3	23.74	8.2770
2002	273.91	104.9	1210.02	109.1	22.64	8.2770
2003	296.92	103.9	1365.65	110.0	21.74	8.2770
2004	362.39	107.5	1607.14	110.1	22.55	8.2768
2005	394.51	105.7	1858.96	111.3	21.22	8.1917
2006	408.11	105.4	2176.57	112.7	18.75	7.9718
2007	488.93	103.9	2680.19	114.2	18.24	7.6040
2008	580.02	105.7	3167.52	109.6	18.31	6.9451
2009	603.61	104.6	3456.29	109.2	17.46	6.8310
2010	693.20	104.4	4089.03	110.6	16.95	6.7695
2011	813.04	104.5	4841.24	109.5	16.79	6.4588
2012	894.53	104.9	5341.23	107.7	16.75	6.3125
2013	969.95	104.0	5880.19	107.7	16.50	6.1932
2014	1022.26	104.2	6361.39	107.3	16.07	6.1428

Data source: China Statistical Yearbook

China's population, which stood at 1.368 billion in 2014 (Table 2), is expected to reach nearly 1.43 billion people by 2020. As a result of income increase, demand for food, particularly meat, grew and continues to grow. The increase in demand for meat, in turn, accelerates the demand for feed grain. Therefore, China is expected to raise its consumption of meat and be the biggest consumer of grain products in the world in the coming decades. This will make China more actively involved in closing the gap between demand and supply domestic market as well as in the world market, despite its great achievement in agriculture production with its limited resources per capita such as arable land, water supply.

Table 2. Population of China (million)

Year	Total population	Urban		Rural	
		Population	Proportion (%)	Population	Proportion (%)
1978	962.59	172.45	17.92	790.14	82.08
1979	975.42	184.95	18.96	790.47	81.04
1980	987.05	191.40	19.39	795.65	80.61
1981	1000.72	201.71	20.16	799.01	79.84
1982	1016.54	214.80	21.13	801.74	78.87
1983	1030.08	222.74	21.62	807.34	78.38
1984	1043.57	240.17	23.01	803.40	76.99
1985	1058.51	250.94	23.71	807.57	76.29
1986	1075.07	263.66	24.52	811.41	75.48
1987	1093.00	276.74	25.32	816.26	74.68
1988	1110.26	286.61	25.81	823.65	74.19
1989	1127.04	295.40	26.21	831.64	73.79
1990	1143.33	301.95	26.41	841.38	73.59
1991	1158.23	312.03	26.94	846.20	73.06
1992	1171.71	321.75	27.46	849.96	72.54
1993	1185.17	331.73	27.99	853.44	72.01
1994	1198.50	341.69	28.51	856.81	71.49
1995	1211.21	351.74	29.04	859.47	70.96
1996	1223.89	373.04	30.48	850.85	69.52
1997	1236.26	394.49	31.91	841.77	68.09
1998	1247.61	416.08	33.35	831.53	66.65
1999	1257.86	437.48	34.78	820.38	65.22
2000	1267.43	459.06	36.22	808.37	63.78
2001	1276.27	480.64	37.66	795.63	62.34
2002	1284.53	502.12	39.09	782.41	60.91
2003	1292.27	523.76	40.53	768.51	59.47
2004	1299.88	542.83	41.76	757.05	58.24
2005	1307.56	562.12	42.99	745.44	57.01
2006	1314.48	582.88	44.34	731.60	55.66
2007	1321.29	606.33	45.89	714.96	54.11
2008	1328.02	624.03	46.99	703.99	53.01
2009	1334.50	645.12	48.34	689.38	51.66
2010	1340.91	669.78	49.95	671.13	50.05
2011	1347.35	690.79	51.27	656.56	48.73

Contd...

Table 2 (Contd.)

Year	Total population	Urban		Rural	
		Population	Proportion (%)	Population	Proportion (%)
2012	1354.04	711.82	52.57	642.22	47.43
2013	1360.72	731.11	53.73	629.61	46.27
2014	1367.82	749.16	54.77	618.66	45.23

Data source: China Statistical Yearbook

National strategy, therefore, aims to increase national grain production, particularly that of wheat and rice (Chinese staple foods), and maize (main source of feed). In line with the strategy, a policy environment geared toward increasing grain production has implications on sustainable agricultural development determined by the market forces, on a free domestic and international trading environment, inter-regional and rural development, farm income, as well as on overall economic development. However, the ratio of world prices to domestic prices of agricultural commodities affects food security and overall economy performance. Also, the impact of market forces that induce production and efficient allocation of resources depends not only on the level of liberalization in the international trade but also on the level of liberalization in the domestic market. The policy issues and options facing China are, therefore, complex.

Government Financial support for Agriculture, Agricultural Science and Technology Research

Based the national condition being very limited agricultural resources per capita, Chinese government has been giving high priority to the development of agriculture for a long time. It invests more and more into agricultural productions, rural societies, and farmers in recent years as the development of whole economy. The increasing investment can be shown in the change in general public budget expenditure of the central and local governments for agriculture, forestry and water conservancy listed in table 3, which are just part of government investment into agriculture.

Table 3. General public budget expenditure of the central and local governments for agriculture, forestry and water conservancy (billion Yuan)

Year	General public budget		
	Expenditure	Central government	Local governments
2006	216.14	19.44	196.70
2007	340.47	31.37	309.10
2008	454.40	30.84	423.56
2009	672.04	31.87	640.17
2010	812.96	38.79	774.17
2011	993.76	41.66	952.10
2012	1197.39	50.25	1147.14
2013	1334.96	52.69	1282.26
2014	1417.38	53.97	1363.42

Data source: China Statistical Yearbook

In China, the major bodies for agricultural science and technology research are state-owned and collective-owned (especially state-owned) enterprises and institutions, though there comes more and more research activities in big agricultural companies. It is shown in table 4 that technical personnel who do research on agricultural science and technology in state-owned and collective-owned enterprises and institutions are stably maintained 600-700 thousands. There are still many other researchers of agricultural science and technology in universities, companies, as well as government agencies who are not included in table 4. Table 5 shows that the number of R&D institutions of agricultural sciences is also stable. This stability shows that China maintains a stable research team in agricultural science and technology.

Table 4. Technical personnel in state-owned and collective-owned enterprises and institutions (person)

Year	Total	Agriculture	Proportion (%)
1995	27053663	535731	1.98
1996	28019313	579157	2.07
1997	28603117	611458	2.14
1998	28773511	635929	2.21
1999	29042988	654138	2.25
2000	28874159	670105	2.32
2001	28477431	674644	2.37
2002	28344158	666998	2.35
2003	27745585	683437	2.46
2004	27504073	704576	2.56
2005	27567260	705720	2.56
2006	27739287	701930	2.53
2007	28014657	701481	2.50
2008	28635696	715774	2.50
2009	28879635	714720	2.47
2010	28157323	688651	2.45
2011	29186650	714489	2.45
2012	29774237	711841	2.39
2013	30259517	733474	2.42

Data source: China Statistical Yearbook on Science and Technology

Table 5. R&D personnel in R&D institutions of agricultural sciences

Year	R&D institutions (unit)	Employed personnel (person)	R&D personnel (person)
2009	1293	103056	42843
2010	1293	103539	46323
2011	1288	103173	47641
2012	1284	103507	51491
2013	1279	102108	52240

Data source: China Statistical Yearbook on Science and Technology

The research funding for researchers of agricultural science and technology comes mainly from central government (Table 6) or local governments. The governments usually design research programmes or projects which are public to all researchers. Researchers apply for these programmes or projects with competition. There are, nevertheless, more and more research projects from companies and non-government agencies for researchers to apply.

Table 6. Appropriation for S&T by Central Government in agriculture (million Yuan)

Year	Agricultural science and technology transfer fund	Agricultural technologies R&D programme	National agriculture basic research programme
2005	300	303	109
2006	300	789	111
2007	300	1184	145
2008	300	1020	170
2009	400	966	229
2010	500	1101	220
2011	500	1319	260
2012	500	1150	313
2013	500	1122	253

Data source: China Statistical Yearbook on Science and Technology

Government Agricultural Policies and Strategies

The government agricultural policies mainly include three categories: policies of promoting agriculture production and ensuring food security, policies of increasing farmer's income, policies of developing rural economy.

The major strategy adopted for implementing policies of promoting agriculture production and ensuring food security are: i) transformation of agriculture from traditional agriculture to resource saving and environmental friendly agriculture which is focused on sustainable development of agriculture; ii) progress and innovation in agriculture sciences and technologies, as well as transformation and popularization of agricultural scientific and technological achievements which is focused on improvement of agricultural productivity.

The major strategies adopted for implementing policies of increasing farmer's income are: i) urbanization at county level which is focused on employment of redundant rural labors released in the process of agricultural modernization; ii) farmer's entrepreneurship which is focused on extension of farmer's income generation.

The major strategies adopted for implementing policies of developing rural economy are: i) overall planning urban and rural development which is focused on integration of rural economy with urban economy; ii) gradually cancelling the difference of resident registration system (so called Hukou) between urban and rural residents which is focused on the equal development opportunity.

These three broad policies mentioned above are formulated by Chinese central government and usually promulgated by related ministries such as National Development and Reform Commission (NDRC), Ministry of Agriculture (MOA), Ministry of Finance (MOF), Ministry of Science and Technology (MOST). NDRC makes programmes and projects based on government policies and MOF makes budgets for these programmes and projects based on the government policies that should be implemented by multiple ministries. Each ministry also makes its programmes and projects that should be implemented by the ministry, and the budgets for these programmes and projects come from the ministry or MOF. The similar process occurs at the provincial level. All these programmes and projects are public to all researchers to apply with competition.

Most of the policies relating to agricultural production, farmer's income, and rural society are promulgated by MOA and MOF. Table 7 lists the policies promulgated in 2014.

Table 7. Policies promulgated by MOA in 2014

Policy	Remarks
1. Direct subsidy for grain production	Since 2004. 15. 1 billion Yuan budget in 2014; mainly focusing on encouraging rice, wheat, maize production
2. Synthetical subsidy for agricultural production materials	Since 2006. 107.1 billion Yuan budget in 2014; focusing on efficient use of fertilizer, pesticide
3. Subsidy for improved seed	Since 2005. 10 Yuan/mu for wheat, maize, soybean, rapeseed, barley, and 15 Yuan/mu for wheat in Xinjiang, 15 Yuan/mu for rice, cotton, 100 Yuan/mu for potato, 50 Yuan/mu for peanut seed breeding and 10 Yuan/mu for peanut field production; mainly focusing on encouraging use of improved seed
4. Subsidy for farm machinery purchase	Since 2004. Covering 175 items of 48 subcategories of 12 categories; focusing on promoting agricultural mechanization
5. Subsidy for update of old farm machinery	Since 2014. Synchronous implementation with policy 4
6. Subsidy for farmer at large scale, family farm, farmer cooperative	Since 2014. Mainly focusing on enlarging scale of agricultural production
7. Lowest procurement price for wheat, rice	Since 2004 for rice, 2006 for wheat. In 2014, 2.36 Yuan/kg for wheat, 2.7 Yuan/kg for early indica rice, 2.76 Yuan/kg for middle or late indica rice, 3.1 Yuan/kg for japonica rice; focusing on protecting farmer's income from wheat, rice production
8. Award to county of large production of grain or edible oil	Since 2005. 32 billion Yuan budget in 2013, and increasing budget in 2014; focusing on encouraging these counties' production of grain or edible oil
9. Award to county of large production of pig	Since 2007. 3.5 billion Yuan budget in 2013, and increasing budget in 2014; focusing on encouraging these counties' production of pig
10. Agricultural product target price	Since 2014 for cotton and soybean; focusing on price formation of agricultural product through market

Contd...

Table 7 (Contd.)

Policy	Remarks
11. Subsidy for key technologies of prevention and alleviation of agricultural disaster, stabilizing and/or increasing agricultural production	Since 2012. 6.05 billion Yuan budget in 2013, and increasing budget in 2014; focusing on stable agricultural production with S&T
12. Subsidy for establishment of high yield field of grain, cotton, edible oil, sugar	Since 2010. 2 billion Yuan budget in 2013, 2014; focusing on the demonstration roles of these fields
13. Support of establishment of standard garden of horticultural crops	Since 2009. Focusing on the demonstration roles of standard garden of horticultural crops
14. Subsidy for fertilizer use based on soil formula	Since 2005. 0.7 billion Yuan budget in 2014; focusing on efficient use of fertilizer
15. Subsidy for increasing soil organic matter	Since 2006. 0.8 million Yuan budget in 2014; focusing on improvement of soil quality
16. Support of seed enterprises being of integration of breeding and extension	Since 2011. Focusing on the development of integration of breeding and extension in big and strong seed enterprises
17. Subsidy for establishment of agricultural product traceability system	Since 2008. 49.85 million Yuan budget in 2011-2015; focusing on food safety
18. Subsidy for the standardization of agricultural production	Since 2006. 25 million Yuan budget per year; focusing on the demonstration roles of standardization of agricultural production
19. Subsidy for improvement of animal husbandry	Since 2005. 1.2 billion Yuan budget in 2013; focusing on the production of improved animal husbandry
20. Subsidy for animal husbandry breeding in standardization and scale	Since 2007. 2.5 billion Yuan per year; focusing on the demonstration roles of animal husbandry breeding in standardization and scale
21. Support of animal epidemic prevention	Since 2007. Focusing on the stability of animal husbandry production
22. Subsidy for grassland ecological protection	Since 2011. 6 Yuan/mu to herdsman; focusing on the sustainable development of grassland
23. Subsidy for alfalfa planting in order to revitalize the dairy industry	Since 2012. 0.3 billion Yuan budget per year; focusing on the development of dairy industry
24. Subsidy for diesel oil used in fishery industry.	Since 2006. Focusing on the development of fishery industry
25. Subsidy for protection of fishery resources.	Since 2012. 0.4 billion Yuan budget per year; focusing on sustainable development of fishery industry
26. Subsidy for ashore home construction for fishermen	Since 2013. 0.5 billion Yuan budget per year; focusing on the improvement of fishermen's living condition

Contd...

Table 7 (Contd.)

Policy	Remarks
27. Subsidy for renovation of marine fishing vessel	Since 2012. 4.2 billion Yuan budget in total; focusing on the development of marine fishing industry
28. Support of establishment of national modern agricultural demonstration zone	Since 2010. Focusing on the establishment of modern agriculture
29. Support of establishment of rural reform pilot area	Since 2012. Focusing new reform in rural region
30. Subsidy for primary processing of agricultural products in producing area	Since 2012. 0.5 billion Yuan budget per year; focusing on the improvement of farmer's entrepreneurship
31. Green channel for fresh agricultural products transport	Since 1995. Focusing on the facilitation of fresh agricultural products transport
32. Tax deduction in circulation of fresh agricultural products	Since 2013. Focusing on the facilitation of fresh agricultural products circulation
33. Support of rural biogas construction	Since 2003. Focusing on the improvement of rural environment
34. Recuperation of agricultural resources	Since 2014. Focusing on sustainable development of agriculture
35. Improvement of human settlement environment in village	Since 2014. Focusing on the quality of rural people's life
36. Training for new professional farmers	Since 2013. Focusing on the improvement of farmer's entrepreneurship
37. Subsidy for the establishment of demonstration counties for reform of extension system of agricultural technology	Since 2009. 2.6 billion Yuan budget in 2014; focusing on extension of agricultural technology
38. Sunshine project	Since 2005. Focusing on training rural labours
39. Training of rural skilled labors	Since 2009. Focusing on improving rural labor's skill
40. Urbanization of rural residents	Since 2014. Focusing on narrowing the difference in welfare, life style, behavior, etc. between urban and rural residents
41. Development of new rural finance cooperative	Since 2014. Focusing on farmer's demand for finance
42. Support of agricultural insurance	Since 2007. Focusing on the risk of agricultural production
43. Subsidy for village public utilities	Since 2008. 23.8 billion Yuan budget in 2013 and increase in 2014; Focusing on improvement of villager's public welfare
44. Support of the development of family farm	Since 2013. Focusing on the scale of agricultural production
45. Subsidy for the development of farmer cooperatives	Since 2010. 1.85 billion Yuan budget in 2013 and increase in 2014; focusing on the cooperation of farmers' various economic activities
46. Development of various forms of moderate scale of operation	Since 2014. Focusing on the diversification of rural economic activities in moderate scale

Contd...

Table 7 (Contd.)

Policy	Remarks
47. Improvement of agricultural social service system	Since 2014. Focusing on agricultural social services
48. Improvement of farmland contract system	Since 2014. Focusing on the reconfirmation of farmland contract
49. Reform of rural property rights system	Since 2014. Focusing on regulation of rural property rights
50. Renovation of rural dilapidated buildings	Since 2008. Focusing on improvement of rural residential quality

There are also many policies promulgated by other ministries. Science and technology researchers play important roles in the process of design, implementation, result evaluation, science and technology support, etc. of these policies.

Achievements

Great achievement has been made in agricultural sciences and technologies, such as the development of super rice, animal vaccine, *bt* cotton, soil improvement, etc. The big progress in recent years is the transfer and extension of research results more and more through market power. Researchers can be benefited more from their research results. Meanwhile, international cooperation in research and exchange of information and technology are also fruitful. China's agricultural science and technology is marching forward towards the advanced ranks in the world. The details of major achievements in different areas are given in tables 8-12.

Table 8. Major research results of science and technology in farming, forestry, animal husbandry and fishery

Year	Item	Year	Item
2005	5123	2010	5868
2006	5216	2011	6170
2007	5148	2012	7354
2008	5006	2013	7311
2009	5169		

Data source: China Statistical Yearbook on Science and Technology

Table 9. National science and technology awards to farming, forestry, animal husbandry and fishery (item)

Year	National S&T advancement award	National invention award	Year	National S&T advancement award	National invention award
2005	27	5	2010	41	4
2006	30	5	2011	27	5
2007	26	5	2012	56	11
2008	35	3	2013	24	8
2009	38	4			

Data source: China Statistical Yearbook on Science and Technology

Table 10. Application and granted of new variety rights of agriculture plants (piece)

	Grand Total from 1999 to 2013		Application in 2013
	Application	Granted	
Total	11710	4018	1333
by Units			
Domestic Research	5151	2113	494
Domestic Enterprises	4253	1313	618
Domestic Education	882	325	65
Domestic Individuals	663	175	52
Foreign Enterprises	681	89	98
Foreign Individuals	40	1	2
Foreign Education	22	2	1
Foreign Research	18		3
by Plant Species			
Field Crops	9811	3692	1079
Vegetables	658	152	74
Flowers	834	106	117
Fruit Tree	353	68	47
Pasture	11		
Others	43		16

Data source: China Statistical Yearbook on Science and Technology

Table 11. Contract deals in domestic technical markets by type of contracts (item)

Year	New species of animals and plants patent right transfer	New species of animals and plants	Agriculture technology	Farming, forestry and fishery
2006	113	326	5962	6663
2007	143	471	6442	6926
2008	157	454	5981	6964
2009	195	607	5669	6686
2010	344	1076	6091	6917
2011	220	799	6699	7611
2012	179	779	9188	10405
2013	160	590	11766	13204

Data source: China Statistical Yearbook on Science and Technology

Table 12. Value of contract deals in domestic technical markets by type of contracts (million Yuan)

Year	New species of animals and plants patent right transfer	New species of animals and plants	Agriculture technology	Farming, forestry and fishery
2006	252.36	411.52	4579.05	5069.06
2007	236.01	661.49	6048.84	6245.55
2008	515.33	1216.28	5352.15	5389.05
2009	624.88	916.72	9816.95	10305.31
2010	2494.44	931.59	8557.98	9129.55
2011	395.87	1209.13	20204.74	20109.48
2012	372.24	2356.67	18091.70	19394.58
2013	315.23	2312.23	23302.07	23512.18

Data source: China Statistical Yearbook on Science and Technology

There are, nevertheless, many challenges faced by agricultural researchers. The major challenges that are faced by Chinese researchers are to solve various new problems caused by climate change, rural social transformation, and adjustment of agricultural production structure, etc.

8. Country Status Report: Fiji

Apaitia Macanawai

Ministry of Agriculture (MoA), Raiwaqa, Suva, Republic of Fiji

Basic Information

Indicator	Particulars
1. Name of the Country	Republic of Fiji
2. Reporting Agency	Ministry of Agriculture
3. Value of GDP in Local Currency (specify)*	Average GDP (2012-2014) at current basic prices FJD [million] = 6527
4. Value of GDP in USD*	Average GDP (2012-2014) at current basic prices USD [million] = 3057
5. Value of Ag. GDP in Local Currency (specify)*	Average GDP (2012-2014) at current basic prices FJD [million] = 592
6. Value of Ag. GDP in USD*	Average GDP (2012-2014) at current basic prices USD [million] = 277
7. Ag. GDP as % of GDP*	9% Population census in 2007 was 837,271

**Source: Fiji Bureau of Statistics (Viewed on 25/10/15 at <http://www.statsfiji.gov.fj>)*

Current Policies

Policies adopted that have implications on agricultural research for development are given below:

- Commodity Development Framework (CDF)-1990
- Farming Assistance Programme (FAS)-2000
- Rural Land Use Policy for Fiji-2005
- Alternative Livelihood Programme (ALP)-2006
- Demand Driven Approach (DDA)- Subpolicies are Export Promotion Programme, Import Substitution Programme, Rural and Outer Island, Sigatoka Rural Development Programme and Dairy Industry Support-2007
- Fiji 2020 Agriculture Sector Policy Agenda Modernizing Agriculture-2014

Strategies

Major strategies were adopted for implementing above policies for modernizing agriculture - 2014. The strategic actions for the Fiji 2020 Agriculture Sector Policy Agenda are as follows:

- Build modern agriculture in Fiji as an organized system of producing, processing, and marketing crops, livestock, and aquaculture products
- Develop integrated production, processing, energy, and transport infrastructure support system for agriculture
- Improve delivery of agriculture support services
- Enhance capabilities to generate fund and secure investment through foreign investment, public private partnership, and other innovative business arrangements
- Improve project implementation and policy formulation capability within the MOA and its partner institutions

Specific Focus

Areas covering commodities, enterprises, systems, approaches (adaptive, applied, basic & strategic, anticipatory, etc.)

- Rural Transformation Center with Farmers Field School (FFS)
- Agroforestry with FFS
- Outer island strategy with FFS
- Industry focused programmes are as follows: i) sugarcane, ii) coconut, iii) beef, small ruminants, and dairy, vi) poultry and swine, v) BQA crops, vi) root crops, vii) rice, viii) aquaculture, ix) fruits, x) kava and other nutraceutical crops, xi) seeds, xii) farm machinery and xiii) feeds
- Research, training and extension
- Animal health and production
- Climate change
- Soils, water, and nutrient technology
- Value-adding and marketing
- Agriculture statistics
- Biosecurity
- Credit and crop insurance

Explanation: Here approaches such as adaptive, applied, basic and strategic, anticipatory, etc., to be released to.

Priorities for Agricultural Research and Innovations for Development (ARI4D)

Major priority areas of ARI4D focus are:

Conventional areas (breeding, agronomy, crop protection, NRM, soil science, agricultural engineering)

- Taro breeding for resistance to taro leaf blight

- Coconut breeding
- Evaluation of introduced sweet potato drought tolerant varieties
- Evaluation of introduced rice varieties and improvement of rice cultivation
- Improvement of potato cultivation
- Introduction and evaluation of high yielding tropical crops
- Organic crop production
- Food product development – value addition
- Pesticide residue analysis
- Biopesticides
- Tissue culture
- Soil nutrient analysis
- Soil fertility improvement
- Integrated management of economically important pests: i) fruit fly, ii) taro beetle, iii) coconut rhinoceros beetle, iv) coconut stick insect, v) thrips, vi) chilli anthracnose and vii) african tulip tree (*Spathodea campanulata*)
- Biological control of invasive species
- Other areas of development are: i) farm business management and ii) national seed policy

Targets

2015 targets:

- Food and nutritional security
- Increased crop and livestock production
- i) 26 land use and farm plans incorporating best farm practices and technology that are disseminated and adopted by farmers
- ii) 318 farmers diversifying agriculture to increase farm production
- Enhance food security through increase in awareness and coordination
- i) 31 integrated programmes assisted and implemented
- Strengthening agriculture research services
- i) 74 researched farm practices developed
- Reduction of disaster risks and strengthening disaster preparedness
- i) 35 crop germplasm conserved
- ii) 2020 indigenous breed of livestock to support community rehabilitation

- Poverty reduction
- Capacity building of farmers
- i) 79 farmer trainings/farmer field schools conducted\
- ii) 5935 farm visit/advisory services conducted
- iii) 196 subsistence farmers progressed to semi-commercial level
- Reduced environmental degradation/disaster risks
- i) Provision/cultivation of vertivar grass
- ii) 26 farmers implementing sustainable land management (SLM)
- iii) 21 awareness on disaster response and preparedness conducted
- iv) Eight awareness on sustainable farming practices conducted

Explanation : Target is time bound number to be achieved under given examples.

Institutional Roles, Responsibilities and Partnerships

Which agencies/organizations (including the state/province central), private sector, CSOs, FOs, regional and international programmes) doing what, and what kind of partnership/collaboration has been adopted

Natures Way Cooperative Fiji Ltd (NWC): NWC was formed in 1995 to undertake mandatory quarantine treatment of fruit fly host products on behalf of Fiji's fruit export industry. NWC is a service-cooperative that treats and packs fruit on behalf of its members and charges a fee per kilogram for this service. It is not involved in exporting, which is handled by individual exporters

Tei Tei Taveuni (TTT): There are approximately 300 farmers and their families affiliated to TTT. TTT's core business is finding viable solutions to:

- Sustainable farming and soil regeneration
- Food security and sustainable livelihood
- Conservation and environmental awareness

Tutu Rural Training Centre: Formed in 1969, the mission statement of the Centre is 'to provide a place/presence in which the people of Cakaudrove are empowered to become more autonomous and take charge of their lives in a rapidly changing world' with its prime objective being to train people to return home to farm their own land

Foundation for Rural Integrated Enterprises and Development (FRIEND): Vision is to make Fiji a country where everyone enjoys sustainable livelihoods by linking resources to opportunities and where communities take ownership and responsibility for their own development

Secretariat of the Pacific Community: Secretariat of the Pacific Community's Land Resources Division is mandated to provide support services in the areas of crop production, animal health and production, plant health, climate change, land use management, marketing etc in the 22 Pacific Island countries & territories

Infrastructure and Financial Investments

The Ministry of Agriculture's Research Division is mandated to support the Ministry of Agriculture through the development of new technologies and its transfer to suit the need of farmers, the clients and the stakeholders for the enhancement of the agricultural sector through applied research. The Research Division has eight research stations at strategic locations around Fiji.

The Agronomy and the Horticulture Sections form the core units to devise and develop technologies while the Chemistry and the Plant Protection Section provide technical, scientific support and regulatory mechanism of the Research Division. There are 49 technical staff (excluding office support and government wage earners) in the division with one Ph.D., eight Masters, four Postgraduate diploma, 15 Bachelor degrees, 20 diplomas and one with certificate.

Major Challenges and Opportunities

Challenges

- Infrastructure and human resources needs
- Molecular laboratory for pest diagnostics & training of technical staff
- Fiji agricultural chemistry laboratory needs latest technology on soil/water/plant nutrient analysis to replace old equipment. The lab also need a pesticide residue analysis equipment & training of technical staff
- Capacity development on plant breeding & physiology

Opportunities

- Availability of potential crops for overseas markets
- Need and potential for future collaboration (within and outside)
 - i) Collaboration with Fiji National University College of Agriculture, Fisheries & Forests
 - ii) Collaboration with National Agricultural Research Institute

Looking Ahead (short to medium-term)

Fiji looks forward to implement, Fiji 2020 Agriculture Sector Policy Agenda Modernizing Agriculture-2014.

9. Country Status Report: India

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Indian Council of Agricultural Research (ICAR), New Delhi, India

Investment in Priority Areas of Agricultural Research and Education in India

India presently supports 17 per cent of the world human population on 4.2 per cent of the world water resources and 2.4 per cent of the global land. Per capita availability of resources is about four to six times less as compared to world average that will further decrease due to increasing demographic pressure and consequent land diversion for non-agricultural usage. India is one of the mega-centres of biodiversity accounting for 12 per cent of world's flora and seven per cent of world's fauna.

Though the share of agriculture in national economy has declined sharply over time, consistent with the process of economic growth and development, agriculture remains fundamental for food and nutrition security, livelihood, poverty reduction, economic growth, and environmental sustainability. Creation of infrastructure through public investments is crucial for long-term growth and development of agriculture sector. The state has played leading role in creating hardcore infrastructure like agricultural research, education and extension institutions, major and medium irrigation projects, rural roads, rural electrification, and setting up of agricultural markets.

Presently, agriculture directly or indirectly, supports 65 per cent of population and contributes about 18 per cent to GDP (Table 1) Net sown area in India is about 43 per cent of country's total geographical area. The rainfed drylands constitute more than 60 per cent of the total cultivated area. There are projections that demand for food grains and high-value commodities

Table 1. Agriculture in national economy

Indicator	Particulars
1. Name of the Country	India
2. Reporting Agency	ICAR
3. Value of GDP in Local Currency (INR in billion)*	1047280.70
4. Value of GDP in USD (in billion)*	1611.20
5. Value of Ag. GDP in Local Currency (INR in billion)*	1906348.00
6. Value of Ag. GDP in USD (in billion)*	293.28
7. Ag. GDP as % of GDP*	18.20

Source: Economic Survey 2013-14 and CSO; Agricultural statistics -2014, Min. of Agric, Govt of India

will grow fast and there is need to increase production of all agricultural commodities from a shrinking and deteriorating production environment. In order to address these challenges, there is an imminent need for adopting innovative approaches and deploying new tools and techniques for enhancing efficiency, profitability and productivity in agriculture. Efficiency-mediated improvement in productivity is the most viable option for sustainable developments in agriculture.

Over the years, the National Agricultural Research and Education System (NARES) under the aegis of Indian Council of Agricultural Research (ICAR) is serving the cause of agriculture through generation of new agro-technologies and has contributed significantly to usher the Green Revolution in the country and improve the national food and nutritional security. As a result of science led developments in farming India ranks among the leading producers of major cereals, fruits, vegetables, milk, eggs and fish. The overall internal rates of return to public investment in agricultural research during the period 1975-2005 turned out to be 29 per cent for rice, 38 per cent for wheat, 28 per cent for maize, 39 per cent for sorghum, 31 per cent for pearl millet, 34 per cent for chickpea, 57 per cent for pigeonpea, 18 per cent for groundnut, 20 per cent for rapeseed & mustard, and 39 per cent for cotton.

Current Policies

The National Policy on Agriculture targets an annual growth of four per cent plus in agriculture sector. Two important goals of the National Policy, among others, are i) to improve economic viability of farming by substantially increasing the net income of farmers and to ensure that agricultural progress is measured by advances made in this income and ii) To protect and improve land, water, biodiversity and genetic resources essential for sustained increase in the productivity, profitability and stability of major farming systems by creating an economic stake in conservation. These goals call for continued research and innovations for agricultural development so as to make agriculture an instrument of an inclusive economic growth.

India is predominated by small farm agriculture. According to Agriculture Census, the total number of operational holdings in India numbered 138.35 million with an average size of 1.15 hectares. Of the total holdings, 85 per cent are in marginal and small farm categories of less than two hectares (Agriculture Census, GOI, 2014). These small farms, though operating only on 44 per cent of land under cultivation, are the main providers of food and nutritional security to the nation, but have limited access to technology, inputs, credit, capital and markets. Technologies that cater to the needs of landless, small and marginal farmers are need of the hour to free the rural households from the poverty.

Strategies

The present agricultural development objectives focus on the higher and inclusive growth, raising farm income and protecting the natural resources and environment. In order to achieve these, all-out efforts are required for increasing farmers' access to improved technologies, inputs and services, and product markets. The national strategy for development of agriculture sector relies on generation and infusion of new technologies. The NARES consisting of research institutes of the ICAR and the agricultural universities, provide technology, policy and institutional

support based on leveraging knowledge and the best talents for agricultural research. The five important objectives are: i) create and accelerate sustainable increases in the productivity and production; ii) conserve, enhance, and sustainably use natural resources and biodiversity; iii) incentivise value addition; iv) increase income and livelihood opportunities; v) evolve evidence based recommendations for policy and institutional changes which will stimulate agricultural growth and equity; and vi) promote excellence in agricultural research, education and extension for sustained food and nutritional security. Thus, key elements of the future strategy to address the emerging challenges emphasize on research relevance, infrastructure, diversification, efficiency, equity, environmental sustainability, enlightened human resource, partnerships, growth oriented responsive governance and policy setting.

Emergence of strong Intellectual Property Right (IPR) regime is leading to complete control of inventor/innovator over future use of technologies. Consequently, technologies are becoming exclusive property and future wealth of those who generate technology. Others cannot have access to these technologies without consent and without paying required price to the owner of technologies. Because of these changes in ownership rule of agricultural technologies, advance countries and private sector are aggressively investing in biotechnology and other advance areas to control future use and to release these technologies by extracting the maximum benefit for them. In case, public sector in India does not generate and puts its claim on technologies that can be generated using modern tools of science, the country would become heavily dependent on developed countries and their private sector which may involve very serious implications and heavy price in future.

The Specific Focus

Areas covering commodities, enterprises, systems, approaches (adaptive, applied, basic & strategic, anticipatory, etc.) are given below:

- Genetic potential enhancement of agricultural commodities
- Agricultural productivity, efficiency and profitability improvement
- Build resilience to climate change and abiotic and biotic stresses
- Improve nutritional food, and health security
- Risk management against climate change and market stresses
- Agricultural value chains
- Sustainability of natural resource base of agriculture
- Valuation of ecosystem services
- Agricultural markets, policies, and institutions
- Biosecurity, especially the one emerging from gene piracy and cross-border vector borne diseases
- New products and uses (e.g., bioenergy, new crops, synthetic foods, special foods)
- New educational and learning systems and environments

- Technologies for increasing resource use efficiency, efficiency of farm operations and reduction of post harvest losses
- Promoting high value agriculture, secondary and specialty agriculture and processing and value addition

Priorities for Agricultural Research and Innovations for Development (ARI4D)

While there is a need to focus on sustaining the productivity gains in the irrigated agriculture, the major emphasis should, however, be on the development of rainfed agriculture, promotion of integrated farming, high value agriculture, secondary and specialty agriculture. Anticipatory and strategic research on genomics, quality seed and planting material, climate change, diagnostics and vaccines, precision farming, conservation agriculture, dryland agriculture, farming system, protected cultivation, farm mechanization, alternative sources of energy, biosensors, health foods, feed and fodder need to be accorded high priority. A strong need is felt to address acid soils, saline and alkaline soils, water logged conditions, drought mitigation mechanisms, wasteland development, nutrient and water use efficiency on farmers fields, weed management, integrated pest and disease management, carbon sequestration, breed and feed development in livestock and fisheries, protected cultivation, hydroponics and aeroponics and xerophytes for dryland. Besides, increasing the farm productivity, it is equally important to improve farmers' income and to make agriculture an attractive occupation for the youth.

Targets

The growing population, expanding urbanization and rising incomes have raised a wide range of important issues linked to national food-security, including dietary preferences (higher demand for livestock products), consumption of more processed foods and crowding out of peri-urban agriculture which plays a significant role in the supply of perishable commodities. The population of India is projected to be 1.65 billion by 2050 with an average income of INR 4,01,839 (USD 6,182)/capita, up from the level of INR 53,331 (USD 820)/capita in 2010-11, with 50 per cent people residing in the urban areas.

The size of population in the middle-income bracket will exceed 600 million (about 30% of the total population) by 2050. It is projected that by 2050, the calorie consumption will reach 3,000 k cal/cap, with rise in the share of animal-based calories from the current level of eight per cent to 16 per cent. This will increase the demand for food grains.

There are various projections of increase in demand for food commodities in India. According to one scenario (Kumar, 2015), at seven per cent growth rate in national GDP, though the demand for food grains will only grow by about 50 per cent, the rise in demands for fruits, vegetables and animal products will be more spectacular, the range being 100-300 per cent (Fig. 1). Achieving such a high productivity will entail increase in total factor productivity (TFP). One-third of TFP must contribute to the agricultural growth. Food safety is an integral part of food security, because unsafe food has significant economic costs in terms of health problems as well as cross border trade, which is hampered by inconsistent/poor food safety standards. The latent demand for food safety among urban India is set to grow with urbanization and will also increase acceptability in the export market.

Food and nutritional security

- Poverty reduction (by enhancing the farmers' incomes)
- Reduced environmental degradation (by adopting measures such as biocontrol, bioenergy, conservation agriculture, biosafety and other environmental safeguards/applications)
- Enhance profitability, productivity, resource use efficiency
- Conserve, improve and use natural resources
- Manage biotic/abiotic stresses and climatic variability
- Enhance cropping intensity and diversify production system
- Minimize production and post-production losses
- Increase factor productivity
- Value addition and recycle agricultural waste
- Core competence, specialized human resource (HR), partnerships in IPR regime
- Innovation in technology dissemination, ICT in agriculture
- Regional and global strategic alliances

Institutional Roles, Responsibilities and Partnerships, Infrastructure and Financial Investments

For implementing its research policies and programmes, the ICAR has developed a strong network of 100 ICAR Institutes, 78 All India Coordinated Projects/Networks, four deemed to be universities, three Central Agricultural Universities and 642 Farm Science Centres or *Krishi Vigyan Kendras* (KVKs) spread across the country. In addition, there are 65 State Agricultural/Veterinary/Horticultural/Fishery universities and 4 general universities with agricultural faculty, as part of the NARES. NARES is among the largest public funded systems in the world with a scientific manpower of about 25,000. The Council has developed a fairly good national (SAUs, CSIR, IITs and industry) and international (CGIAR institutes, ACIAR, European Union, etc.) collaborative network. The public support and appreciation for the ICAR, by way of favourable research policies, funding and recognitions, is steadily growing.

ICAR has research institutes in the areas of crops, horticulture, soils, engineering, animal sciences, fisheries and the National Academy of Agricultural Research Management for human resource department (HRD) programmes for in service personnel. These institutes carry out basic and applied research on problems of national importance with some focus on regional problems as well. These institutes have specified mandate. They are required to confine their activities according to their mandate, which may authorize them to work on problems related to a commodity/species, a group of commodities, a discipline, a geographic area, a technology or specific issues.

There are five Bureaus, each on plant, animal, fish, microbial and insect genetic resources; agriculturally important microorganisms and insects and one on soils of the country. The National Bureau of Plant Genetic Resources, New Delhi also has one of the most advanced

National Gene Bank. Four of the ICAR institutes, Indian Agricultural Research Institute (IARI), Indian Veterinary Research Institute (IVRI), National Dairy Research Institute (NDRI) and Central Institute of Fisheries Education (CIFE) also are deemed to be Universities and impart higher agricultural education.

The ICAR has established since 1957 a large number of All India Coordinated Research Projects (AICRPs) that link up the research programmes in the ICAR research institutes, the state agricultural universities, and private non-governmental institutions in a cooperative framework. These projects constitute an effective national grid of coordinated experiments by integrating different institutions and disciplines. The State Agricultural Universities (SAUs) with a multi-faculty and multi-campus structure serve as regional institutions for developing competent human resource and providing technological support for development of agriculture in respective states.

The Farm Science Centres, known as KVKs, form an institutional extension mechanism mainly to conduct frontline demonstrations of new technologies and perform supportive and a catalytic role to accelerate the process of technology dissemination. The first KVK was established in 1974 in Pondicherry and the countrywide number of KVKs now is 642.

Among the developing countries, India is a major donor for the CGIAR. International Crop Research Institute for Semi Arid Tropics (ICRISAT) and Borlaug Institute for South Asia of the CGIAR have their Headquarters in India. The Regional/Country office of International Rice Research Institute (IRRI), Centro Internacional Mejoramiento de Maize y Trigo (CIMMYT), Bioversity International (BI), International Food Policy Research Institute (IFPRI), International Center for Research in Agroforestry (ICRAF), International Water Management Institute (IWMI), International Livestock Research Institute (ILRI), International Center for Agricultural Research in the Dry Areas (ICARDA) and International Potato Centre (CIP) are also located in National Agricultural Science Complex, Pusa, New Delhi. These Centres have collaborative research programmes with India-NARS institutions.

Major Challenges

- Water crisis
- Weather aberrations and climate change
- Soil degradation
- Genetic erosion
- Biotic and abiotic pressures
- Post-harvest losses
- Energy management
- Access to markets and market uncertainties
- Knowledge and information gap
- Lack of policy support

Looking Ahead (short to medium-term)

Addressing agricultural challenges requires short and long-term research strategy.

Short Term Strategy: The short-term strategy involves quick transfer of already developed and proven technology to farms addressing critical issues whereas the long term strategy requires strong agricultural research preparedness, in terms of an inclusive blend of basic, strategic, applied and participatory researches and synergistic combination of modern and traditional knowledge and a vibrant agricultural research system.

Frontline demonstrations and other evidence show large gap between what can be achieved with the available improved technologies and practices and what is realized by farmers. To fill this gap, all agricultural R&D institutes should prepare a list of technologies available with them which can be readily transferred to farm. This should be passed on to KVKs in each district for dissemination at farmers' field through coordination with district level extension agency Agricultural Technology Management Agency (ATMA) with immediate effect and show results in next two years.

Today's agriculture has become more knowledge-intensive, technology-led, market-oriented and demand-driven. Therefore, the extension system is required to be reoriented from commodity focus to system's perspective to address entire value chain from production to consumption. New modes of fast information dissemination are emerging and new players (such as agri-business houses) are entering in this important area. Following action plan is proposed to strengthen existing technology transfer system:

- Develop extension system in a continuum to promote research-extension-farmer interfacing
- Evolve progressive farmer-centered technology dissemination mechanism by equipping such farmers with up to date knowledge and infrastructure and by providing appropriate incentives
- Have a dedicated Agri-satellite/Agri-specific band to facilitate real time data communication of all kinds among the actors and agencies concerned
- Promote ICT driven technology and information dissemination system. KVKs need to be strengthened to equip for collating and disseminating location-specific technology and information

Long Term Strategy: Research in general has to make use of the expertise and strengths existing in different departments under public sector such as Council for Scientific and Industrial Research (CSIR), Department of Science and Technology (DST), Department of Biotechnology (DBT), Ministry of Environment and Forests (MoEF), Ministry of Food Processing Industries (MFPI), Ministry of Earth Sciences (MoES). Several inter-disciplinary and multi-institutional platforms in thematic areas comprising frontier and applied sciences to cater to anticipatory, problem-solving and strategic research needs have been identified. Some of the proposed areas for platforms are: agri-biodiversity management, genomics, seed (planting material, propagules, semen), hybrids, biofortification, climate change (rainfed agriculture/dryland farming), conservation agriculture, water, waste (agro-waste, municipal waste, residues), health foods & high value compounds, feed and fodder, fibre, diagnostics and vaccines, precision farming and farm mechanization, agri-energy, nanotechnology, agri-incubators and e-extension.

The next generation breeding options that enable accumulative and qualitative enhancement of genetic potential to cope with abiotic and biotic stresses with a conscious effort for nutritional

enhancement will need to be developed, validated and adopted for location-specific improvement of crops, animals and fish. The investments in agricultural research and education in India, from public sources has remained below one per cent of the AGDP as given in the table 2. There is need to step-up these allocations to at least one per cent in the short run and gradually should go beyond two per cent, to strengthen agriculture to meet future goals of national development.

Table 2. Investments in agricultural research and education

(₹ Crore at 2006-07 prices)

		Tenth plan	2007- 08	2008- 09	2009- 10	2010- 11	2011- 12	Eleventh plan
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
State	Plan	4151	694	965	1070	1289	1382	5401
	Non-Plan	6477	1464	1315	1497	1755	1599	7629
	Total	10629	2158	2279	2567	3044	2981	13030
Centre	Plan	4977	1210	1418	1402	1909	1998	7938
	Non-Plan	4125	852	1040	1235	2168	1512	6808
	Total	9102	2063	2458	2636	4077	3510	14745
RKVY	Plan		55	197	63	100	160	576
Centre and states	Plan	9128	1961	2580	2534	3298	3540	13914
	Non-Plan	10603	2316	2355	2732	3923	3111	14437
	Total	19732	4277	4935	5266	7221	6652	28351
GDP agriculture and allied (2006-07 prices)		3340648	764890	765601	773565	827969	850812	3982837
Research/education as % GDP agriculture		0.59%	0.55%	0.61%	0.67%	0.86%	0.76%	0.70%

Source: 12th plan document, planning commission

Strong R&D is only a necessary condition for addressing needs of agriculture sector but it is not sufficient by itself. A country can benefit from R&D only if enabling institutions and policies are in place to take R&D output to the users and to provide incentive for adoption of the R&D output. There must be an effective mechanism in the form of extension system to disseminate R&D product developed in the lab to ultimate users. Greater interactions with the Development Departments and concerned sister organizations for effective technology transfer and formulation of action plans in agriculture through the existing mechanisms must be ensured. The second aspect is timely and adequate delivery of inputs like quality seed, fertiliser and empowerment of farmers to purchase these inputs. The last and most important ingredient of technology led growth is efficient market and remunerative prices for farm produce. If any of these elements is missing the benefit of R&D will not accrue or accrue only partly. In the light of contribution of research in agriculture to self-sufficiency attainment in food, growth of total factor productivity (TFP) and high payoff to investment in agricultural research and extension, it is imperative to provide adequate funding for research and extension.

10. Country Status Report: Iran

Javad Mozafari

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General Economic Features

Iran is among the largest economies in the Central Asia, West Asia and North Africa (CWANA) region, with an estimated Gross Domestic Product (GDP) in 2014 of USD 406.3 billion (Table 1). It also has the second largest population of the region after Egypt, with an estimated 78.5 million people in 2014. Approximately, 70.8 per cent of the population live in urban areas with a annual growth rate of 1.9 per cent. Remaining 29.2 per cent are inhabitants of rural areas with a annual growth rate of -0.9 per cent. The Average Annual Population Growth Rate is calculated at 1.1 per cent for 2010-2015.

Table 1. Basic economic information for 2014

Indicator	Particulars
1. Name of the Country	I.R. Iran
2. Reporting Agency	AREEO
3. Value of GDP in Local Currency (Iranian Rials in billion)	2,630,000.0
4. Value of GDP in USD*	406.3
5. Value of Ag. GDP in Local Currency (specify) ^{\$}	
6. Value of Ag. GDP in USD*	8.8
7. Ag. GDP as % of GDP*	8.8

Following two years of recession, the Iranian economy recovered during the 2014 Iranian calendar year (*i.e.*, March 2014-February 2015) as the new administration took office in July 2013. The economy expanded by three per cent in 2014, on the heels of annual economic contraction of 6.6 per cent and 1.9 per cent in 2012 and 2013, respectively. Inflation rate declined from a year-on-year peak of 45.1 per cent in 2012 to 15.6 per cent in June 2015. Iran has adopted a comprehensive strategy encompassing market-based reforms as reflected in the government's 20-year vision document and the recently issued sixth five-year development plan for the 2016-2021 period. The sixth five-year development plan remains ambitious, comprised of three pillars, namely, the development of a resistance economy, progress in science and technology, and the promotion of cultural excellence (World Bank 2015).

The Role of Agriculture in the country

The Islamic Republic (I.R.) Iran is a predominantly agricultural country. Iran's economy is mainly

characterized by a large hydrocarbon sector, a strong sector of small scale agriculture and a considerable manufacturing and financial services sectors with a noticeable state presence. (FAO 2015, World Bank 2015).

Food security is a top national priority and pursues: i) reliance on national resources through higher domestic productivity and self-sufficiency in staple crops and animal products, including wheat, barley, maize, oilseeds, sugarbeet, sugarcane, poultry meat, redmeat, milk, eggs; and ii) improvement of food consumption patterns through increasing share of animal protein intake (from livestock, poultry and aquatics).

Environmental and Agricultural Diversity

The Islamic Republic of Iran covers 164.8 million hectares between latitudes 25° and 40° N, from which 86 million hectares (52.4%) are rangelands; 14.2 million hectares (8.6%) forests and 32 million hectares (19.5%) deserts including bare salty lands. Approximately only 18.5 million hectares (11%) are under cultivation, of which 8.5 million hectares are irrigated and 10 million hectares rainfed.

Iran is considered predominantly dry due to its location in the arid and semi-arid region of the world and her geographic features. Thus, the country receives an average annual rainfall of 240 mm, less than a third of world average precipitation. However, annual precipitation in the inland dry deserts of the country can be as low as only 10 mm. As a result, most rivers are seasonal and their flows depend heavily upon the amount of rainfall.

The altitude range varies from -26 m below the sea level to 5,770 m above the sea level. However, the main part of the country is located on highlands with more than 1200 m above the sea level. The temperature ranges from the minimum of -35° in the North West of the country to the maximum of 50° in Persian Gulf coasts in the South. The country features three main climatic zones:

- Arid and semi-arid zone in the interior and far south, which is covering nearly 85 per cent of the country and characterized by long, warm and dry periods with annual precipitation ranging from 30 to 250 mm.
- Mediterranean climate (mainly in the western Zagros mountains, the high plateau of Azerbaijan, and the Alborz mountains), characterized by warm, dry summers and cool, damp winters, with annual rainfall between 250 mm and 600 mm, and covering about five per cent of the land surface.
- Temperate humid and semi-humid zone (mainly in the Caspian sea coasts, but also in West Azerbaijan and the South Western Zagros), with an annual precipitation rate of 600 mm to 2000 mm, also covering about 10 per cent of the land area.

Existence of, diverse climatic conditions, varied ecosystems, various cultures and ethnicities, and long history of agriculture have contributed to the richness and uniqueness of the megabiodiversity in the country. In the Iranian ecosystems, approximately 8,000 plant species of 167 families and 1,200 genera have been reported. Nearly 20 per cent of these species are considered endemic. Field surveys confirmed the presence of 521 species of birds, 194 mammals, 203 reptiles, 22 amphibians and 1,035 species of fish. Iranian fish resources include 750 species of Persian Gulf and Sea of Oman (with 9 endemic sp.), 100 species of Caspian

Sea (with 10 endemic sp.) and 180 species living in inland and fresh waters (with 15 endemic sp.) (CBD 2012, Mozafari 2014).

Crop Production

Traditional small-scale farming was the main structure of farming communities for centuries and this has caused a great diversity in crop production and tremendous accumulation of indigenous knowledge in farming practices and food production. All agricultural lands are owned by the people, except some portions of which are used by the government sector for particular (research, development projects, etc.) purposes.

Both irrigated and rainfed or dryland agriculture are practiced in different parts of the country. About 91 per cent of the irrigated land is under annual crops (remaining nine per cent is used for production of perennial crops, mostly fruit trees (Table 2). In rainfed areas, annual crops constitute about 98 per cent of the total production.

In 2012 about 12.04 million hectare were under annual crops including cereals, food legumes, vegetables and forage crops. Iran with 1.63 million hectare under various fruit tree orchards, is also ranked among the world's largest fruit producers (Table 3).

Table 2. Types of plantation and crop cultivated area as of 2012

Type of plantation	Crop area (ha)	% of the total
Total field crops	12033740	100.0
Irrigated annual crops	6404084	53.2
Rainfed annual crops	5629657	46.8
Total perennials (trees)	1631200	100.0
Fruit trees	1384800	91.0
Ornamental trees and shrubs	146400	9.0

Table 3. Cultivated area, production and average yield of main crops in Iran, 2012

Crop	Crop area (ha)	Production (ton)	Average yield (kg/ha)
Cereals			
Wheat	7,000,000	13,800,000	1,971
Barley	1,680,000	3,400,000	2,024
Rice (paddy)	480,000	2,400,000	5,000
Maize	350,000	1,223,000	3,494
Food legumes			
Chickpea	565,000	315,000	558
Lentils	135,000	85,000	630
Bean	95,000	250,000	2,632

Contd...

Table 3. Contd...

Crop	Crop area (ha)	Production (ton)	Average yield (kg/ha)
Industrial crops			
Cotton	117,000	271,000	2,340
Sugarbeet	105,000	4,150,000	39,524
Sunflower	70,000	78,000	1,114
Soybean	80,000	200,000	2,500
Rapeseed	170,000	350,000	2,059
Sugarcane	70,000	6,000,000	85,714
Vegetables			
Potato	180,000	5,400,000	30,000
Onion (dry)	71,000	2,260,000	31,831
Tomato	160,000	6,000,000	37,500
Vegetables (fresh)	165,000	4,000,000	24,242
Fruits			
Pome fruits (apple, pear, quince)	276,997	3,178,615	47,216
Stone fruits	253,477	1,988,058	98,925
Nuts	928,047	886,820	8,453
Citrus	289,017	4,560,437	103,566

Animal Production

Livestock, mainly small ruminants, continue to be an important component of the farming systems in the drylands of the country and are always considered by farmers and herders as important sources of agricultural income and as a key element in their strategies to cope with prevailing droughts. There are about 124 million animal units across the country, from which 83 million animal units currently graze over rangelands (Table 4). It reveals that the rangelands are being exploited 2.2 times more than their grazing capacity.

Table 4. Livestock population in Iran as of 2006

Livestock	Population (1000 heads)	AU equivalency	Population (1000 AU)
Sheep	54000	1.00	54000.0
Goat	25757	0.75	19318.0
Native cattle	5500	4.00	22000.0
Hybrid cattle	1806	6.50	11739.0
Pure cattle	741	9.50	7044.0
Camel	143	5.50	786.5
Buffalo	475	6.50	3087.5
Draught animal	1727	3.50	6044.5
Total			12400.0

Agricultural Research

Due to the huge diversity in Iranian agriculture systems, described above, the national agenda for agricultural research, education and extension services is accordingly very diverse and comprehensive with many disciplines and areas. Agricultural research and extension agenda is carried out predominantly by Government Organization known as 'Agricultural Research, Education and Extension Organization (AREEO)' in the Ministry of Jihad-e-Agriculture. AREEO plays a pivotal role in the sustainable development of agriculture sector by generating appropriate technologies and solutions for farmers and producers through its nationwide affiliated research and training institutes and centers. It also provides comprehensive information for sustainable utilization of natural resources.

The universities are mainly engaged in agricultural education and basic sciences, and to a lesser extent in target oriented applied agricultural research. Only limited specialized research is performed by the private sector, however, there is a national policy in place to increase the role of the private sector through promoting the establishment of knowledge based companies, particularly in seed, vaccine and biotechnology sectors. The role of non-government organizations (NGOs) and farmers organizations is also being promoted in agricultural research by adopting participatory approaches and decentralized governmental role.

Water scarcity and depletion of water tables as well as salinization of soils are emerging as major overarching concerns for Iranian agriculture and thus national agricultural research system (NARS). In that direction Iran is pursuing policies of developing knowledge-based agriculture with a higher and sustainable productivity of water resources and lands. However, problems such as limited access to financial resources and input distribution system continue to hamper agricultural development.

Agricultural Research, Education and Extension Organization (AREEO)

AREEO is an umbrella organization governing all institutions and departments of agricultural research, education and extension under the Ministry of Jihad-e-Agriculture in Iran. AREEO's mission is to enhance the food security and improve the livelihood of Iranian people through research for development of technologies, train skilled human resources for agriculture sector in order to increase agricultural production, improve food quality, conserving biodiversity and sustainably managing natural resources.

In the light of new developments in science and technology, on one hand, and in national and global circumstances, on the other hand, AREEO has set new policies, strategies and action plans to fulfill its mandates and attain its main goals:

- Playing a key role in developing National Agricultural Innovation System
- Producing applied knowledge and technologies required for developing knowledge-based agriculture sector
- Training farmers, transferring and promoting technologies at the farm level
- Enhancing technical capacity, innovative skills and entrepreneurship of human resources working in agriculture sector as well as supporting agricultural innovators, entrepreneurs and producers

Main Policies

- Making policy decisions on national science and technology system
- Supporting and promoting relevant applied research
- Enhancing and modernizing of extension activities
- Review and improvement of education system
- Streamlining and reforming the organization for efficient policy making and monitoring
- Human resources development and capacity building
- Mobilizing resources and improving infrastructures

Strategies for Implementing Each Policy

Making policy decisions on national science and technology system

- Enhancing coherence and coordination in making decision on agricultural science and technology
- Supporting and pursuing applied agricultural research in universities for targeting the needs of agriculture sector
- Supporting agricultural research and development in the private sector
- Developing efficient interaction with all academia, NGOs and CSOs relevant to agricultural sciences
- Supporting and promoting the establishment of research consortia among stakeholders

Supporting and promoting relevant applied research

- Utilizing the capacities of universities in responding to agricultural problems
- Utilizing international capacities and promoting regional collaborative research
- Decentralizing and partnership with the private sector for enhancing its contribution to agricultural research
- Commercialization of research findings at national and international levels
- Enhancing research activities with the aim of reducing dependency to imported agricultural inputs

Enhancing and modernizing of extension activities

- Empowering rural women
- Taping on potentials of universities, private sector, NGOs and international agencies for promoting extension activities
- Privatization of some extension activities

- Training farmers of the future from among the rural youth
- Taking innovative approaches and media for technology transfer
- Increasing the role of researchers and experts in transferring and promoting of technologies
- Partnering with NGOs and pioneer farmers in support of extension activities

Review and improvement of education system

- Reforming education system based on providing short-term trainings
- Limiting degree courses only to technical collage diplomas
- Making partnership with entrepreneurs, consultancy firms and international agencies for providing skills to producers
- Building capacity in the sector using innovative education approach

Streamlining and reforming the organization for efficient policy making and monitoring

- Reducing operational role and providing policy guidance
- Streamlining and Increasing the efficiency of the organization by reforming structure and downsizing
- Effective monitoring and assessment of efficacy of activities
- Upgrading national information systems and databases using new technologies

Human resources development and capacity building

- Improvement of human resource structure in line with the prioritized plans and projects
- Building the technical capacity of researchers of the organization
- Upgrading knowhow and skills of employees
- Increasing employees' satisfaction

Mobilizing resources and improving infrastructures

- Renovation and standardization of facilities, equipment and infrastructures in accordance to plans and priorities
- Increasing the efficiency and the synergy of research environments and facilities
- Diversifying and mobilizing financial resources
- Creating incentives for investing by the private sector in agricultural research
- Effective management of resources, facilities and funds

Specific Focus

- Responding to farmers' needs and the sector's demands by deploying relevant applied research
- Contributing to the development of science & technology in the area of agriculture

Priorities for Agricultural Research and Innovations for Development (ARI4D)

Conventional areas

As Iranian agriculture encompasses various production systems of crops, fruit trees, livestock animals, aquatics and wide range of agrobiodiversity, the priorities for agricultural research also includes many disciplines and hundreds of research topics. Some of the main conventional areas are listed below:

- Water management and irrigation in the field
- Mechanization and agricultural engineering
- Soil conservation
- Watershed management
- Soil, water and crop relations
- Plant nutrition and fertilizer
- Postharvest and food science and technology
- Food safety
- Plant protection
- Dryland agriculture
- Production and breeding of horticultural plants
- Salinity tolerance
- Plant genetics
- Conservation and use of genetic resources
- Crop production and breeding
- Cereal production and breeding
- Rice production and breeding
- Forage crops production and breeding
- Oilseed crops production and breeding
- Vegetable seed production
- Sugarbeet and sugarcane production and breeding

- Cotton production, breeding and technology
- Animal production and breeding
- Silk production
- Honey bee production and breeding
- Fisheries and aquaculture
- Sturgeon production and breeding
- Vaccine and serum production
- Veterinary and animal diseases
- Forests and wood production
- Rangeland production and management
- Production and use of medicinal plants
- Agriculture economy and food security

Frontier areas

- Agricultural biotechnology
- Support system decisions
- Precision and smart agriculture
- Adaptation to climate change

Other areas

- Conservation agriculture
- Integrated farming system
- Agricultural production value chains

Targets

- Achieving food security
- Achieving self-sufficiency in the production of strategic crops
- Increasing agricultural productivity based on water productivity
- Combating environmental challenges (salinization, desertification, etc.)

Institutional Roles, Responsibilities and Partnerships

AREEO is the main responsible body addressing the urgent needs of farmers and the sector. AREEO is mandated to: enhance food security and improve the livelihood of Iranian people

through research and development of technologies, transfer of new technologies to the field, train skilled human resources for agriculture sector in order to increase agricultural production, improve food quality, conserving biodiversity and sustainably managing natural resources. AREEO carries out its roles and responsibilities through its affiliated institutions throughout the country including:

- 23 nationwide research institutes
- Networks of research stations scattered across the country
- 23 major agriculture and natural resources colleges
- Agricultural training and education centers
- Local and nationwide farming cooperatives and unions

Due to restricted budgets, shrinking financial support from the government and increasing cost of research activities, AREEO is gradually moving towards delegating some the research activities to private sector, particularly, in the areas of vegetable seed production, hybrid seed production, vaccine and biotechnology. In order to encourage the private sector to invest on research, government is taking initiatives on making some market reforms and more open policies on promoting intellectual property rights. However, the Iranian NARS still plays a key role in providing the critical link between the global research system and research users, particularly farmers. Interaction of AREEO with commodity groups and farmer organizations are growing as an important force in defining research priorities and acting as major part of extension system.

In the higher education system of Iran, more than 60 universities are offering degree programmes in agricultural fields. Some of these programmes facilitate technology development and transfer particularly from the foreign universities. However, the main responsibility of these programmes yet to have well defined research objectives in response to the needs of agriculture sector.

Infrastructure and Financial Investments

AREEO is considered the largest scientific body outside the Ministry of Sciences, Research and Technology; and Ministry of Health and Medical Education. It operates across the country with a vast human resources, numerous research institutions, education centers, laboratories, training hubs and stations, scientific and research publication and a noticeable annual public budget. Some of the major infrastructures of AREEO are listed below:

Research

Nationwide research institutes & centres

- Razi Vaccine and Serum Research Institute
- Iranian Research Institute of Plant Protection
- Seed and Plant Improvement Institute
- Soil and Water Research Institute
- Iranian Fisheries Sciences Research Institute

- Animal Science Research Institute of Iran
- Research Institute of Forests and Rangelands
- Agricultural Engineering Research Institute
- Soil Conservation and Watershed Management Research Institute
- Dryland Agricultural Research Institute
- Horticultural Sciences Research Institute
- Seed and Plant Certification and Registration Institute
- International Sturgeon Research Institute
- Iran Silk Research Centre
- National Salinity Research Centre
- Rice Research Institute of Iran
- Cotton Research Institute of Iran
- Iranian Citrus Research Institute
- Iranian Pistachio Research Institute
- Sugarbeat Seed Institute
- Date Palm and Tropical Fruit Research Institute (DPTFRI)
- Tea Research Centre
- National Research Centre for Ornamental Plants

Provincial research centres on agriculture and natural resources

- 33 provincial research centres
- Nearly 400 research stations and sites across the country

Research facilities

- 931 laboratories
- National plant gene-bank
- Gene-bank of forest and rangeland plants
- Gene-bank of micro-organisms
- Conservation sites of animal and fishery genetic resources
- Herbaria
- Botanical gardens and arboretums
- Invertebrates museums
- Approximately 200,000 hectares of experimental area

Education and extension

- Provincial education centres for agriculture in all 31 provinces
- Institute of Technical & Vocational Higher Education
- The Haraz Extension and Technology Development Centre
- Imam Khomeyni Agricultural College

Human resources

- 12,500 employees
- 5,000 research staff
- 2,450 faculty members
- 5,005 supporting staff and labours

Collaboration with international agricultural agencies and research centers

- Established offices of three CGIAR centres – ICARDA, CIMMYT and IRRI in the country
- Established a regional rice research and training centre in Iran with the membership – Central and West Asian countries
- Close collaboration with relevant UN agencies including – FAO, UNDP, WHO, UNEP and WIPO

Outputs/achievements of the organization as of 2014

- More than 5580 applied research projects/activities were conducted
- More than 90 new and improved plant varieties were released
- Develop and introduced 1310 production technologies
- Transferred 105 technologies to the industry and commercialized by licensing out
- Based on the outputs of AREEO, 72 knowledge based spin-off companies producing high-tech products were developed
- Publishing 21 scientific and research journals

Major Challenges and Opportunities

Challenges

- Shrinking financial resources and governmental support
- Old facilities and laboratories which need to be renewed
- Sanction effects on International affairs and trades
- Natural disasters and environmental harms such as drought, climate changes, etc.

Opportunities

- Skilled and capable human resources
- Rich biodiversity and genetic resources
- Good collaboration with international centers and agencies

Looking Ahead (short to medium-term)

The Sixth Five Year Plan of the Organization will be launched from 2016 which will have two main policies:

The review and reform of AREEO

- Enhancing the economy of agricultural research by mobilizing and streamlining funds
- Reviewing and reforming the structure of AREEO in accordance with new realities and priorities
- Strengthening the role of private sector in agricultural research
- Enhancing the efficiency of extension in transfer of knowledge and technology through innovative approaches
- Extending scientific cooperation and partnership with universities
- Increasing international relations and technical collaborations
- Extending Iranian knowhow and services on agriculture and natural resources to other countries
- Prioritizing agricultural research disciplines and areas based on the
- Economic realities and resources

Integrating and streamlining agricultural research

Concerted efforts will be made to integrate and streamline the agricultural research in the country with holistic view of environment, agroecosystem approach and sustainable agricultural productivity through the following major research programmes:

- Sustainable production for food security
- Sustainable management of water, land and natural resources
- Sustainable management of agricultural biodiversity and genetic resources
- Adaptation to climate change
- Management of knowledge, economy and social issues of agriculture

11. Country Status Report: Japan

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Japanese International Research Center for Agricultural Sciences (JIRCAS), Japan

Basic Information

Indicator	Particulars
1. Name of the Country	Japan
2. Reporting Agency	JIRCAS
3. Value of GDP in Local Currency	¥477.62 trillion (2012-13 average, ¥ = Japanese yen) [¥480.13 trillion (2013 calendar year (CY)), ¥475.11 trillion (2012 CY)]
4. Value of GDP in USD	USD 5.38 trillion (2012-13 average: USD 1 = ¥88.74) [USD 4.92 trillion (2013 CY: USD 1 = ¥97.7), 5.95 trillion USD (2012 CY: USD 1 = ¥79.8)]
5. Value of Ag. GDP in Local Currency	¥5.75 trillion (2012-13 average, Ag, Fo, & Fi) [¥5.75 trillion (2013 CY), ¥5.74 trillion (2012 CY)]
	¥4.88 trillion (2012-13 average, Ag. only) [¥4.88 trillion (2013 CY), 4.87 trillion (2012 CY)]
6. Value of Ag. GDP in USD*	USD 64.8 billion (2012-13 average, Ag, Fo, & Fi) [USD 58.9 billion (2013 CY), USD 71.9 billion (2012 CY)]
	USD 54.9 billion (2012-13 average, Ag. only) [USD 50.0 billion (2013 CY), USD 61.0 billion (2012 CY)]
7. Ag. GDP as % of GDP*	1.20% (2012-13 average, Ag, Fo, & Fi) [1.20% (2013 CY), 1.21% (2012 CY)]
	1.02% (2012-13 average, Ag. only) [1.02% (2013 CY), 1.03% (2012 CY)]

*Total Population: 127 million (2012-2013)

127 million (Oct 1, 2013), 128 million (Oct 1, 2012)

Current Policies

The Japanese Government's 'Basic Plan for Food, Agriculture and Rural Areas (hereafter 'Plan')', which sets Japan's agricultural policy direction for the next 10 years, is revised every five years. The latest Plan was approved by the Cabinet in March 2015. The 'New Basic Plan for Agriculture, Forestry and Fisheries Research (hereafter 'Research Plan')' was announced at the same time with the Plan (March 2015). The Research Plan has also been revised every five years. The detail of the new Research Plan are mentioned in the following sections:

The new plan stated the basic views on policy implementation as implementing reform measures for food, agriculture and rural areas by two driving forces: ‘Industrial Policy’ to promote transforming agricultural and food industry into growth industries, and ‘Regional Policy’ to promote maintaining and demonstrating multifunctionality of agriculture and rural areas.

The plan states that rapidly ageing and decreasing agricultural population must be kept in mind when tackling various economic issues, such as globalization of food supply and demand, diversified consumer needs, nurturing leading farmers, and developing the potential of rural areas. Accordingly, it summarizes that there are five key policy measures to be implemented comprehensively and systematically: i) securing a stable food supply, ii) sustainable development of agriculture, iii) development of rural areas, iv) restoration/Reconstruction from the Great East Japan Earthquake, and v) reformation of agricultural cooperatives and other agricultural organizations.

Strategies

The new Research Plan sets three basic policies for promoting research on agriculture, forestry, and fisheries.

Reform of R&D management: The R&D should be efficient, strategically developed, and directly linked to needs. R&D management are reformed to strengthen the collaboration of various stakeholders and to enforce selection and concentration on research themes (Fig. 1). Knowledge accumulation, intellectual property management, regulatory science, and outreach are major emphasis. The evaluation is done by a third party.



Figure 1. Reform of R&D management

Source: MAFF Research Plan 2015

Acceleration of technology transfer: The technology transfer should be accelerated by rapid innovation through knowledge accumulation and by effective extension through collaboration as illustrated in figure 2. The research platform is developed to promote industry-academia-government collaboration.

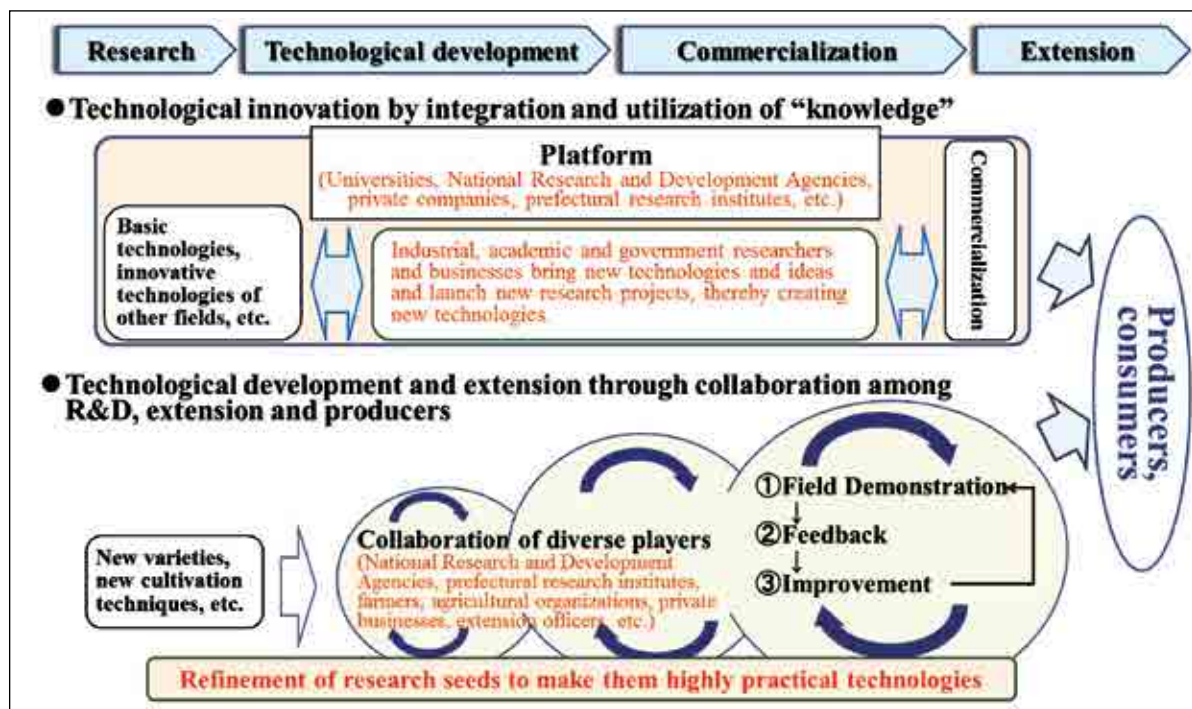


Figure 2. Acceleration of technology transfer

Source: MAFF Research Plan 2015

Improvement in research environment: Several efforts to improve research conditions are proposed in order to create diverse knowledge. Reorganization of National Research and Development Agencies is scheduled in April 2016 so the development of effective system to utilize the new agency is needed.¹ Also development of effective operation of research funding system, collection and analysis of R&D information (research information management using bibliometrics, etc.), and human resource development are considered. International collaboration is further promoted by encouraging active participation in international research networks.

Specific Focus

The Research Plan gives priority to 'R&D for promptly solving problems faced by the producers'. By facilitating joint R&D with extension organizations, farmers, and other stakeholders, R&D which directly linked to needs are promoted and technology transfer is accelerated. The Research Plan also aims to establish a new system of industry-academia-government collaboration that links seeds for cutting-edge technologies, such as ICT and robot technologies, to the value chain of domestic agricultural, forestry and fisheries products.

¹See section 8.

Due to the ageing and decrease in workers, the production base of agriculture, forestry and fisheries industries has been weakened. Hence, the Research Plan suggests to transform these industries into the advanced the number of 'knowledge & information industries' and make them more attractive to young people. This would lead to continue stably supplying quality food while improving the food self-sufficiency ratio.

For the R&D on the challenges that should be addressed with mid-to long-term perspectives, such as global warming and the falling birth rate/aging population, six basic direction for the future are set (next section). These R&D steps are expected to make a steady progress.

Priorities for Agricultural Research and Innovations for Development (ARI4D)

For the issues require medium to long-term perspectives, 11 priority targets under six basic directions are set. R&D strategy for key R&D themes are developed with a consultation of relevant parties and outside experts. Each target is set by backcasting (first define the goal and then go backward to identify the process) so that the targets are directly linked to the actual needs of farmers or society.

- Stably supplying safe and reliable food, thereby contributing to the health and longevity of people
 - i) Thorough safety management from production to table, and development of techniques to protect animals and plants from the introduction and spread of pests and diseases
 - ii) Technological development for supplying nutritional and functional agriculture, forestry and fisheries products, that support healthy and long-lived society
- Innovating a production and distribution system in agriculture, forestry and fisheries, thereby drastically cutting costs
 - i) Technological development for innovating agriculture, forestry and fisheries production/distribution (ICT, robot, etc.)
- Creating new industries and employment in rural areas
 - i) Technological development for creating new industries using local resources (biomass, genetic modification, etc.)
- Improving yield/quality for agriculture, forestry and fisheries products, building on existing strengths
 - i) Development of world-class agriculture, forestry and fisheries products (breeding, genetics, etc.)
- Promoting sustainability and stability of agriculture, forestry and fisheries
 - i) Development of agriculture, forestry and fisheries adaptation technologies in response to climate change
 - ii) Improvement of prevention techniques for plant pests and infectious diseases of livestock (IPM, etc.)
 - iii) Establishment of a recycling-oriented sustainable agriculture, forestry and fisheries system (biomass, etc.)

- iv) Development of technologies for sustainably managing rural infrastructure and forests, by maximizing the multifunctionality of rural areas
- v) Development of marine ecosystem-friendly fishery technologies that support sustainable use of marine resources
- Addressing global food and environmental challenges, thereby contributing to the international society
 - i) International research in response to global challenges such as climate change and stable food production in developing countries

Targets

The Plan lowers Japan's food self-sufficiency target to a more attainable ratio and establishes a new indicator, 'food self-sufficiency potential (*Shokuryo Jikyu Ryoku*)' to evaluate latent food production capability. The new target for the calorie-based food self-sufficiency ratio has been lowered from the previous 50 per cent by 2020 to 45 per cent by 2025 (actual: 39% in 2013).

In the Research Plan, 21 key targets were particularly set for realizing models of efficient and stable farming and for promptly solving production and distribution problems in different fields/items. The time span is five years to develop and achieve the practical use of new technologies, and then promptly introducing them to production.

Paddy farming: Establishment of a highly profitable paddy farming system for different local conditions.

Paddy fields in mountainous areas: Establishment of a sustainable paddy farming system in hilly and mountainous areas using local strengths.

Upland farming in Hokkaido: Establishment of upland farming system for Hokkaido region that allows scale expansion and highly productive farming (sugarcane, wheat, soybean, onion, rapeseed, potato, azuki bean, etc.).

Upland farming in Southern Kyushu and Okinawa: Establishment of a highly profitable upland farming system in Southern Kyushu and Okinawa (sweet potato, sugar cane, rapeseed, livestock, etc.).

Tea: Increase in tea demands through joint product development with tea companies, and establishment of efficient farming system.

Vegetables: Establishment of a low-cost production and distribution system for vegetables to meet demands for processing uses and food businesses (cabbage, green onion, broccoli, onion, Chinese cabbage, etc.).

Greenhouse horticulture: Development of a model of next generation greenhouse horticulture, realizing energy- and labor-saving technologies and high yield (tomato, eggplant, strawberry, pepper, etc.).

Fruit trees: Development of labor-saving and fast orchard establishment techniques for high-quality fruits that support scale expansion for producers (pear, apple, citrus, etc.).

Flowers: Development of techniques to breed various flower varieties and to preserve quality during transportation (carnation, Torenia, etc.).

Dairy cows: Establishment of dairy farming system, allowing labour-saving practices and accurate rearing management.

Beef cattle: Establishment of efficient breeding and fattening system for beef cattle based on self-supplying forage.

Swine and poultry: Establishment of swine and poultry farming models to make the maximum use of domestic feed ingredients.

Sustainable agriculture: Development of techniques that strike a balance between production efficiency and environmental conservation, and visualization of their benefits.

Forests and forestry: Advancement of technologies for forestry utilization and development of new demands for forestry products (cedar, etc.).

Fisheries: Technological development for realizing attractive fisheries and aquaculture (bluefin tuna, eel, yellowtail, etc.).

AFFrinnovation (the 6th industry)²: Technological development for AFFrinnovation contributing to local employment and income growth.

Promotion of export: Development of export related technologies for supporting realization of country-by-country and item-by-item export strategy for agriculture, forestry and fisheries products.

Food safety, pests and disease control in animals and plants: Development of techniques to improve food safety and to control pests and diseases in animals and plants.

Agricultural and rural infrastructures: Development of efficient farm water management technologies, effective technologies for maintenance and management of agricultural and rural infrastructure, and information system for natural disasters prevention and reduction for rural areas.

Prevention of damage due to wildlife: Establishment of effective and efficient damage control technologies that take wildlife characteristics into consideration (deer, boar, monkey, etc.).

The Great East Japan Earthquake: Solutions to technical problems hampering the resumption of farming and forestry work of the affected farming or forestry households and fishery operation of the affected fishery households.

Institutional Roles, Responsibilities and Partnerships

Agricultural research is implemented by national research organizations, prefectural (local government) research organizations, universities and private companies. National institutes are the largest research organizations in the respective research fields while prefectural research institutes implement researches to meet technological needs in respective prefectures. Japanese

²AFFrinnovation: Agrinnovation, Forestrinnovation, and Fisherinnovation. It adds value to agricultural, forestry, and fishery products in innovative ways by making new combinations and creating a value chain.

universities not only promote international agriculture research, but also contribute to educating and training the people who will play important roles in the international community. Private companies focus on applied research in order to commercially use the developed technologies.

The MAFF encourages collaboration among industry-academia-government and among different fields. The MAFF supports the cross-ministrial Strategic Innovation Promotion Programme (SIP).

Compared with western countries, Japanese NGOs are small in terms of scale and finance. It is not common that NGOs conduct international collaborative research. Regardless of their sizes, however, they have accumulated experiences and know-how through their activities, and are expected to provide effective information to figure out the true demand of people.

Infrastructure and Financial Investments

As of 2014, there are seven national research organizations and 267 prefectural research organizations. In total, 16,642 people belong to the organizations (national: 5,048, prefectural: 11,594). The number of researchers are 8,425 (national: 2,693, prefectural: 5,732), including 1,288 women (national: 388, prefectural: 900). Of these, 3,096 researchers have doctoral degrees (national: 2,207, prefectural: 889) and 2,228 have master's degrees (national: 528, prefectural: 1,700). Total expenditure is 217 billion yen (national: 89 billion, prefectural: 128 billion yen).³

Most of these national research organizations, except Policy Research Institute of the MAFF (PRIMAFF), are called National Research and Development Agency. They were called Incorporated Administrative Agency till March 2015. The National Agriculture and Food Research Organization (NARO) is the largest research organization under MAFF which conducts research specifically in the area of food related science and technology. NARO, National Institute of Agricultural Sciences (NIAS), National Institute for Agro-Environmental Sciences (NIAES), and National Center for Seeds and Seedlings are scheduled to be unified in April 2016. In addition, Fisheries Research Agency (FRA) and National Fisheries University will be integrated in April 2016.⁴

The Japan International Research Center for Agricultural Sciences (JIRCAS) is the sole national institute that undertakes comprehensive research on agriculture, forestry and fisheries technology in developing countries aiming at providing solutions to international food supply and environmental problems through technology development. JIRCAS carries out international collaborative studies with other countries' research organizations or international institutes supported by CGIAR.

Major Challenges and Opportunities

The rapidly aging Japanese population began to decline year-on-year in 2011 - and in rural areas, that decline is moving at an alarming pace- which negatively affects domestic agricultural production and utilization of farmland. Also, the restoration/reconstruction from the Great East Japan Earthquake is a challenge. On the other hand, various possibilities such as ICT and robots are recognized. The Tokyo 2020 Olympic and Paralympic Games are seen as a big opportunity for research presentation (showcase of technology) and for global development of the Japanese agricultural and agriculture-related industries.

³It corresponds approximately to 2.1 billion US dollars.

⁴National Center for Seeds and Seedlings and National Fisheries University are not included in the previously mentioned seven national research organizations.

Looking Ahead (short to medium-term)

The R&D progress is managed using a road map. The road map will be newly created with stakeholders in industry, academia, and government.

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12. Country Status Report: Laos

Bounthong Bouahom

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Basic Information

Indicator	Particulars	Explanation
1. Name of the Country	Lao PDR	National Statistic Center
2. Reporting Agency	NAFRI	
3. Value of GDP in Local Currency (Kips in billion)*	90.823	GDP of 2014
4. Value of GDP in USD in billion*	1,119.000	
5. Value of Ag. GDP in Local Currency (Kips in billion)*	22.524	
6. Value of Ag. GDP in USD in billion*	277.000	Population as of January 2015 is 6,987,260
7. Ag. GDP as % of GDP*	248.000	

*1 USD = 8,000 Kips

Source: World Bank and National Statistic Center

Current Policies

The Lao People's Democratic Republic (hereafter, Laos) is transforming to be land-linked and has policy to lift the country out of the status of less developed country in 2020.

In 1986, the government of Laos realized that reforms were necessary and slowly took first strides to open up its economy by encouraging private enterprise and foreign direct investment. Rates and prices of agricultural produce were reset to close the gap with actual market prices and import barriers were lifted. These reforms led to remarkable economic growth during the 1990s (albeit from an extremely low base). However, the Asian financial crisis in 1997, along with the Lao government's own inability to manage the country's economy, led to sky rocketing inflation and a sharp depreciation of the Lao kip.

Recognizing the important of agriculture research, the government of Laos, particularly Ministry of Agriculture and Forestry (MAF) has established National Agriculture and Forestry Research Institute (NAFRI) in April 1999 through the amalgamation of existing agriculture, livestock, fisheries, and forestry research centers, with the tasks of designing, implementing, and coordinating all agriculture and forestry research in Laos. Since its establishment in 1999, NAFRI has depended almost exclusively on donor support, with the result that its donor-driven research does not always contribute to Laos' overall agricultural R&D needs. NAFRI is the only government agency involved in agricultural R&D in Laos. In 2003, NAFRI accounted for roughly 84 per cent of the

country's total agricultural researchers and 90 per cent of expenditures (Gert-Jan Stads *et al.*, 2006). During the last five years 2011 to 2015 the investment in agriculture research is slightly changed. The investment in agriculture research at National University of Laos (NUOL) and its branch universities is creased and shared about one quarter of total investment, while NAFRI accounted for about 75 per cent of the investment.

Since 2012, the government initiated the research fund for all sectors, including the research fund for NAFRI for rice, maize and cattle breeding project implementation in response to the need of local people and become more demand driven research.

The higher-education sector plays a limited role in the Lao agricultural research system, accounting for just 15 per cent of the country's total full time equivalent (FTE) research staff and an estimated nine per cent of agricultural R&D spending. We identified two faculties involved in agricultural R&D under the Vientiane-based National University of Laos (NUoL). The Faculty of Forestry (FoF) is the larger of the two, employing 12 FTE researchers in 2003. FoF's research activities concentrate mainly on silvicultural issues and to a limited extent agroforestry and community forest issues. Most research activities are performed by individual staff members as part of collaborative programmes initiated by other agencies. The faculty is currently setting up a formal research programme for the next five years. NUoL's Faculty of Agriculture (FoA) employed seven FTE researchers in 2003. These researchers were spread across three formal research programmes: cropping systems and crop management, livestock and fisheries, and agribusiness and agro-processing.

The private sector in the sector is still under developed in Laos and not yet contributes to the agriculture research in the country. Private sector involvement in agricultural R&D is very limited.

In 2013, the National Assembly historically endorsed the Research Fund to be legally included in the government budget. The Research Fund approved one per cent of the government expenses. However, this research fund is still limited and is about 24 billion kips in 2013 (about 3 million USD). But, this research fund is for all sectors.

As of 1 January 2015, the population of Laos was estimated to be 6,987,260 people. This is an increase of 1.68 per cent (115,717 people) compared to population of 6,871,543 the year before. In 2014 the natural increase was positive, as the number of births exceeded the number of deaths by 123,688. Due to external migration, the population declined by 7,971. The sex ratio of the total population was 0.997 (997 males per 1,000 females) which is lower than global sex ratio. The global sex ratio in the world was approximately 1,016 males to 1,000 females as of 2014.

Strategy

Agriculture Development Strategy: The agricultural sector continues to be important sector of the Lao economy. As this sector is largely based on subsistence activities, it mostly operates outside the fiscal economy. In 2014, nearly 70 per cent of the population is still active in the agricultural sector, accounting for 25 per cent of gross domestic product (GDP) (World Bank 2015). Rice farming predominates. Steady production increases have made Laos self-sufficient

in rice production commenced from the year 2000 (FAO). Other important commodities include coffee, maize, peanut, sesame, soybean, tobacco, cassava, and sugarcane. Forestry also makes a significant contribution to the national economy. Many rural households depend heavily on forests for timber and non-timber forest products.

The Government of Lao PDR recognizes the importance of agriculture in the Agricultural Development Strategy 2025, and the 8th National Socio-economic Development Plan (2016-2020). However, the Lao PDR already struggling agriculture sector is further challenged by several emerging trends, the most prominent of which are smallholder-based production with low productivity; low labor availability and productivity; minimal farmer experience with modern agriculture technologies and marketing; post-harvest loss still high and lack of value-addition; high regional and international marketing competitiveness.

Lao PDR has always been vulnerable to several types of natural disasters including, floods and drought and according to projections the quantity and intensity of these events will increase with climate change. Farmers, especially those working in rainfed conditions including uplands are subject to the vagaries of the weather, natural forces such as pest and diseases, soil erosion and nutrient degradation; and other natural resources degraded and loss of agrobiodiversity.

Finally, agricultural research has suffered from deficient financial support, facilities and capacities for R&D in terms of the envelope and delivery of resources, which has limited funding for core research and much less critical research programmes. Global economic liberalization and the country's admission to the World Trade Organization (WTO) and Asian Economic Community (AEC) raises new challenges but also opportunities, this has created pressure on national agricultural research system to develop cost effective technologies.

Agriculture Research Strategy 2025: The agriculture and forestry research strategy (AFRS) 2025 and vision up to 2030 focused on the identification of strategic issues in NAFRI's internal and external environment and elaborated a number of recommendations. AFRS is an instrument response to MAF in agriculture and forestry development in achieving its Development Goals (ADS 2025). The strategic goal of research strategy is to better define and articulate how NAFRI intends to carry out 'research for development' to contribute in achieving the goals of Agriculture Development Strategy (ADS) 2025, in food security and nutrition, poverty alleviation through the effective and efficient use of scientific knowledge to increase sustainable agriculture productivity and related natural resources. NAFRI envisions the future where innovation and modernized agricultural technologies are developed for improvement of agriculture production systems which support a higher national food and nutrition security, commercialized production, and the utilisation of resources is managed sustainably.

Specific Focus Areas and Targets

MAF has developed ADS 2025, and vision up to 2030; a number of prominent goals have to be achieved, these include:

- Food and nutrition security, achieving zero hunger by 2025

- Commercialized commodity production; rural livelihoods and poverty alleviation, and
- Sustainable forest utilization and conservation

Future research priorities will be based on creating and scaling up technologies that contribute to food and nutrition security, poverty reduction, value addition, export promotion, environmental sustainability and cost effectiveness. In order to deliver those desired results, NAFRI's research areas are rationalized into six broad based thematic areas or strategic research programmes of intervention, these are:

Sustainable agrobiodiversity programme

- Coordinate the national agrobiodiversity programme
- Develop a sustainable practice for natural resources utilization, management and conservation of agriculture genetic resources to support of potential future needs for food security and suitable commercial production
- Support the development of improved methods, mechanisms and technical recommendations to ensure the sustainable management of agrobiodiversity

Improved agriculture productivity programme; this programme aims to

- Develop and use appropriate agricultural technologies (effective low cost technologies) for improvement of agriculture production systems
- Testing and developing good agriculture practices relating to soil nutrient depletion, loss of agrobiodiversity, maintaining of land productivity, developed of skilled human resources and improved water use efficiency
- Enhancing the regional competitiveness of the Lao agricultural sector through improved post-harvesting and processing technologies, and local value-addition to enable access to markets and viable integration in these markets

Agriculture adaptation to climate change programme

- Develop climate information services (agroclimate advisory) and deliver improved farmer guidance for better and climate-safe management of production, and provide technical support to the climate adaptation capacity of farmers
- Develop climate-smart agricultural practices through testing and scaling-up of technologies and improved practices that are needed to further build farmers' adaptive capacity to climate change
- Strengthening of policies and institutions for climate-resilience through vulnerability assessments, scenario modelling and policy analyses to provide the information and tools for planners and decision-makers for well targeted support to agriculture and food security under changing climatic conditions

Agriculture and forestry policy research programme

- Provide policy makers at different levels (MAF and other concerned institutions) with information and guidance on emerging national, regional and global opportunities and challenges in the sector

- Improve rural livelihoods and rural empowerment through relevant policy development
- Improve accessibility to information and knowledge of different actors so they can make more informed decisions at all levels

Capacity building programme: This programme aims to further build on NAFRI's institutional capacity, focusing on three areas:

- Human resources development
- Organizational and institutional development
- Research infrastructure and facilities development

Information and Communication programme

- Improve communication facilities and management systems (ICT, library, information and communication support)
- Develop agricultural knowledge and information systems (AKIS) (sharing of information, resources and responsibilities; networking; linking)
- Strengthen multi-level and multi-stakeholder information, communication and coordination

Each thematic programme will include several research issues such as variety and commodity improvement, resources management, marketing and value chain development. The major agricultural research areas presently included are rice, field crops, coffee, fruits and vegetables, livestock, aquatic resources, on-farm soil and water management, forestry, related natural resources management issues, socioeconomic aspects of the agricultural communities and farming systems, post-harvest operations, gender issues, and policy research for rural development.

Each theme will include several research issues such as, commodity improvement, resource management, marketing and value chain development. The major agricultural research areas include rice, field crops, coffee, horticulture, livestock, fisheries, on-farm soil and water management, forestry, related natural resources issues, socioeconomic aspects of the farming systems, post-harvest operations, gender issues, and policy research.

Considering the agroecological diversity, socioeconomic situation and R&D actors, NAFRI will emphasize the development of region-specific agricultural research programmes. It will prioritize a participatory systems-based research approach that incorporates multiple disciplines and address multiple and specific commodities. Environmental sustainability, inclusiveness, and income generation will be the distinguishing features of all research undertaking, besides their explicit positive contribution to poverty alleviation and food and nutrition security and sustainable.

Indigenous knowledge, traditional practices and local resources including soil, water, genetic materials, and skills will be used in research and technology development in sustainable way. NAFRI will also promote commercial agriculture by generating post-harvest technologies that create value added products from rice, cash crops, vegetables and fruits, coffee, livestock and fisheries and non-timber forest products (NTFPs); and their downstream processing opportunities. By the same token, it will also give attention to the problems and needs of the end-users (farmers).

NAFRI will shift to the role of promoter, facilitator, regulator, and implementer of efficient modern agricultural technology in partnership with stakeholders. It will draw on research results from neighboring countries, the Consultative Group for International Agricultural Research (CGIAR), and relevant international institutions to the extent possible, but it must enhance Lao PDR's own capacity to adapt and modify technologies to best meet its farmers' requirements.

In addition to its role of technology generation and policy analysis, NAFRI will contribute to establishing national and international research collaboration and networks that provide a favorable environment for agriculture and forestry research, and pluralistic participation and resource investment amongst all potential stakeholders, donors and beneficiaries for agriculture research and development.

Institutional Roles and Partnerships

In agriculture research in Laos, NAFRI is the only one research institute in the country. National University of Laos and its network including Souphanouvong University in Louangprabang province, Savannakhet University in Savannakhet province, and Champassak University in Champasak province also carry out the agriculture research. In 2003, The principal agricultural research agency, the National Agriculture and Forestry Research Institute (NAFRI) accounted for 90 per cent of Laos' agricultural R&D spending in 2003 (Gert-Jan Stads *et al.*, 2006).

Infrastructure and Financial Investment

In 2003, NAFRI accounted for roughly 84 per cent of the country's total agricultural researchers and 90 per cent of expenditures. It is observed that the investment for agriculture research at NUOL is relatively increased. The donors support in agriculture research by different subsectors for NAFRI and NUOL is in average for the last five years (2010-2015) about USD 800,000 and USD 450,000 respectively.

The government investment in agriculture research comprises of three sources:

- From the regular budget of Ministry of Agriculture. The source is still limited since it is an administrative budget. This source of agriculture research fund is about 10 per cent of the annual expenditure of MAF
- From government special fund such as disaster prevention
- The Government Research Fund has been established in 2012 by the National Assembly announces. The Ministry of Science and Technology is in-charge of the disbursement on the priority project proposal. The Government Research Fund is set to be one per cent of annual total government investment budget

In general, the government investment in agriculture research for both NAFRI and NUOL from 2005 to 2010 is relatively small and significantly increased by double to triple during the period of 2010 to 2015. However, the agriculture research budget of NAFRI is relatively still higher than that NUOL.

In 2015, NAFRI has 22 researchers with Ph.D., 83 M.Sc., 151 B.Sc. and technicians.

Major Challenges and Opportunities

- Need appropriate infrastructure development (laboratory, equipment needed). The investment in infrastructure of agriculture research institute and university is very limited and most of the investment based on donors support. There are existing laboratory with capacity of few analysis. There is no accredited laboratory in the country which makes difficulty for analysis and evidence-based research. The research facility such as laboratory improvement for accredited
- There are limited scientific and trained manpower in high technology, biotechnology, breeding, post harvest loss, farm machinery etc. At the same time, large proportions of the workforce are trapped in lower-productivity farming jobs: seven in 10 Lao workers are employed in the agriculture sector. This implies that a very large number of workers is needed, each producing very little and making only a meager living. Boosting agricultural productivity is a top priority to raise farm incomes, lower the need for labor in the agricultural sector, and eventually free agricultural workers to move out of farming to higher-productive, higher-paying sectors with more growth prospects
- There is an opportunity for agriculture research improvement in the country. Laos is rich in agrobiodiversity, genetic resources for breeding, better road network within the country and regional integration which will accelerate the regional trade. The increased number of tourism opportunities for locally based export of traditional agriculture organic products. There opportunities can include trade, favourable resource base, genetic resources, etc.
- More cooperation and effective network between the organizations involved in agriculture research: NAFRI, NUOL and private sectors are needed. AEC is an opportunity for future fruitful cooperation within ASEAN partners in agriculture research and with regional and international organizations

Looking Ahead (Short and mid-term)

NAFRI needs to mobilizing fund and resources for research for development, strengthen national and international research collaboration, and research and extension linkage. Donors and partners need to align their support to the priorities outlined in research programmes in the research strategy.

- Support to implement NABP - National Agrobiodiversity Programme for conservation and sustainable use the agrobiodiversity. Lao PDR as a contracting party to Commission on Genetic Resources for Food and Agriculture (CGRFA) and International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)
- Improve the productivity through appropriate plant, animal breeding, innovation and technology development for minimizing the production cost, reducing post harvest loss, value chains
- Establish the agriculture resilience to climate change center
- Strengthening the policy think tank for better agriculture and forestry policy research
- Capacity development in research facilities, laboratory and institutional development

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13. Country Status Report: Malaysia

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Basic Information

Indicator	Particulars		
1. Name of the Country	Malaysia		
2. Reporting Agency	MARDI		
	Year 2012	Year 2013	Year 2014*
3. Value of GDP in Ringgit Malaysia (RM million)	941,949	986,733.0	520,776.0
4. Value of GDP in USD million**	235,487	246,683.0	130,194.0
5. Value of food sector GDP in Ringgit Malaysia (RM million)	33,136	38,014.0	20,066.0
6. Value food sector GDP in USD million**	8,284	9,504.0	5,017.0
7. Value of Non-food sector GDP in Ringgit Malaysia (RM million)	61,453	53,805.0	27709.0
8. Value Non-food sector GDP in USD million**	15,363	13,451.0	6,927.0
9. Value of total agriculture GDP in Ringgit Malaysia (RM million)	94,589	91,819.0	47,774.0
10. Value of Total Agriculture GDP in USD**	26,647	22,955.0	11,944.0
11. Agriculture GDP as % of GDP	10	9.3	9.2

*Until June 2014

**Assumed 1 USD = RM 4.00

Source: Agrofood Statistics 2014, Ministry of Agriculture and Agro Based Industry, Malaysia

Current Policies

Malaysia is a middle income country and aspires to become high-productivity economy by the year 2020. Towards this end, the philosophy of inclusiveness for all in the society is the core principle together with sustainable development without compromising the welfare of the current and future generations. Thus, re-engineering economic growth on agro-food

sector remains an important element in national agenda. However, the initiatives of poverty alleviation and eradication especially in the agricultural and rural sector, has always been one of the core thrusts in all of our “Five Year Development Plans, right from the First Malaysia Plan (1966-1970) to current Tenth Malaysia Plan (2011-2015). In propelling the nation towards a high-productivity economy, the framework of government philosophy and approach is implemented through the National Key Result Areas (NKRA). Among the major strategies are creating a conducive environment for unleashing economic growth, moving towards inclusive socioeconomic development, developing and retaining a first world talent base as well as building an environment that enhances quality of life. Repositioning and strengthening the agricultural sector to face the global and local challenges in the competitive era as well as to remain a major mechanism in rural poverty alleviation become more crucial. Some major challenges are achieving high income in agricultural venture, ensuring national food security, increasing agricultural competitiveness, reducing deficit in country’s food balance of trade, fulfilling consumer’s dietary change, increasing productivity and sustaining natural resources.

The continuing challenges in the agricultural sector such as competition for land with other sectors, short of labour and increase of cost of production requires a new set of strategic direction. The competition in land use for food production and bioenergy is expected to increase from eight per cent in 2008 to 20 per cent in 2020. In the global scenario, the increase of world population, climate change, trade liberalization and the changes of lifestyle due to higher disposable income require a special attention and direction. The world population is projected to increase from 6.2 billion people in 2010 to 9.2 billion in 2050. Climate change will definitely affect the production of food commodity. The demand for better quality and affordable by the majority of the people is another challenges faced by the agricultural sector.

The National Agro-food Policy (NAP4) was formulated to address challenges in domestic and global markets to ensure sustainable production for food security and safety. The policy has been put in place to tackle the issue of sustainable agriculture and the competitiveness of the agro-food industry with food safety and nutrition aspects along its value chain. It also aims to reform and transform the agro-food industry to become a more modern and dynamic industry. Under NAP4, agriculture has been identified as a National Key Result Area. Under this initiative, the agriculture sector is also targeted to increase the Gross National Income by RM28.9 billion (USD 9.1 billion) to reach RM49.1 billion (USD 15.4 billion) by 2020. The agricultural sector is also targeted to create more than 109,000 job opportunities by 2020, primarily in the rural areas.

The NAP4 has incorporated strategies that are in line with the nutritional aspects of the food system. The programmes implemented under the NAP4 include increased food production through optimization and sustainable land, development and upgrading agriculture infrastructure and increase the quality and safety of food by expanding the compliance of standards. Efforts have also been taken to strengthen human capital and to ensure sufficient skill labour force in the agricultural sector. This includes the use of modern technology and mechanization to reduce the dependency of manpower. The government also provides sectorial based incentives to encourage the private sector to invest in the agriculture and agro-based industry.

Strategies

Government Transformation Programme, New Economic Model and the Economic Transformation Programme are the main bases of the country's development towards achieving Vision 2020 of becoming a developed and high income country. This goal requires more significant contributions from all sectors, including the agro-food industry to ensure that country achieve the targeted economic growth. Thus, the transformation and modernization of agro-food industry will be enhanced to allow this industry to improve productivity and competitiveness and create more high-income farmers. The NAP4 is focusing on improving the efficiency of the agro-food industry across the value chain to ensure the industry becomes more productive, competitive and knowledge-intensive. The new approach includes eight main ideas that have been identified to support the process of transformation of the agro-food industry as follows:

- Food security - adequacy, availability, safety and affordability
- Development of high value agriculture
- Development of sustainable agriculture
- Dynamic agriculture clustering for maximizing revenue generation
- Private investment as a catalyst for the transformation of modern agriculture
- Human capital and smart agriculture
- Modernization of research, technology and innovation driven agriculture
- Strengthening agricultural support services

In relation to those ideas, the objectives of NAP4 were formulated as follows:

- Ensuring adequate and safe supply of food
- Ensuring competitive and sustainable agro-food industry
- Increasing the income level of entrepreneurs

The strategic directions outlined to achieve the objectives

- Ensuring the nation's food supply
- Increasing the contribution of the agro-food industry
- Completing the value chain
- Strengthening human capital
- Strengthening the R&D, innovation and use of technology
- Creating a business environment that led the private sector
- Strengthening delivery services systems

Specific Focus

Increase production and food supply: Contraction of the land area will be offset by optimizing land use through the efforts such as zoning for Permanent Food Production Park, promotion

of integration in agricultural practices, optimization of land use outside the rice granary areas, large-scale cultivation in rice granary areas and strengthening of regional cooperation to ensure secure food supplies.

Improving food access: More direct access opportunities such as the Farmers' Market were set-up to increase access to food. In these efforts, farmers will be encouraged to participate directly to sell their agricultural products in order to get higher returns while users can enjoy affordable prices.

Stabilizing food prices: Global food prices are expected to increase in the future due to increasing population and rising costs of agricultural inputs. Global food supply system deals with uncertainty and requires innovative strategies to ensure affordable food prices. The strategies implemented include food price monitoring system and the early warning system for food supply.

Ensure food safety and nutrition: The increase in consumer income and demographic changes expected to change the diet and dietary patterns of the population who are more concerned with safety and nutrition. In this regard, the focus will be to improve the quality and safety of food by expanding the good agricultural practices (GAP), good manufacturing practices (GMP), hazard analysis and critical control point (HACCP), sanitary and phytosanitary (SPS) and halal accreditation as well as to increase quality grading, packaging, labelling and branding.

Increasing the contribution of the agro-food industry: Economic structural changes in order to achieve high-income and status of developed nation by the year 2020 requires more competitive agro-food industry to play a significant role in the country development. The sector remains relevant as the main economic activity of rural areas as well as supplying of raw materials to the manufacturing industry and food resources of the country, despite decreasing percentage of contribution of the agro-food industry to GDP. Efforts to increase the contribution of the agro-food industry competitiveness could be realized through the following strategies:

- Explore the potential of high-value agricultural commodity products
- Increase productivity through the use of agricultural intensification
- Developing agro-based industries (processing)

Completing the value chain: The development of a complete integrated and efficient value chain is critical in the development of the agro-food industry which is become more competitive and able to contribute effectively to economic growth. In this respect, the approach of linking the activities along the value chain from upstream to downstream must be strengthened with a focus on improving the competitiveness and sustainability. The value chain approach will be supported by components such as human capital management, technology development and innovation as well as resources. Among strategies identified to complete the value chain in the agro-food industry are:

- Developing a dynamic, integrated and sustainable cluster
- Strengthening linkages with local and global markets
- Integrating sustainability practices and product tracking system as part of the value chain

Strengthening local and global market network: Local and global market network can be strengthened with the following approaches:

- Strengthening support services and logistics facilities
- Facilitate market access
- Integrating sustainability practices and products tracking systems as part of value chain
- Expanding sustainable agricultural practices
- Develop a tracking system of agricultural products

Strengthening human capital: Quality and progressive human capital is one of the factors supporting the transformation and modernization of agro-food industry. Strengthening human capital, particularly among skilled and semi-skilled workers will rapidly drive the modernization of agro-food industry. The well-trained human capital will be capable in using and distributing the latest technology to increase productivity and efficiency as well as expand good agricultural practices. In this regard, the development of knowledge-based, skills and technological driven human capital will be emphasized through the following strategies:

- Providing agricultural employment, education and training; and
- Creating a generation of entrepreneurs with progressive-minded

Strengthening R&D, innovation and technology: Efforts to transform the agro-food industry as a sector of a modern and high-tech should be supported by the R&D and innovation that is sufficient to increase productivity and reduce production costs. R&D and innovation will be driven to a demand-based orientation. More proactive innovation rather than adaptive innovation which is more focused on solving current problems will be encouraged. In this regard, several initiatives have been identified for strengthening R&D and innovation and enhancing the use of modern technology in agriculture as follows:

- Creating an environment which is conducive to stimulate creativity and innovation
- Accelerate the commercialization of R&D and development of innovative products
- Expanding mechanization and automation along with effective technology transfer

Creating private-led business environment: Private investment in food production is a catalyst towards achieving the goal of modernizing and creating a competitive agro-food industry. To increase private sector participation in the agro-food industry, favourable business environment in terms of financing facilities, basic infrastructure, agricultural support services and business-friendly regulation as well as better market opportunities are encouraged. Thus, the following strategies are implemented:

- Provide infrastructure and integrated comprehensive info structure
- Simplifying procedures related to food production businesses
- Provide a more competitive investment incentives to attract local and foreign investments
- Improve access to financing and risk sharing

- Strengthening the role of agricultural small and medium enterprises (SMEs)
- Rationalize subsidies and minimize market distortions

Strengthening delivery services system: Dynamic and challenging global market environment demands innovative and proactive delivery services. In order to achieve high-income status by the year 2020, the role of agricultural agencies should be strengthened to increase the contribution of the agro-food industry to economic growth. The role of these agencies will be streamlined and rationalized to enhance functionality and ensure the effectiveness. The role of the agencies should be more focused on the primary task (core functions) and avoid duplication of functions. It is important to ensure that the financial and human resources can be used efficiently and effectively in the delivery of services to the target groups. The strategy of strengthening delivery services system is as follows:

- Rationalize the functions and roles of agriculture departments and agencies
- Strengthening the role of agricultural organizations
- Establish a strategic industry development councils
- Strengthening the agricultural delivery services through the involvement of various stakeholders

Priorities for Agricultural Research and Innovations for Development (ARI4D)

The Government recognizes the importance of transformation and empowerment in agriculture which is driven by research and development (R&D), technology and innovation in order to achieve a developed nation by the year 2020. Therefore, in order to ensure an adequate and safe food supply and increasing the income of farmer and entrepreneurs, establishing competitive and sustainable agro-food industry is necessary. In relation to that, seven strategic directions were outlined in the National Agro-Food Policy (2011-2020), where strengthening of the R&D, innovation and the use of technology are among those that have been identified.

Accordingly, facilitating innovation and R&D such as the establishment of favourable environment such as institutional structure, legislation, funding, expertise and research facilities are critical in supporting and stimulating the generation of science and innovation. R&D activities will focus on selected areas, especially the development of high-yielding varieties, farm mechanization and technology application as well as development of high value products, especially green technologies products. The use and transfer of technology such as precision agriculture, information and communication technology (ICT), biotechnology and the low mechanization became an obstacle in the modernization and transformation of the agro-food industry. Therefore, efforts should be undertaken to improve the skills and knowledge of extension agents and entrepreneurs to improve the effectiveness of delivery systems. Appropriate investment incentives support and assistance to entrepreneurs will ensure the success of the farmers. Competency of scientists and researchers will be enhanced with the emphasis on applied R&D of modern technology that enables cost saving in planting, field management, harvesting, post-harvest and processing. The use of technology and mechanization, particularly in large-scale agriculture will be expanded to modernize the agro-food industry.

National Science Research Council which is composed of all stakeholders including the private research institutions, universities and industry is also responsible for identifying needs and promoting the sharing of research expertise and facilities. R&D Electronic network (e-network) that can connect MARDI with local and foreign government research agencies, universities and the private sector will be developed as a platform in sharing the information. Through these initiatives, dependency of agricultural public research institutions to public funds will be reduced gradually to encourage private sector involvement in financing research in strategic fields for mutual benefits. However, public funding is still needed as the main source of financing in R&D activities in the country.

Smart partnership between government research agencies, universities and industry will be accelerated to spur market-oriented R&D and ensure the smooth transfer and commercialization of technology. The network between researchers, extension officers and the target group will be strengthened through demonstration farm and commercial model farm in order to expedite the transfer of technology. Dialogue and exchange of information related to innovation such as seminar that is required by the industry will be undertaken on a regular basis with the participation of agencies and related research institutions. The transfer and commercialization of technology and innovation could be strengthened more widely through licensing, franchising as well intensification of incubator and technology testbeds to companies and entrepreneurs.

R&D will also be carried out selectively, according to agro-food sector challenges such as improving competitiveness, sustainability and food security, preserving the environment and attract private investment. It should also be in line with market requirements and customer's needs. In the 10th and 11th Malaysian Plan several themes of R&D in the field of agro-food sector are being emphasized, such as:

- Post-harvest technology to increase production
- Competitiveness
- Food security safety and quality
- Development of green technology
- Efficient use of resources for sustainable agriculture
- Unlocking and generating new wealth through biotechnology and agrobiodiversity
- Increasing the efficiency of agricultural production through mechanization
- Development of early warning systems and crops pests and disease management system
- Adaptation and mitigation to climate change
- Development of high value agricultural products
- Technology promotion and technology transfer

However, the priority areas of emphasis in R&D will also be adjusted to the current needs of customers and markets as well as the issues and challenges faced by the country. Agricultural research and extension agencies will be encouraged to increase the efficiency of technology transfer to farmers and operators. Entrepreneurs will be encouraged to adopt innovation in

upstream and downstream activities in order to reduce production costs and improve the quality and attractiveness of agricultural products, especially in terms of packaging and branding to enhance the product. Recognition will be given to entrepreneurs to the best innovations in the district, state and national levels to encourage innovative culture among them.

Targets

Initiatives, action plans and activities specified in NAP4 are targeted to have the impact in the development of national agro-food industry. The targets set are summarized in tables 1, 2, 3 and 4 as follows:

Table 1. Targets of major food commodities productions, 2010-2020 ('000 MT)

Commodities/Year	2010	2015	2020	Average annual growth (%)		
				2011-2015	2016-2020	2011-2020
Crops	4,060	4,930	6,102	4.0	4.4	4.2
Rice	1,642	1,785	1,875	1.7	1.0	1.3
Fruits	1,768	2,115	2,569	3.7	4.0	3.8
Vegetables	651	1,029	1,658	9.6	10.0	9.8
Livestock	2,186	2,540	2,956	3.1	3.1	3.1
Beef	47	59	76	5.0	5.0	5.0
Mutton/Goat meat	2	4.8	11.9	15.0	20.0	17.5
Poultry meat	1,296	1,505	1,746	3.0	3.0	3.0
Pork	234	231	231	-0.3	0.0	-0.1
Eggs	540	651	773	3.8	3.5	3.6
Milk (million lit.)	67	89	118	5.8	5.8	5.8
Fish	1,338	1,626	2,117	4.0	5.4	4.7
Marine fish	989	1,141	1,323	2.9	3.0	3.0
Aquaculture	349	485	794	6.8	10.4	8.6
Total production	7,584	9,096	11,175	3.7	4.2	4.0

Table 2: Targets of major food commodities demand 2010-2020 ('000 MT)

Commodities/Year	2010	2015	2020	Average annual growth (%)		
				2011-2015	2016-2020	2011-2020
Crops	6,569	7,395	8,504	2.4	2.8	2.6
Rice	2,300	2,495	2,685	1.6	1.5	1.6
Fruits	2,689	2,993	3,365	2.2	2.4	2.3
Vegetables	1,580	1,907	2,454	3.8	5.2	4.5

Contd...

Table 2. Contd...

Commodities/Year	2010	2015	2020	Average annual growth (%)		
				2011-2015	2016-2020	2011-2020
Livestock	3,270	3,787	4,331	3.0	2.7	2.9
Beef	162	194	232	3.7	3.6	3.6
Mutton/Goat meat	23	30	39	5.8	5.2	5.5
Poultry meat	1,013	1,163	1,327	2.8	2.7	2.7
Pork	230	223	212	-0.6	-1.0	-0.8
Eggs	468	553	649	3.4	3.3	3.3
Milk (million lit.)	1,373	1,624	1,873	3.4	2.9	3.2
Fish	1,315	1,593	1,918	3.9	3.8	3.8
Total demand	11,154	12,774	14,753	2.8	2.9	2.8
Total production	7,584	9,096	11,175	3.7	4.2	4.0
Deficit	3,569	3,679	3,579	0.6	-0.6	0.03

Table 3: Targets of major food per capita consumption, 2010-2020 (kg/yr)

Commodities/Year	2010	2015	2020	Average annual growth (%)		
				2011-2015	2016-2020	2011-2020
Crops						
Rice	79.6	78.4	77.0	-0.3	-0.4	-0.3
Fruits	93.0	94.0	96.5	0.2	0.5	0.4
Vegetables	54.7	59.9	70.4	1.8	3.3	2.6
Livestock						
Beef	5.6	6.1	6.6	1.7	1.7	1.7
Mutton/Goat meat	0.8	0.9	1.1	3.8	3.3	3.6
Poultry meat	35.0	36.5	38.0	0.8	0.8	0.8
Pork	19.9	20.0	20.0	0.1	-	0.1
Eggs	16.2	17.4	18.6	1.4	1.4	1.4
Milk (million lit.)	47.5	51.0	53.7	1.4	1.0	1.2
Fish	45.5	50.0	55.0	1.9	1.9	1.9

Table 4: Targets of self-sufficiency level (SSL), 2010-2020 (%)

Commodities/Year	2010	2015	2020	Average annual growth (%)		
				2011-2015	2016-2020	2011-2020
Crops						
Rice	71.4	71.5	69.8	0.0	-0.5	-0.2
Fruits	65.8	70.7	76.3	1.5	1.5	1.5

Contd...

Table 4. Contd...

Commodities/Year	2010	2015	2020	Average annual growth (%)		
				2011-2015	2016-2020	2011-2020
Vegetables	41.2	54.0	67.6	5.6	4.6	5.1
Livestock						
Beef	28.6	30.5	32.7	1.3	1.4	1.3
Mutton/Goat meat	10.6	16.0	30.9	8.7	14.1	11.3
Poultry meat	127.9	129.3	131.6	0.2	0.4	0.3
Pork	101.7	103.7	109.0	0.4	1.0	0.7
Eggs	115.4	117.8	119.1	0.4	0.2	0.3
Milk (million lit.)	4.9	5.5	6.3	2.3	2.8	2.6
Fish	101.7	102.1	110.4	0.1	1.6	0.8

Conclusion

In addition to ensuring food security and safety, the agro-food subsector will be modernized to provide employment opportunities, generate higher income and ensure sustainable development. Emphasis will be given to improve productivity, strengthen the food supply chain, improve the support system and services, increase knowledge and skills of farmers as well as ensure market compliance. The agro-food industry will gradually progress from being associated with low income and unskilled jobs to higher income and professions of choice.

During the 10th Malaysia Plan period (2010-2015), the agriculture sector achieved an overall improved performance in production, value added and the self-sufficiency level (SSL). Better agronomic practices, quality inputs, modern farming technologies, improved infrastructure and skills training programmes were the main contributors to productivity gains. However, the sector continues to depend on foreign workers for unskilled and semi-skilled jobs.

During the 11th Plan period (2016-2020), the focus of transforming and modernizing agro-food subsector will be remained to continued, towards achieving food security, providing employment opportunities and generating higher income for farmers, fishermen and livestock growers. Initiatives will be undertaken to improve productivity, strengthen the food supply chain, improve support and delivery services, enhance knowledge and skills of farmers, fishermen and livestock growers as well as ensure compliance to standards and good agricultural practices. In achieving these objectives, it is imperative that effective planning, coordination and implementation of agricultural programmes are carried out by all stakeholders.

14. Country Status Report: Nepal

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Nepal Agricultural Research Council (NARC), Kathmandu, Nepal

Basic Information

Indicator	Particulars
1. Name of the Country	Nepal
2. Reporting Agency	NARC
3. Population	26494504 (Census, 2011)
4. Value of GDP in Local Currency (NR million) ^{\$}	1261210 (FY 2011) 1468617 (FY 2012) 1599172 (FY 2013) 1789769 (FY 2014)
5. Value of GDP in USD ^{\$} (billion)	18.85 (FY 2011) 19.21 (FY 2012) 19.29 (FY 2013) 19.45 (FY 2014)
6. Value of Ag. GDP in Local Currency (NR million)	449676 (FY 2011) 515767 (FY 2012) 555585 (FY 2013) 583692 (FY 2014)
7. Value of Ag. GDP in USD ^{\$} (billion)	4.9 (FY 2011) 5.6 (FY 2012) 6.1 (FY 2013) 6.3 (FY 2014)
8. Ag. GDP as % of GDP ^{\$}	35.65 (FY 2011) 35.12 (FY 2012) 34.74 (FY 2013) 32.61 (FY 2014)

1 USD = NRs. 92; NR = Nepalese Rupee

Current Policies for Agricultural Research

Nine institutions are working in agricultural R&D in Nepal. Nepal Agricultural Research Council (NARC) is the biggest one working in this area. It carries out research related to crops, horticulture, aquaculture, livestock and pasture, post-harvest, agricultural economics and natural resources. NARC's head office is based at Kathmandu and has five regional research stations, 13 agricultural research stations, 16 commodities research programmes, three institutes and 20 disciplinary research divisions throughout the country. Department of Forest Research System (DFRS) and Nepal Academy of Science and Technology (NAST) are two other agencies involved in agriculture research. NAST is doing limited research in biofertilizer, biofuel and disease management, while research from DFRS is limited to forest management. Four higher education institutions (Agriculture and Forest University, Tribhuvan University, Kathmandu University, Purbanchal University) are also working in agriculture R&D but, the research work in these institutions is limited to crops breeding, crop husbandry, aquaculture and agricultural economics. Like other Asian countries, the role of NGO's are not to be forgettable in Nepalese context. Two NGO's, namely, LI-BIRD and FORWARD are working in participatory plant breeding, crop husbandry, biodiversity, natural resources and socioeconomic studies.

The leading research institution of Nepal, Nepal Agricultural Research Council, is formed and guided by Nepal Agricultural Research Act (1991). Further to this, time to time government of Nepal formulates strategies for agricultural development which also guides research activities. In the past, NARC was using the long-term goal of Agriculture Prospective Plan (1995-2015). Recently Government of Nepal endorsed agriculture development strategy (ADS) which came into effect from 2016 for 20 years. Beside these, NARC also has prepared its own strategic vision for agricultural research for 20 years which has to be approved by the government of Nepal (<http://goo.gl/mVOuAC>).

Strategies for Agricultural Research

NARC is working based on seven strategies which are as follows:

Providing leadership in agricultural research: NARC provides effective leadership to agricultural research activities from policy creation through dissemination, and enhance the capacity of Nepal's research system to deliver results. NARC accredits qualified research providers and coordinate agriculture research and development activities in both public sector institutions and private sector players such as NGOs, agro-vets and traders.

Building effective partnerships with national and international agencies: NARC encourages scientific cooperation nationally and internationally, capitalizing on achievements made in neighbouring countries and those available from regional organizations such as South Asian Association for Regional Cooperation (SAARC) Agriculture Centre. NARC already works in collaboration with many international research centres such as, International Maize and Wheat Improvement Center (CIMMYT), International Rice Research Institute (IRRI), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Plant Genetic Resources Institute (IPGRI), International Livestock Research Institute (ILRI), World Fish Centre, etc., and National Agriculture Research Systems in the region to develop relevant technologies for ensuring food security and reducing poverty.

Achieving equitable distribution of research resources across agroecological regions:

NARC seeks to balance research among the terai (plain areas), hills, and mountain agroecological regions. Terai farmers are relatively better endowed with farm resources and access to markets, and therefore it is expected that relatively faster impacts can be achieved with new technologies there. However, most farmers are actually located in the mountains and hills, so NARC is emphasizing on developing technologies suitable for those regions in order to improve their livelihoods. Improved food security, higher incomes, and better employment opportunities in the hills and mountain communities may, in turn, stabilize migration into the terai region and urban areas.

Reorienting staff to respond to client demand: NARC ensures that the research and technology development system is responsive to the diverse needs of the Nepali farmers, who work in diverse agroecological, resource endowment, and farming systems. NARC is capitalizing on the ever-changing indigenous technology and knowledge that comes from farmers, agro-veterinarians, and others in agriculture-related economic activities.

Promoting competitive agriculture: To take advantage of globalization and World Trade Organization (WTO) membership, Nepal needs to be competitive both in national and international markets. The country continues to face challenges on the technical standard of exportable agricultural products. While resource productivity constrains production, fertilizer and pesticide residues constraint access to export markets. NARC works with the Government of Nepal to develop policies, strategies, and plans by providing periodic analysis of WTO related issues. NARC strives to overcome these constraints and develop good agricultural practices to enhance Nepal's competitiveness in international markets.

Promoting adaptability to climate change: NARC has identified a number of short-term adaptation measures needed to reduce vulnerability:

- Identifying and developing crop varieties, livestock and fish species that are tolerant to stress conditions and locally-emerging pests and diseases
- Supplying farmers with the new crop varieties, livestock and fish species
- Demonstrating appropriate farming practices to reduce vulnerability and maximize returns from new agricultural technologies

Providing accountability and delivery of results: NARC is promoting transparency by developing appropriate formats and guidelines for priority setting, programme development and budgeting, and programme monitoring. NARC is planning to monitor research activities of participating institutes to assess their effectiveness and overall impact.

Specific Focus Areas

Priority has been given to applied and adaptive research needs identified from bottom-up planning processes (e.g. village level workshops) with participation of farmers, researchers, extension workers, development agencies from NGOs, private sectors with support from regional technical working groups. Emphasis has also been given to a market-led systems research approach, with consideration of environmental sustainability, gender equity, climate change, growth promotion and income generation and their explicit contribution to poverty

alleviation. NARC also put much emphasis on implementing participatory research activities with its stakeholder for uptake and scaling up of the technologies.

Priorities for Agricultural Research and Innovations

There are seven priorities areas on which the agricultural research organization is focusing in Nepal. They are:

- Major food crops (rice, maize, wheat and potato)
- Horticulture crops; citrus, apple, off-season vegetables, vegetable seeds, sericulture, apiculture and floriculture
- Natural Resource Management and Climate Change (Biotechnology, biodiversity, soil, water and environment)
- Commercial crops; (tea, coffee, cardamom, ginger, herbs and spices and others)
- Livestock and fish (Buffalo, cattle, goats, sheep, pig, poultry, fish)
- Socio-economic, policy, processing and marketing research
- Participatory, multi-disciplinary and multi-sectoral research approach

In term of resource allocation crops especially conventional breeding has given high priority (Fig. 1). Recently, research focus is shifting towards climate resilient crop production technology development, resource conservation technology, biotechnology, post-harvest management, agriculture mechanization and market research.

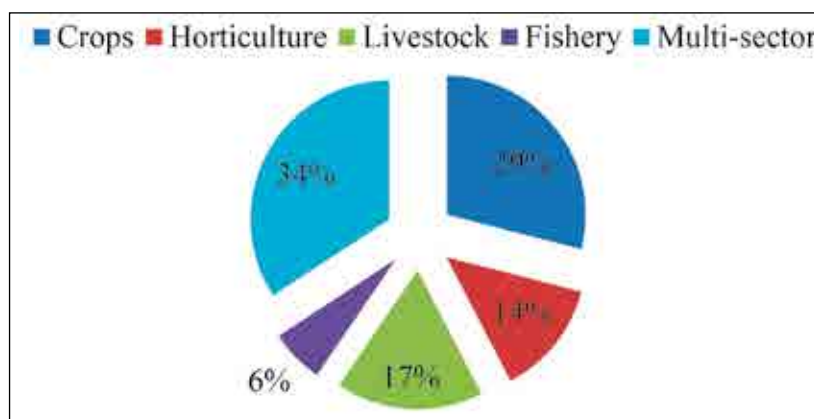


Figure 1. Research budget allocation in different sectors
(Source: NARC, 2014)

Targets

Food security, employment generation, and poverty reduction will continue to be important guiding principles in the agricultural research agenda. Improvement of land and labour productivity and as well as nutritional security are national target as mentioned in Agriculture Development Strategy, 2015. The gist of target are presented in table below:

Table 1. Target of agriculture research in figure (as mentioned in ADS, 2015)

Component	Current (2010)	Short-term (5 yrs)	Medium-term (10 yrs)	Long-term (20 yrs)
Food sufficiency	5 % trade deficit in cereal grains	0% trade deficit in cereal grains	0-5% trade surplus in cereal grains	0-5% trade surplus in cereal
Land productivity	\$1804/ha	\$2302/ha	\$2938/ha	\$4787/ha
Labour productivity	\$794/ag. labour	\$979/ag. labour	\$1206/ag. labour	\$1833/ag. labour
Degraded land	3.2 million ha (28% of land)	2.88 million (reduction of 10%)	2.56 million ha (reduction of 20%)	1.6 million ha (reduction of 50%)
Agribusiness GDP as share of GDP	10%	12%	14%	20%
Av. annual growth of AGDP	3%	4%	5%	6%
Poverty in rural areas	27%	21%	16%	10%
Nutritional security				
Stunting (height among under 5 children)	41.5%	29%	20%	8%
Under weight (weight for age among under 5 children)	31.1%	20%	13%	5%
Wasting (weight for age among under 5 children)	13.7%	5%	2%	1%
Chronic energy deficiency (women in reproductive age)	18% women with low BMI	15% women with low BMI	13% women with low BMI	5% women with low BMI

7. Institutional Roles, Responsibilities and Partnerships

NARC is working in collaboration with various international agricultural research institutions/ organizations such as CIMMYT, IRRI, ICRISAT, IPGRI, CGIAR, etc. and National Agriculture Research System (NARS) in the region to develop relevant technologies for ensuring food security and reducing poverty (Fig. 2). In addition, NARC also collaborate with public and private organizations like government department, universities, academy, NGOs, private laboratories and enterprises, which are involved in the agricultural research and development activities. There are five groups of research organizations working in agriculture research in Nepal.

NARC: It is the lead organization for planning, conducting and coordinating agriculture research. It also provides guidance to government on agricultural policies formulation.

Nepal Academy of Science and Technology (NAST): It is another research organization mainly working in a few areas of agriculture especially disease management using biotechnological tools and biofertilizer development.

Universities: There are three universities, namely, Tribhuvan University (TU), Agricultural and Forestry University (AFU) and Kathmandu University (KU) working in agricultural research.

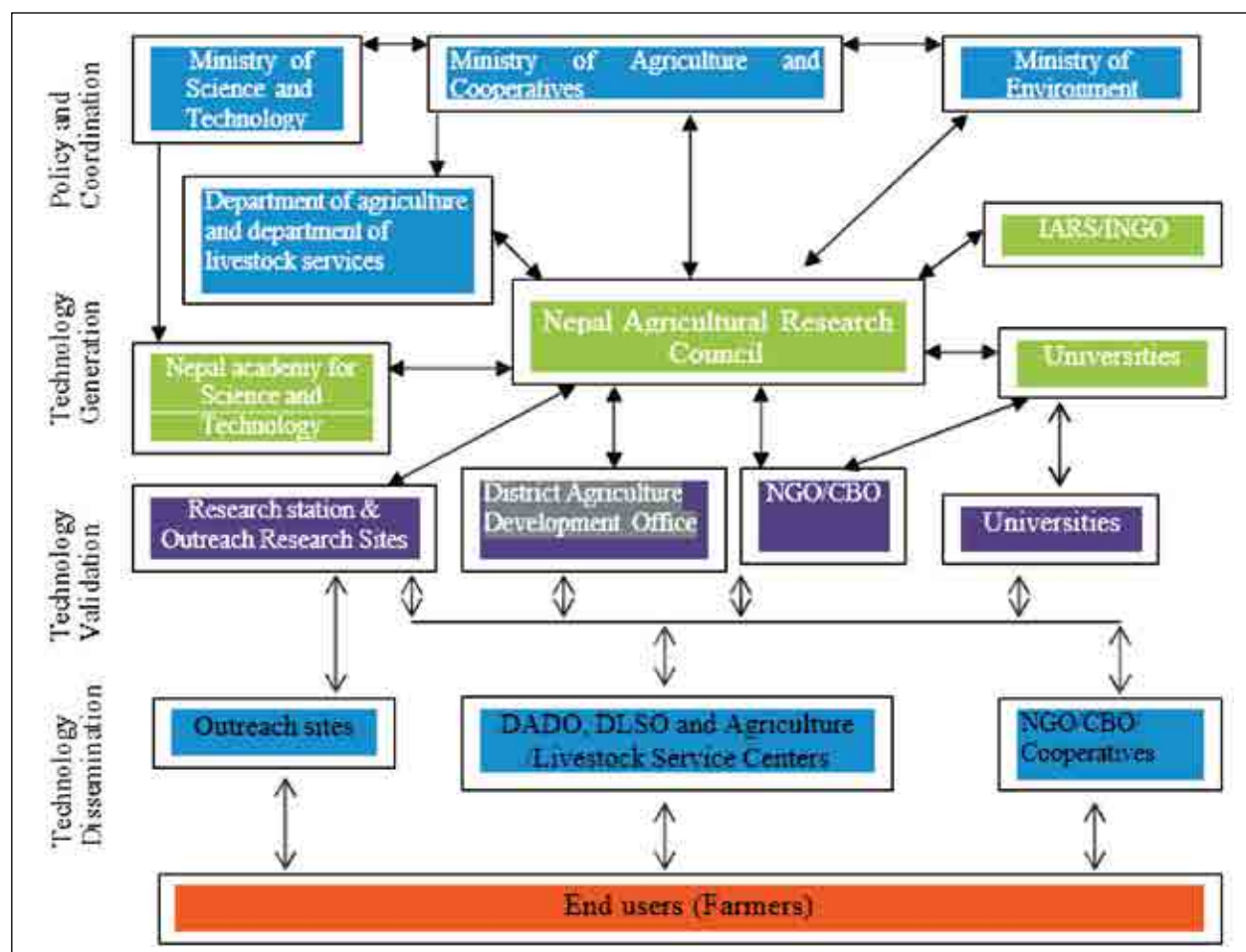


Figure 2. Schematic presentation of partnership among agriculture R&D stakeholders

The contribution of TU on research with strong base of manpower and a central sophisticated central laboratory was admirable until year 2011. However, de-amalgamation of agriculture research and education sector from this university and formulation of AFU has shifted this responsibility. KU is stepping its feet in agriculture research working in biotechnology and environmental issues.

CG Centres: There are a number of branch office of CG centres established in Nepal from early 90's. CIMMYT has its South Asia regional office working on maize and wheat R&D. Further, IRRI is main CG centre working in rice related technology generation and human resource development and has a centre in Nepal. Other CG centres IPGRI, ILRI and IFPRI are working remotely but in close, namely, coordination with NARC. Recently, IWMI has established its centre to work on water related R&D. Being only 19 per cent cultivated area under year round irrigation, agriculture research could make a difference working with IWMI but till now agriculture research has not been directly benefited.

NGOs: There are two NGOs working in agriculture research namely: LIBIRD and FORWARD. These organizations work in conservation and utilization of local plant genetic resources and participatory varietal development in close collaboration with NARC.

Infrastructure and Financial Investments

The funding for agriculture research was over NRs. 1,000 million till year 2002. After 2002, world bank grant project (Agricultural Research and Extension Project) ended and insurgency picked up and the resource allocation shifted from development to security (Fig. 3) and budget was below NRs. 1,000 million. After year 2010, the rise in agricultural budget is seen with settlement of insurgency issue and initiation of peace process. When the agricultural research is compared to national budget, it is not more than 0.35 per cent except year 2013 (Fig. 4). Similarly, the research budget used to be 10-12 per cent of ministry of agricultural development budget in the past, but in recent year it is getting down to as below as eight per cent.

The major source of fund in NARC comes from Government of Nepal as a grant (Fig. 5). Besides these, funds are also generated through national and overseas collaborations.

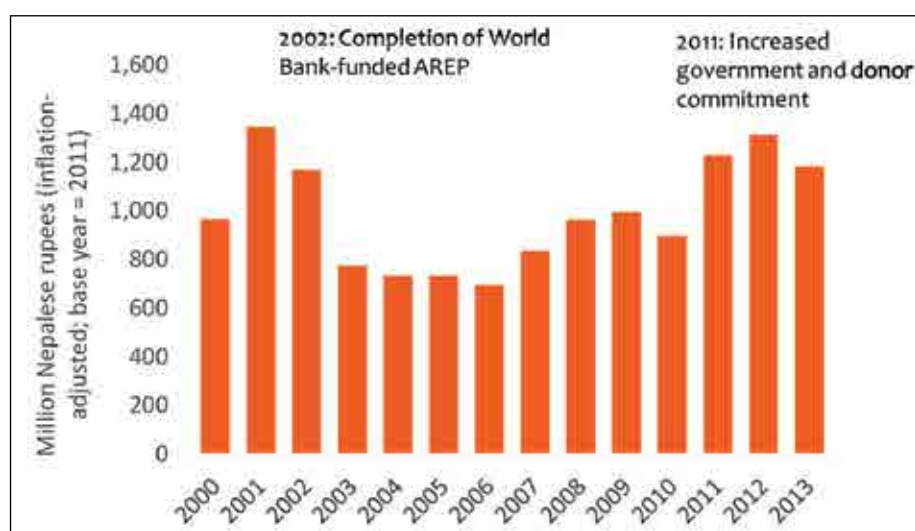


Figure 3: NARC's annual budget over 15 years

(Source: ASTI 2015)

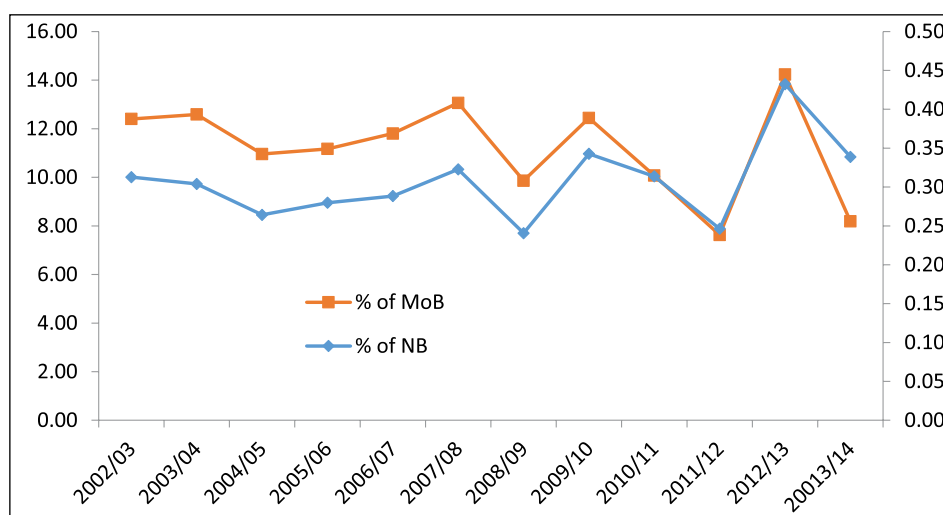


Figure 4: NARC's annual budget as share of annual Ministry of Agricultural Development budget (Y axis in left- purple line) and annual national budget (Y axis in right- blue line)

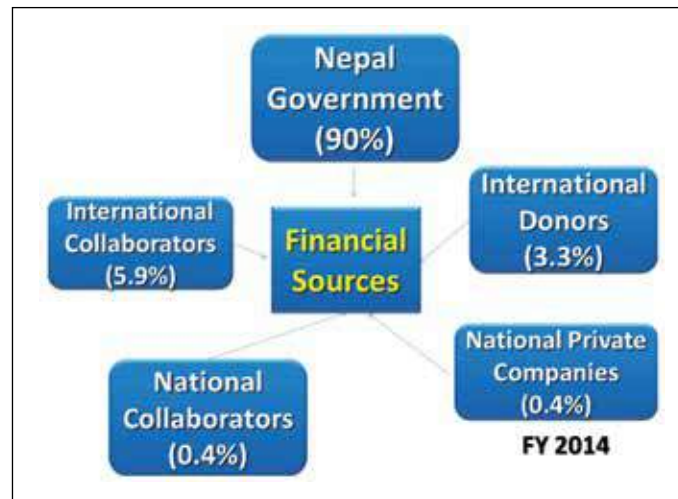


Figure 5. Share of NARC's annual budget from different sources
(Source: NARC 2015)

While analyzing NARC's annual budget expenditure over 15 years, the major share goes to salaries and actual research work (operating and programme) expenditure fluctuates around 30-35 per cent (Fig. 6). The least share goes to capital investment. The result of the least expenditure in this categories reflected in many aspect of research and administrative

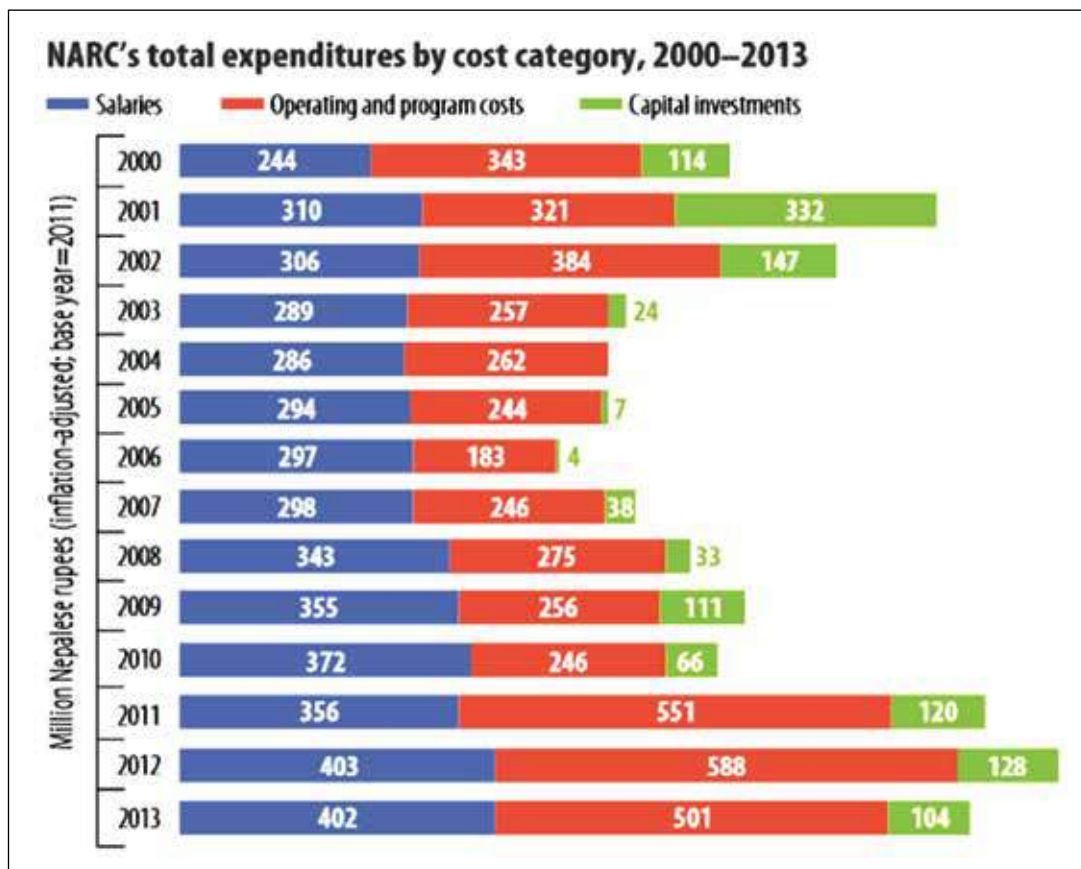


Figure 6. Annual allocation of the NARC's budget in three broad heading of expenditure

management. For example, many NARC stations and laboratories are constrained in their research efforts due to outdated research infrastructure; equipment that has fallen into disrepair, insufficient access to vehicles to conduct field research, frequent power cuts that disrupt laboratory research, unreliable internet access, lack of office space, and lack of up-to-date computer equipments and software. The situation is particularly severe at stations located outside the Kathmandu Valley.

There are 1,823 positions of staff in NARC and of them 1,031 are technicians; 412 scientists and remaining administrative staff. Of 1,823, only 1,525 positions are filled. The researcher working at present are when categorized by age group and their qualification shows that majority of researchers with Ph.D. (90%) are at mid 50's near to their voluntary retirement stage (Fig. 7). There is going to be big void of experienced researcher in near future. Therefore the voluntary retirement age of researcher has to be lifted to be 65 to tackle this problem in short run and more opportunities for higher degree training and international training and collaborative research has to be provided to young researcher to meet the future need.

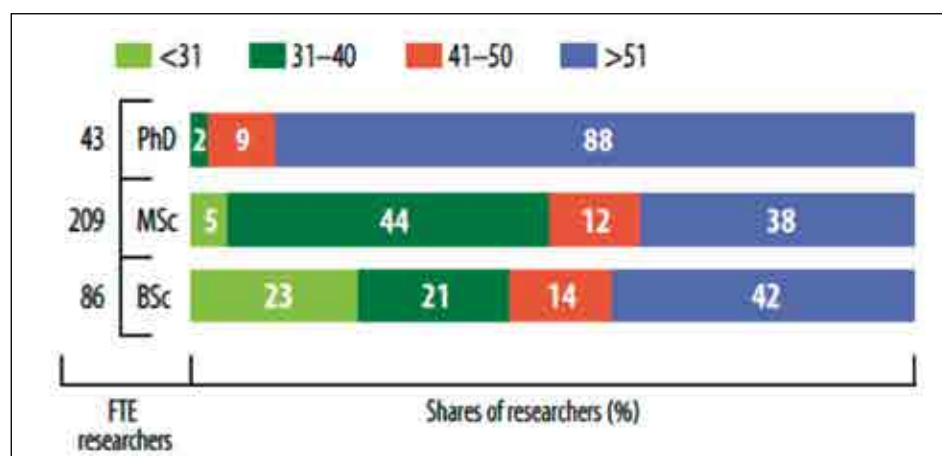


Figure 7. Distribution of NARC researchers by age bracket and qualification
(Source ATSI, 2015)

Major Challenges and Opportunities

Investment in the agricultural research and development has been increased over year and; therefore, number of researchers involved. However, more resources in terms of human and finance needed to tackle many challenges of this sector. The fact that 0.28 per cent of GDP and seven per cent of agricultural budget is spent on agricultural research proves that the agricultural research is not realized as one component appropriate for overall economic growth of the country, while the thumb rule is 12 per cent of total agriculture budget should be spent on research.

Retention of qualified researchers within Nepal is major challenge as they are underpaid as compared to surrounding countries. Although NARC has attempted to introduce a series of monetary and non-monetary incentives, none of these measures have been approved by the Ministry of Finance. Further, professional growth in-terms of higher studies and cutting age training is less to agriculture profession. Many young and talented agricultural scientists have

left Nepal to pursue opportunities in the developed countries, and they are unlikely to return. Another major deterrent to a career in agricultural research in Nepal is that a Ph.D. qualification has no impact on salary levels. Without a monetary incentive to pursue Ph.D. training, Nepal's most talented agricultural researchers are allured into other sectors or abroad. The majority of NARC researchers undertaking Ph.D. training by research under Tribhuvan University's plan are in their 50s, and some will have even retired before completing their degrees. This is not the most efficient use of resources. Moreover, although Plan B increases the number of Ph.D.-qualified researchers in the short run, it hardly addresses capacity constraints in the long-term. Therefore, there is an urgent need of policy reform to resolve these issues; however, bureaucratic hurdle to make amendment in bylaws of agricultural research is another important issue.

Despite scientific human resource and infrastructure constraints, Nepal has tremendous untapped indigenous plant genetic resources which could be utilized for the benefit of humankind. For example, our researchers were successful in developing wheat black rust (Ug99) resistant variety developed through conventional breeding and were recognized with Norman Borlaug Award in 2013 by International Wheat Consortium. Enhancing capacity of NARC researcher in molecular technology for plant breeding could really boost the breeding programme of Nepal which not only benefit Nepal but also other South Asian countries with similar agro-climate.

Further, Nepal is working in development of tools of mechanization for small to medium scale production system. The product developed so far are small in size and low cost (ginger washing machine, coffee pulper, walk-in-solar drier, seed jabber-cum-fertilizer placer, potato harvester) which could really benefit resource poor farmers of South Asia. Resource conservation technology for wheat and rice production are farmers' innovation which have given scientific twist by NARC researchers and benefited the whole South Asian farmer community.

There is unique agroclimatic condition in Nepal as it experience all of four seasons in a year and the climatic condition at one part of the country is different to other parts in the same time period. Therefore, we can grow two crops of rice, wheat and maize in a year. Which could really be helpful in reducing conventional breeding time to half as well as fast track seed multiplication process of promising cultivars for quicker dissemination.

Need and Potential for Future Collaboration

NARC is currently planning to collaborate with ICARDA and CIMMYT to develop and disseminate biofortified legume, wheat and maize varieties. This will help to enhance nutritional and food security as envisioned by Agricultural Development Strategies of Nepal. Nepalese food habit is changing and there is more demand of underutilized cereal crops like foxtail millet, proso-millet, tartary buckwheat and local vegetables. Therefore, NARC is also working together with Bioversity International as well as national level NGOs like LIBIRD on conservation, maintenance and use of local genetic resources.

In the long run, NARC is planning to collaborate with CG centres to attract grant money from Asian Development Bank, World Bank, Bill and Malinda Gates foundation for enhancing food security with increasing land and labour productivity through mechanization of agriculture production system with better use of scarce resources (water and chemical fertilizer).

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15. Country Status Report: New Caledonia

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Basic Information

Indicator	Particulars
1. Name of the Country	New Caledonia
2. Reporting Agency	IAC
3. Value of GDP in Local Currency*	886 billion XFP (2013) ¹ GDP/capita: 3.4 million XFP
4. Value of GDP in USD*	8.2 billion USD (2013) GDP/capita: 31 500 USD
5. Value of Ag. GDP in Local Currency*	13.8 billion XFP (2014) ²
6. Value of Ag. GDP in USD*	128 million USD
7. Ag. GDP as % of GDP*	1.5

*Source: Govt. of Caledonia

¹ISEE 2015 (<http://www.isee.nc/publications/toutes-les-publications>)

²DAVAR 2015 (http://www.davar.gouv.nc/portal/page/portal/davar/secteur_rural/statistiques_agricoles)

Current Policies

New Caledonia is a *sui generis* collectivity to which France has gradually transferred certain powers. It is governed by a Territorial Congress, a legislative body composed of members of three provincial assemblies. The French State is represented in the territory by a High Commissioner.

The distribution of competences between the French State, New Caledonia and the three provinces represents a relatively complex system. In the areas that interest us here, let us remember that research is a shared competence between the French State and New Caledonia, as also international cooperation, and that development and environment are competences transferred to the provinces.

As provided in its statutes, New Caledonia has established in 2013 its land-use planning and development plan with a horizon of 2025, which expresses 'the fundamental orientations in terms of infrastructure, education, environment, equipment, services of territorial interest and economic, social and cultural development' (<http://www.nouvellecaledonie2025.gouv.nc>).

In the area of agriculture, the following priorities were set:

- To reduce food dependency (food security and nutrition)
- To improve food quality
- To improve the preservation of environment
- To enhance the economic value of biodiversity
- To improve the marketing of agricultural products
- To optimize research and development linkage
- To strengthen links between higher education, research and innovation

Strategies

Major strategies adopted for implementing above policies:

Promote vocations in agriculture: Improve social security for farmers, secure the transmission of farming heritage and hereditament, increase compensation for agricultural workers, support new jobs in agriculture, encourage multi-activity, promote a better adaptation of the training offer to agricultural development strategies.

Improve agricultural production in quantity and quality: Target aid towards performance and production quality, set goals by farming sector, improving the quality of agricultural production, organize complementarity between agriculture and environmental preservation.

Improve the marketing of agricultural products: Central purchasing organizations, promote organization of short circuits, promotion of local products, enhance exportation.

Improve agricultural development conditions: Learn more about agriculture (statistics, census, observatory), build urgently a land management policy, optimize governance, improve adaptation of agricultural policy to the natural constraints of the country, optimize the links between research and development.

Specific Focus

Major specific focus areas for implementing the above strategies are:

Encourage multi-activity: For many farmers multi-activity can be seen as an asset and a practice that should be encouraged. It allows to cope with the challenges presented by climate calamities, by the cessation of other activities, etc. Agritourism is for example an already pregnant Caledonian rural activity on customary land. It is a priority for research to get involved in this area to better understand the adaptive and resilience capacity of farmers to cope with changes.

Set goals by farming sector: A possible scenario sets a consumption of vegetables and fruits provided by a local production of 75 per cent, cereals by 50 per cent, the production of beef providing coverage to 95 per cent of needs, for pig meat the coverage ratio increases to 90 per cent, and 33 per cent for chicken meat.

Improving the quality of agricultural production: The emergence of organic certification (Bio Pasifika) and a 'responsible agriculture' shows that new challenges await the Caledonian agriculture. Research needs to address these major challenges by innovation, identification of adapted genetic resources, farming systems and appropriate IPM.

Organize complementarity between agriculture and environmental preservation: The management of water resources, with the inclusion of watershed needs and resources, and the fight against erosion, are axes to remember. Generally, promote practices that reduce energy: use of biofuels, development of renewable energy, etc.

Improve adaptation of agricultural policy to the natural constraints of the country: Environmental constraints in New Caledonia call a specific treatment to optimize agricultural production. In the fight against pests, French standards should be adopted as they are made for temperate environments. Varietal selections should be conducted according to these constraints. The development of a water resources management programme would be very beneficial to agriculture, given the strong seasonal variations and the relief favouring rapid flow of rainwater. A major policy could be based on applied science competences from agricultural and research institutes.

Optimize the links between research and development: The goal must be the best articulation between research and technology transfer, and support for professionals. Indeed, the New Caledonia probably cannot afford to fund basic research programmes too remote from the application. Systematic research partnerships with research institutes in neighbouring countries would benefit from their successful experiences.

Priorities for Agricultural Research and Innovations for Development (ARI4D)

The development of the new five-year scientific programme was started this year at IAC. Four priority areas were identified for agricultural research and innovations:

Genetic resources, recovery and conservation: This set includes research-focusing entries by knowledge of animal or plant genetic material to improve and control traits of interest for protection and production; inventory, characterization, propagation and promotion of local genetic resources and diversification by importation of new genetic resources.

Functioning of cultivated and natural ecosystems: This is to develop knowledge on the functioning of relations between vegetation cover and soil from which they draw their resources, to develop new models of cropping systems, to control the dynamics of forest systems and to protect degraded or threatened environments: management of soil fertility; design of agroecological techniques with low input and adapted to different situations; integrated management of pastures; dynamics and functioning of terrestrial ecosystems, particularly forests; protection of ecosystems and restoration of degraded environments.

Biological interactions (host/parasite, pests/plants, mycorrhizae): This theme includes research issues that privilege the interactions between two (even several) objects, since it is these interactions that are causing the problem identified and it is about themselves that it is planned to intervene: characterization of pests, parasites, pathogens, auxiliaries, invasive species; development of biological control methods; develop alternatives to chemical use; prevention through immunological protection; research and promotion of symbiotic associations.

New ruralities, social forms of production and consumption: This area is part of a further work undertaken for several years on the economic, social and political dimensions of rural development in New Caledonia. The research aims to pursue and develop particular aspects identified during the wide survey on rural households: transformation and diversification of activity systems of the rural world; circuits trade and marketing, in tribes and out; governance and public policy support; and governance on natural resources.

Targets

- **Food and nutritional security:** by increased agricultural productivity and production, increasing the share of value-added accruing to producers, genetic enhancement, diversification of production, development of techniques respectful of agricultural workers, the environment and consumers, and/or value-added processing of foods to mitigate malnutrition and under-nutrition
- **Reduced environmental degradation and increased value of renewable natural resources:** by adopting measures such as biocontrol, bioenergy, conservation agriculture, biosafety and other environmental safeguards/applications
- **Understand and support the dynamics of rural societies:** by recognizing the diversity of forms of exercise of agricultural activities on the territory, encouraging diversification and marketing of commercial products and the organization of the actors involved, better appreciate the weight of non-market productions

Institutional Roles, Responsibilities and Partnerships

- Agronomic institute of New Caledonia (IAC): Applied agricultural research for development
- French State, government of New Caledonia, provinces of New Caledonia: Main research funding in New Caledonia (90% for IAC)
- Private sector: Mining societies, studies funding (environment and social impacts)
- National Agricultural Research System (NARS): Mainly CIRAD and IRD, INRA, University of New Caledonia, IFREMER, CNRS (partnerships with IAC).
- South Pacific Commission (SPC): Collaboration on specific projects (as Bele), mainly with the Land resources division
- Civil Society Organizations (CSOs): Mainly involved in environment protection (CI, WWF, local CSOs). Some collaborations with IAC
- FOs: Chamber of Agriculture of New Caledonia, smaller FOs
- Agency for Economic Development on New Caledonia (ADECAL): Public agency responsible for technology transfer

Infrastructure and Financial Investments

- Consortium for Research, Higher Education, Innovation in New Caledonia (CRESICA): All New Caledonia research organizations came together by 2015 in a consortium (CRESICA).

CRESICA represent nine public bodies, totalling about 250 people contributing to research

- AR4D, mainly covered by IAC: Around 70 people (12 research officers with Ph.D., 10 research associates with master level, 10 research assistants with degree level). A budget of five millions USD per year. A laboratory of molecular biology, a lab of chemistry, three farm stations (totalling around 25 ha)

Major Challenges and Opportunities

Major challenges: Ability of New Caledonia to increase its potential for researchers in areas not currently covered or little covered (water management).

Opportunities: Access to financial instruments (New Caledonia, France, EU), rather favourable climate, a very rich biodiversity, a healthy environment, high demand for healthy local products.

Need and potential for future collaboration (within and outside): Human resource development, plant genetic resources and crop improvement, irrigation and water management, crop protection, Pacific Island Countries are dependent on technology from outside, good linkages with relevant institutions within and outside the region should be developed.

Looking Ahead (short to medium-term)

IAC is in the process of developing its five-year scientific programme. The process started in April 2015 with the meeting of all partners (funders, technical partners, farm organization) to collect their needs (Strategic Policy Committee).

This expression of needs has been synthesized in a report, which has been validated by the participants.

The next step was to translate these needs into research questions, by the Scientific Council of IAC. This exercise is still being completed, it is expected to be adopted by the Board of Directors early 2016.

The scientific programme project will be established with all these elements (human resources and budget, schedule, deliverables, results and impact indicators), which will serve as a roadmap for IAC for 2017-2021, and will allow to request the necessary funding.

16. Country Status Report: Pakistan

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Introduction

The Islamic Republic of Pakistan is one of the developing countries in South Asia. GDP of Pakistan at factor cost was Rs. 22378.9 billion in year 2012-13, while the provisional figure for the year 2014-15 is Rs. 27383.7 billion (GOP, 2015). GDP of the country amounts USD 262.1 billion at current exchange rate (USD 1 = Rs. 104.47). Agriculture sector shares 20.9 per cent in the national GDP. Population of the country has increased four to five folds since first census in 1951. According to last population census in 1998, total population of the country was 132.35 million. However, the present population of the country is reported at 191.71 million (GOP, 2015A).

Current Policies

There is a wide consensus that technology and innovation can play a lead role in order to meet the food security needs of the country besides providing income and employment opportunities in rural areas. Pakistan Agricultural Research Council (PARC), the country's principal R&D organization has a mandate to aid, promote and coordinate the research efforts across the country; ensuring that research results are disseminated and utilized; and creating a cadre of highly trained manpower to undertake and manage research (PARC, 2013). In the recent past, national agriculture and food security policy has been focusing on sustainable food security, increasing productivity, commercial agriculture, imports substitution, income diversification and export orientation. A special policy focus has been on establishing a network of quality testing laboratories in public sector for grains, livestock diseases and products, fertilizer and agro-chemicals, residue testing and strengthening of plant and animal quarantine services (Hanif *et al.* 2004). The most recent draft policy document of the country i.e. Agriculture and Food Security Policy-2014 places main emphasis on acceleration of technology generation and dissemination process. In the current policy, governance and institutional reforms have also been emphasized to ensure proper and sustainable management of the country's physical, human and social capital. Federal government will focus on regulatory mechanisms, to improve service delivery to farmers such as establishment of certification systems for quality control, truth in labeling and traceability in the case of input and services, such as animal health services, fertilizer, pesticide and chemicals' distribution. New policy emphasizes that after the 18th amendment to the constitution main operational responsibility for most of the actions lies at the provincial level (GOP, 2014).

Strategies

Following strategies are being adopted to promote agricultural research and innovation in the country:

- A mix of institutional reforms and higher investments will be made to strengthen research and innovation efforts at federal and provincial level, at universities and research institutes, and to promote close collaboration between public sector research and private sector, NGOs, CSOs and farmers' organizations (GOP, 2014).
- In order to promote a more holistic and multi-stakeholder approach to agriculture research and innovations and to foster an integrated approach for research planning; efficient allocation of research resources, generation of appropriate solutions of the issues faced by various stakeholders in provinces and the expansion of provincial linkages to greater national, regional, and international communities through an overarching mechanism of coordination, Provincial Agricultural Research for Development (AR4D) Boards would be established in Sindh, Balochistan and Khyber Pakhtunkhwa provinces along the lines of Punjab Agricultural Research Board (PARB) with performance based employment (GOP, 2014).
- Development of new technologies and their diffusion to farmers such as high yielding varieties, nutrients based use of fertilizers, alternate energy sources, and high efficiency irrigation systems, etc.
- Development of research infrastructure such as high quality agricultural input testing laboratories and trained man power to operationalize them
- New extension methodologies will be adopted such as Information Communication Technology (ICT), Community Service Centers (CSC), the Farmer Field Schools (FFS) and Plant Clinics (PC), which have already been widely tested in Pakistan and parts of the world, and Business Field Schools that build capacities all along the agricultural value chains for harvesters, pickers, packers and transporters. Extensive use made of digital technologies will be made that can provide instant and virtually costless access to market information and other knowledge sources; and the possible introduction of performance-based incentive systems for extension workers with market based salary scales. Capacity building activities will be undertaken for youth as service providers focusing on areas of high potential such as agro-processing, use of bio-technology in crops and livestock, true-to-type clean nurseries, hybrid seed production, aquaculture, spate irrigation systems, resource conservation, alternate energy and milk and meat production (GOP, 2014).

Specific Focus

Government specific focus areas identified are:

- Sustainable growth in the productivity of major crops as well as the promotion of high value agriculture including horticulture, fisheries and livestock
- Improved resource conservation technologies, including water-harvesting and erosion control, in more agro-climatically fragile areas, such as arid and high elevations lands for planting horticulture crops with low water requirements such as olive, pistachio, pomegranate, grapes, fig, almond and falsa (GOP, 2014)

Priorities for Agricultural Research and Innovations for Development (ARI4D)

Priority would be given to production of public goods such as research, pest and disease surveillance, efficient irrigation water use, alternate energy, agro-processing and creation and

administration of a regulatory and legislative framework; addressing externalities such as enhancing sustainability and adopting environmentally friendly activities; and for social purposes. Farmers and local communities will be increasingly drawn into the management of natural resources. Foremost among these is irrigation, where the reform process related to management of surface and canal irrigation system will be completed and deepened based on an analysis of the strengths and weakness of past reform efforts. This needs to be accompanied by similar reforms related to ground water (MNFSR, 2014).

In order to complement provincial agriculture and food security efforts, the MNFSR will launch a series of national flagship projects. These projects would cover activities which have a high technological component, are in the more remote and agroecologically challenging areas, are high risk but high return, or address high priority national issues. Promotion of high value crops, fisheries and aquaculture and non-traditional horticulture crops are also focused. Provinces will take the primary responsibility for promoting and increasing production of traditional crops and livestock products such as major cereals (wheat, rice, maize); cash crops (sugarcane, cotton, oilseeds); and meat and dairy products, the Federal Government will provide complementary support in activities that need greater technological and research linkages with national and international areas, and special support for developing marketing chains and logistics (MNFSR, 2014).

Targets

Food, water and energy security are the priority areas for the development of the agriculture of Pakistan. Vision 2025 prepared by the Ministry of Planning, Development and Reform envisages road map for future growth and development of food and agriculture sectors along with allied sub-sectors. It has been recognized that sufficient, reliable, clean and cost-effective availability food, water and energy are essential in ensuring sustainable economic growth and development. These key sectors have suffered historically from severe failings of integrated policy and execution. Meeting this challenge has further been complicated due to the impacts of ongoing climate change. However, this is the target area in vision 2050 and government has renewed national consensus on committing major new investments, through public and private sector collaboration, to fulfill the large gaps that threatened the wellbeing and progress of country. While investments to ensure the needed additional supply is being made in creating and encouraging a culture of conservation and efficiency in the usage of natural resources. Vision 2025 seeks a Pakistan where 'all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'. Vision 2025 envisages food security in the context of the entire supply-chain from production, processing, storage and distribution to consumption. The targeted areas for achieving food security are to:

- Create a modern, efficient and diversified agricultural sector, aligned with associated water and energy infrastructure that can ensure a stable and adequate provision of basic food supplies for the country's population, and provide high quality products to its industries and for export
- Use the resource base in an efficient and sustainable manner with outcome based benchmarks agreed in line with regional and global standards

- Development of new high yielding varieties through collaboration with international organizations
- Ensure availability of precision agricultural machinery to farmers either on subsidized prices or through mechanization services providers

Institutional Roles, Responsibilities and Partnerships

Ministry of Science and Technology (MoST) is the national focal point and enabling arm of government for planning, coordinating and directing efforts to initiate and launch scientific and technological programmes and projects. The Scientific and Technological Research Division of the MoST has had sanctioned various research and development projects in the agriculture sector, mainly for development of natural resources. Pakistan Council for Science and Technology (PCST), an autonomous organization working under the umbrella of the MoST advise the government on S&T policy and plans, evaluates scientific research through bibliographic and bolometric and peer review techniques. PCST also awards Research Productivity Allowance to active scientists on the basis of their publications in international journals and their performance (MoST, 2015).

Ministry of National Food Security and Research (MNFSR) is mainly responsible for policy formulation, economic coordination and planning in respect of food grains and agriculture in the country (MNFSR, 2015). PARC is an autonomous body of MNFSR and has a broad mandate to coordinate research among federal, provincial, and higher education agencies and to address areas of research not covered by other agencies. It is an apex national organization working in close collaboration with other federal and provincial institutions in the country. PARC has National Coordinated Research Programmes (NCRPs) on different crops, fruits, vegetables and livestock as a mechanism for conducting joint research (MNFSR, 2014). PARC's research is generally basic and long-term in nature. The research being undertaken is mainly focused towards areas of national importance which fall under one of the following themes:

- Neglected or inadequately covered research
- Research beyond the resources of the provincial institutions
- Research requiring sophisticated and costly equipments and facilities
- Research requiring highly qualified but scarce manpower and frequent interaction with international agricultural research institutions

Four other federal agencies under MNFSR are involved in agricultural research. The Agricultural Price Commission (APC) and the Soil Survey of Pakistan conduct applied research related to agricultural prices and soil resources, respectively. The Federal Seed Certification and Registration Department focuses on the sampling and testing of seeds and the conduct of post-control trials. The National Veterinary Laboratory conducts research related to animal disease control and vaccine development. Aside from PARC, a number of federal government agencies conduct agriculture related R&D under the auspices of various ministries. These agencies include the Pakistan Council of Research on Water Resources (Ministry of Science and Technology), International Waterlogging and Salinity Research Institute (Ministry of Water and Power), National Fertilizer Development Centre (Ministry of Planning and Development),

Marine Fisheries Department (Ministry of Ports and Shipping), and Pakistan Forest Institute (Ministry of Environment). Among others, the Pakistan Atomic Energy Commission oversees four relatively large research agencies related to agriculture: the National Institute for Biotechnology and Genetic Engineering (NIBGE), Nuclear Institute for Agriculture and Biology (NIAB), Nuclear Institute for Agriculture (NIA) and Nuclear Institute for Food and Agriculture (NIFA) (Beintema *et al.*, 2007).

At the provincial government level, agriculture is divided into five fields: crops, livestock and fisheries, food, natural resources (soil water, forestry, and wildlife), and education. Research conducted by the federal government agencies is largely long-term priority research, while the research conducted by the provincial research system is mostly adaptive in nature. Each of the four provinces has a main agricultural research institute under the administrative oversight of the Department of Agriculture. Ayub Agricultural Research Institute (AARI) is the main institute in the Punjab and is located in Faisalabad. The Livestock and Dairy Development Department is responsible for livestock and veterinary research in the province. The department consists of four research institutes and conducted research at the Forestry, Wildlife, and Fisheries departments focused on forestry, wildlife, and fisheries research, respectively (Beintema *et al.*, 2007).

Agricultural research under the Department of Agriculture in Balochistan and Khyber Pakhtun Khuda (KPK) is organized in a similar manner as the Department of Agriculture in the Punjab, with all research activities taking place under one entity, the Agricultural Research Institute Sariab in Balochistan and the Agricultural Research System in Khyber Pakhtunkhwa. Agricultural research under Sindh's Department of Agriculture is less consolidated than in the other three provinces. The Agricultural Research Institute Tandojam (ARIT) focuses on crops research except for rice, wheat, and horticulture - for which separate commodity research institutes exist. Livestock research is also separate and falls under the provincial Department of Livestock and Fisheries. In Pakistan there are 17 higher education units involved in agricultural research. The most important higher education agencies in Pakistan are the agricultural universities located in Faisalabad, Rawalpindi, Peshawar, Tandojam and Lasbela (Beintema *et al.*, 2007).

Besides cooperating at the national level, R&D institutions in the country cooperate widely at the regional and international levels as well. PARC maintains close links with the Consultative Group on International Agricultural Research (CGIAR) centers and has been drawing upon their facilities for training, expert service, research methodologies, germplasm, and scientific information. These centers include International Maize and Wheat Improvement Center (CIMMYT), International Center for Agricultural Research in the Dry Areas (ICARDA), International Rice Research Institute (IRRI), International Livestock Research Institute (ILRI), HarvestPlus and International Water Management Institute (IWMI). Other links are in place between Pakistan Agricultural Research Council (PARC) and the Asian Vegetable Research and Development Centre (AVRDC), Australian Centre for International Agricultural Research (ACIAR), International Centre for Integrated Mountain Development (ICIMOD) and Asia Pacific Association of Agricultural Research Institutions (APAARI). PARC has technical cooperation programmes on various commodities with FAO. Moreover, PARC cooperates with institutes in some 40 countries in Asia, the Middle East, Latin America, Africa, Europe, Australia and North America (Beintema *et al.*, 2007).

Nonprofit and for-profit private companies have a minimal, but growing, involvement in agricultural R&D in Pakistan. A number of private companies have active breeding programmes, including programmes focused on genetically modified *Bt* cotton, hybrid maize, vegetables, and several other crops. A recent survey of firms engaged in seed research estimated aggregate investment at 121 million rupees or USD 1.3 million (current prices) with the average firm spending 5.5 per cent of its sales revenue on R&D. Private R&D is also sizeable in the fertilizer sector; one of the largest firm spent nearly 287 million rupees in 2009, primarily on research to improve fertilizer manufacturing (for example, energy saving technologies). Private research investments in livestock, irrigation, processing, and other areas were nominal (Naseem *et al.*, 2012).

Infrastructure and Financial Investments

A total of 123 institutions are identified to be involved in agricultural R&D in Pakistan. In 2009, these 123 institutions together employed more than 3,500 full-time equivalent (FTE) researchers and spent 3.2 billion Pakistani rupees—equivalent to nearly 171 million constant international dollars at year 2005 prices. The country's principal agricultural R&D organization PARC has 12 satellite institutes and oversees a number of federal government research agencies located in various parts of the country. One of the largest is the National Agricultural Research Center (NARC) which also oversees a number of its own research institutes. Including NARC, PARC accounts for one-fifth of all investments and 14 per cent of total research capacity in national agricultural research. Excluding NARC, the number of researchers employed at the remaining PARC agencies are 202 FTEs in 2009. Punjab employed nearly 1,000 agricultural researchers in 2009 (in FTEs) and accounted for half of the country's provincial-level investment. After Punjab, the provinces with the next highest human resource capacity for agriculture R&D were Khyber Pakhtunkhwa (405 FTEs), and Balochistan (218 FTEs). Almost same pattern was observed in research spending across provinces; Punjab was the leading province, followed by Sindh, Khyber Pakhtunkhwa and Balochistan (Table 1). The higher education sector accounted for 14 per cent of national agricultural research capacity, employing 487 FTEs. The University of Agriculture, Faisalabad (UAF) remains Pakistan's largest agricultural university by total research staffing, other universities include Sindh Agriculture University, Tandojam; Agricultural University Peshawar; Pir Meher Ali Shah Arid Agriculture University, Rawalpindi; University of Veterinary and Animal Sciences, Lahore and Lasbela University of Agriculture, Water and Marine Sciences, Lasbela. Overall the enrollment was about 27,000 students in 2009 (Flaherty *et al.*, 2012).

Table 1. Overview of public agricultural R&D spending and research staff levels in 2009

	Total spending			Total staffing	
	Pakistani rupees	PPP dollars	Shares	Number	Shares
	(million 2005 prices)		(%)	(FTEs)	(%)
PARC/NARC (34)	711	37	21.6	495	14.0
Other federal (18)	498	25	15.1	581	16.4
Balochistan (2)	165	9	5.0	218	6.2

Contd...

Table 1. Contd...

	Total spending			Total staffing	
	Pakistani rupees	PPP dollars	Shares	Number	Shares
	(million 2005 prices)		(%)	(FTEs)	(%)
Khyber Pakhtunkhwa (5)	156	13	7.8	402	11.4
Punjab (18)	929	49	28.3	968	27.4
Sindh (16)	274	14	8.3	380	10.8
Higher education (30)	454	24	13.9	487	13.8
Total (123)	3187	171	100.0	3531	100.0

Source: Flaherty *et al.* 2012 (Compiled from ASTI-PARC 2011-12)

Note: Figures in parenthesis indicate the number of institutions in each category. Data exclude degree-qualified technicians not officially classified as researchers

M.Sc. qualified staff accounted for about three-quarters of Pakistan's total agricultural research capacity, whereas researchers with B.Sc. degrees constituted 11 per cent, and those with Ph.D. degrees represented 18 per cent. Universities worldwide generally employ higher shares of agricultural researchers with Ph.D. and M.Sc. degrees, and this holds true in Pakistan. In 2009, the share of Ph.D. qualified researchers in the higher education sector was 46 per cent, whereas M.Sc. qualified researchers accounted for about half of capacity. After the universities, Punjab and NARC employed the highest number of faculty staff with Ph.D. degrees. In contrast, Sindh and Balochistan employed only 13 and five FTE researchers with Ph.Ds., respectively (Flaherty *et al.*, 2012).

Major Challenges and Opportunities

Pakistan has one of the largest agricultural research systems among developing countries, employing over 3,500 FTE, researchers. However, based on a number of indicators, Pakistan appears to be falling behind other South Asian countries. Agricultural research did not match Agricultural GDP growth, resulting in weakening agricultural research intensity ratio of 0.21; the share of agricultural researcher holding Ph.D. degree is low, at 18 per cent and employment of female researchers is also low. Moreover, number of Ph.D. degree holding researcher is expected to decrease rapidly in the near future, due to a long spanned ban on new recruitments in the near past and retirements of the scientists recruited in late 1980s. Private investment in agricultural research is also relatively small. After amendment to the country's constitution, provincial institutes have taken on a larger role in agricultural research, but question remains as to whether they are resourced and structured enough to do so effectively (Flaherty *et al.*, 2012). Involvement of farmers associations and non-profit organization in agricultural research is low. Thus, there is an opportunity to involve them in research or undertake it on their own by providing incentives. Well established and large research system of the country provides an opportunity in itself, to gain benefits by increasing investment in the sector on priority areas.

Looking Ahead (short to medium-term)

Growth in agriculture needs to be accelerated in order to meet food security, and provide income and employment opportunities in rural areas. Yield growth for most crops and

livestock products in Pakistan has stagnated and become more variable in recent years and there continue to be large gaps between achievable and realized productivity in most crops. Diversification and a move to higher value added had been limited, particularly in the crops sector, with the cultivated area under 'high-value' crops more or less unchanged between 1960 and 2000. Performance has been somewhat better in the livestock and fisheries sectors but major problems with poor practices and very limited animal health services continue to limit production. The apex agricultural research organization in the country has planned changes in its structure and process along with enabling environment for the national research system. This will include finances for enhancing the involvement of other stakeholders; fostering international linkages; coordinating and guiding the research efforts across the country; promoting the utilization, dissemination and commercialization of research findings through the provincial extension system, private sector, non-profit organizations and the electronic media; and training of high level staff in technical and managerial skills. Reforming PARC and improving the enabling environment will not, by themselves, be enough. There is a clear and urgent need to substantially increase the amount of resources allocated to agricultural research and bring it into line with other countries in the region. PARC envisaged a programme for upstream and strategic research with an estimated incremental cost of about Rs. 20.0 billion (USD 200 million) over five years. These research activities will be shared between PARC and its institutes (about 20%), the provincial research systems (50%), the universities (10%), NGOs/CSOs and farmers' organizations (15%) and the private sector (5%). The bulk of these funds would be disbursed through a competitive grant processes but some funding will also be used to strengthen research institutions at federal and provincial level as well as universities. It is further proposed that wherever possible research should involve partnerships between federal and provincial institutes, private sector and farmers with a focus on topics that impact small and poor farmers, women and those living in marginal areas and fragile ecosystems. There is also a need to substantially increase the amount of resources allocated to agricultural research, which as a proportion of agriculture GDP, is 30 per cent lower than in Bangladesh, India and Sri Lanka, and 40 per cent lower than the average for the Asia-Pacific region. After the discussions with provinces, whose role in agriculture have been enhanced following the 18th Constitutional Amendment, as well as with other stakeholders suggests that PARC needs to do much more work creating an enabling environment for research in the country as a whole. This will require much more work on areas of its mandate related to: aiding, promoting and coordinating research, ensuring that research results are disseminated and utilized and creating a cadre of highly trained manpower to undertake and manage research (PARC, 2013).

To meet and ensure national food security and nutritional requirements, the major issues to be addressed are:

Raising productivity and output

- Improving inputs (planting materials, feed/fertilizer, breeds)
- Strengthening the value chain (harvesting, transport, storage)
- Land and water conservation and management
- Value addition

Climate smart agriculture

- Harnessing alternative energies
- Adapting to climate change
- Environment protection

Good agriculture practices

- Reduced reliance on chemical use (pesticides and fertilizer)
- Product quality and competitiveness
- Disease/pests surveillance, diagnostics and solutions

Knowledge management

- Commercialization and international market information
- Diagnostics for establishing research priorities (including for small farmers)
- Use of new technologies for knowledge transfer

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17. Country Status Report: The Philippines

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Basic Information

Indicator	Particulars
1. Name of the Country	The Philippines
2. Reporting Agency	PCAARRD
3. Value of GDP in Local Currency*	6,338,478 (as of Q2 2015) ¹
4. Value of GDP in USD*	284.58 (projected for annual value) ²
5. Value of Ag. GDP in Local Currency*	642,328 (as of Q2 2015) ³
6. Value of Ag. GDP in USD*	13,722.03 (as of Q2 2015) ⁴
7. Ag. GDP as % of GDP*	10.13 (as of Q2 2015)

*Source

¹Philippine Statistics Authority (PSA), as of August 27, 2015.

²Trading Economics (<http://www.tradingeconomics.com/philippines/gdp>) citing the World Bank (2015).

³PSA, 2015.

⁴Converted based on the ex change rate of US\$1 = P46.81 (as of September 29, 2015).

Current Policies

- The overall long-term goal of PCAARRD is to reduce poverty incidence, attain food security and global competitiveness, and address the related environmental issues and concerns. PCAARRD's commitment-programmes, projects, and activities are anchored on the Philippine Development Plan (PDP) 2011-2016, and the Philippine Agriculture (PA) 2020. More specifically, it supports President Benigno Aquino III's Social Contract with the Filipino People as stipulated in Executive Order (E.O.) No. 43. President Aquino's Social Contract with the Filipino People has five Result Areas (KRAs). PCAARRD's banner programs address four out of the five KRAs of the national goals and commitments embodied in the President's Social Contract, namely KRAs 1,2,3, and 5.
- For Key Result Area (KRA) 1 (Transparent, accountable, and participatory governance): PCAARRD consults its stakeholders (research agencies, academicians, farmers, fisherfolk, local government units (LGUs), policy-makers, donor agencies) to identify priority concerns in the Agriculture, Aquatic and Natural Resources (AANR) sector that need to be addressed by S&T interventions. As such, the limited/competitive budget for R&D is used where S&T will make

a difference and have a positive impact on the lives of the Filipinos. PCAARRD collaborates with the National Agriculture, Aquatic and Resources Research and Development Network (NAARRDN) in implementing R&D programmes/projects that are monitored and evaluated by PCAARRD based on agreed targets/outputs. PCAARRD also equips its personnel and researchers in the NAARRDN to enable them effectively and efficiently perform their tasks. Strategies include resource generation; human resource development; facilities development; enhancement of information management system; continual improvement programme; strengthening information and technology deliverables; R&D management and coordination; and support to the regional consortia.

- For KRA 2 (Poverty reduction and empowerment of the poor and vulnerable): PCAARRD believes that the employment and livelihood opportunities and revenues to be generated by the application of S&T interventions in the AANR sector will initiate poverty reduction and finally contribute to economic development. Hence, PCAARRD collaborates with the NAARRDN in pursuing R&D programmes/projects and technology transfer modalities to provide farmers and fisherfolk with more and better options to improve their traditional practices and increase their productivity. PCAARRD also supports/collaborates in national agricultural productivity programmes/initiatives of the Department of Agriculture (DA) such as the 'National Organic Agriculture Programme (NOAP)'.
- For KRA 3 (Rapid, inclusive, and sustained economic growth): PCAARRD's Industry Strategic S&T Programmes (ISPs) for selected AANR commodities and cross-cutting concerns encapsulate interventions under the four strategic banner programmes where S&T will make a difference. The S&T interventions aim to resolve industry problems within the technology/value chains through delivery of identified outputs and potential outcomes/impacts. Moreover, PCAARRD believes that S&T innovations are critical for the Philippines' competitiveness, especially with the Association of Southeast Nations (ASEAN) Economic Integration this 2015. Hence, PCAARRD invests on increasing the knowledge of NAARRDN researchers as well as in expanding their networks in the international arena. Through such exposure, they learn about new trends and scientific discoveries that could be adapted under Philippine conditions to improve productivity of the AANR sector.
- For KRA 5 (Integrity of the environment and climate change adaptation and mitigation): PCAARRD recognizes that climate change adversely affects the AANR sector, threatening food production and, consequently, the Philippines' food security. In view of the significant portion of the Philippine population that relies on agriculture and fisheries for livelihood, PCAARRD, through the NAARRDN, develops and disseminates technologies and information that will enable the AANR sector adapt to extreme weather conditions (drought, floods, strong winds, saline soils and water). PCAARRD also develops S&T-based strategies for biodiversity and resource conservation and for soil and water resources management. Moreover, PCAARRD promotes organic agriculture technologies for sustainable productivity of the agricultural sector. PCAARRD also supports/collaborates in national environment protection programmes/initiatives of the Department of Environment and Natural Resources (DENR) such as the "National Greening Programme (NGP)".
- The strategic interventions under the PCAARRD Corporate Plan (CorPlan) 2012-2016 support the government's commitment under the President's Social Contract. Moreover, PCAARRD has anchored its strategic interventions, to achieve its goals and objectives

for the AANR sector, to the Department of Science and Technology (DOST) Harmonized National R&D Agenda.

- DOST led in crafting the Harmonized National R&D Agenda 2013-2017. It supports the four KRAs of the President's Social Contract, particularly on poverty alleviation and inclusive growth, and climate change adaptation/mitigation and disaster risk reduction. The Agenda will also create more significant inputs to a more S&T-based Philippine Development Plan. The aspiration in crafting the agenda is to pursue and create a better life for the Filipinos through science, technology, and innovation and a globally competitive capacity for science, technology, and innovation.
- The Harmonized National R&D Agenda also embodies one of the DOST outcomes and strategies which PCAARRD addresses. In pursuing national goals for the development of science, technology, and innovation and improving the Philippines' competitiveness, DOST outlined and commits to eight outcomes to the President. One of the eight DOST outcomes is being addressed by PCAARRD and one of its strategies in aligning its priorities, plans, and programmes to contribute to the achievement of the DOST outcomes. DOST, through PCAARRD, commits to: Science-based know-how and tools that enable the agriculture sector to raise productivity to world-class standards

In crafting the Harmonized National R&D Agenda, the priorities set under the Economic Development Clusters (EDC); DENR's NGP; DA's NOAP, and the R&D Innovation Clusters' priorities of the Congressional Commission on Science and Technology and Engineering (COMSTE) were also significantly considered.

- Priorities under the specific EDC are focused on the promotion of rapid, inclusive, and sustained economic growth. PCAARRD's support to the NGP focuses on bamboo, cacao, and industrial tree plantation (ITP) initiatives, whereas PCAARRD is one with DA in aiming to secure sources of farm productivity growth in agriculture, forestry and natural resources (AFNR) and diversifying income resources. Meanwhile, the R&D Innovation Clusters of PCAARRD include Algae Research and Commercialization and Precision Farming and Smart Agriculture programme and projects.

Strategies

- PCAARRD's vision of sustained dynamic leadership in S&T innovation in the AANR sector is realized through its following Banner Programmes:

- PCAARRD's Strategic R&D banner programme focuses on high-end sciences, technologies, and management systems for greater productivity and sustained growth. Member-agencies of the NAARRDN implement programmes/projects on nationally directed priorities and focus commodities in order to generate technologies that will raise farm productivity, increase incomes, enhance competitiveness of AANR products, and generate employment through S&T-based livelihood opportunities and microenterprises. Through the years, the Council has developed and implemented various R&D programmes for different commodities under crops, forestry and environment, inland



aquatic resources, livestock and poultry, marine resources, and cross cutting concerns for these sectors.

- For the R&D Results Utilization banner programme, the Council ensures that knowledge and innovations generated from R&D reach the end-users, such as the farmers, entrepreneurs, LGUs, policy-makers, researchers, extension workers, industries and students. The banner programme aims to implement technology transfer programmes and other dissemination initiatives that are strategically focused on priority products and commodities. Thus, the Council has driven the effective use of S&T results and innovation from its programmes/projects through innovative modalities for technology transfer and information dissemination.
- PCAARRD has a five-pronged technology transfer strategy: i) Technology Assessment; ii) Weaning of the Techno Gabay Program (TGP); iii) Pinoy S&T Services for Farmers and Entrepreneurs (PSF); iv) Development of Innovative Technology Transfer Modalities; and v) Advocacy for the Technology Transfer Act and Intellectual Property (IP) Rights and Management. These components represent the Council's clear-cut effort to consolidate its technology transfer initiatives into an efficient and effective technology delivery system that is holistic and responsive, as well as connected and complementary to other S&T input service providers.
- PCAARRD also strengthens the institutional capabilities of the national agriculture, aquatic and natural resources R&D system to manage the country's development goals. Through the Capability Building and R&D Governance banner programme, facilities and equipment are enhanced and R&D networks and human resources are empowered to complement the government's initiatives for the AANR sector. This programme also includes the enhancement of information management systems (Intranet-based and web-deployed) to improve provision of information by PCAARRD.
- Lastly, the Policy Research and Advocacy banner programme is the Council's way to ensure that R&D outputs will help the country become more competitive and progressive through policies to improve the S&T environment. It focuses on sector and commodity based issues identified in the supply chain and on cross-cutting concerns that constrain the development of the AANR sector [e.g. extension services, regulatory environment (grades and standards), and climate change]. The programme also includes assessment of impact of PCAARRD's programmes/projects to ensure that public investment for AANR R&D really benefit PCAARRD's intended clients. Among the strategies that PCAARRD pioneered are supply chain improvement studies; *ex-ante* analysis and impact assessment of technologies and R&D programmes; evaluation of R&D information systems; and provision of policy advisories for the AANR sector.

Specific Focus

Considering all these priorities and opportunities of convergence from agencies with similar goals and objectives for the AANR sector, under the National Harmonized R&D Agenda, PCAARRD crafted the Industry Strategic S&T Programme (ISP) as a direct and concrete translation and strategy of PCAARRD to address the needs and issues in the AANR sector. The ISPs are commodity industry plans with S&T agenda based on the demand of the industry. The purpose of the ISPs is to provide a framework to articulate the priorities, initiatives and

underlying actions of PCAARRD where resources can be applied toward strengthening industry objectives and outcomes. The ISPs also provide the R&D direction for all stakeholders working in the industry's value chain. The S&T interventions outlined in the PCAARRD ISP embody PCAARRD's four banner programmes. The PCAARRD ISP includes focused commodities under the sectors on Crops; Inland Aquatic Resources; Forestry and Environment; Livestock; Marine Resources; and Environmental Services.

PCAARRD crafted an ISP for each of the 34 commodity industries in the sectors identified. The ISP focuses on the science solutions where S&T will matter the most. Through a series of stakeholders' consultations, the status of each industry was assessed, while the key constraints and opportunities were identified. These have been the bases of the S&T interventions identified in the ISP. The set of S&T interventions for each ISP are categorized according to PCAARRD's four banner programmes. Furthermore, it contains the R&D agenda, results and utilization strategies, policy initiatives, and institutional development for the AANR industries. The ISP lays down specific science solutions crafted to address the challenges faced by the AANR industries. The collective output of these S&T innovations seek to optimize productivity and facilitate transfer of S&T products to clients, thereby improving the welfare of the key actors in AANR industries. These are also intended to strengthen S&T-based enterprises and improve efficiency of distribution and marketing by improving producers' capability to bring competitive AANR products to wider market.

S&T interventions on breeding and varietal improvement, fine-tuning packages of technologies, and development of tools and facilities for post-harvest handling are some key areas in strategic R&D, while technology transfer and assessment and IP protection are interventions under R&D results utilization. Initiatives on analysis and development of models to address concerns on marketing, information asymmetry, and product grades and standards are under policy researches. On the other hand, interventions under R&D governance focus on building human capital among the Council's network of research implementers. Corresponding outputs of the science solutions are classified as S&T products and processes, policies and services. S&T products may refer to the 'tangible' output such as high-yielding varieties for crops and improved feeding formulation for livestock and aquatic resources. Policies and S&T services are the institutional innovations that could improve access to and the ability to make the most of scientific knowledge. All these S&T interventions seek to increase productivity, reduce post-harvest losses, decrease pest and disease infestation and mortality rates, and achieve sustainable production through economic use of resources. On a macro level, science solutions strive to develop and improve the performance of the AANR industries that will improve the welfare of the key actors in AANR industries. Moreover, it will increase its contribution to the aggregate income of the country¹.

Priorities for Agricultural Research and Innovations for Development (ARI4D)

Major priority areas of ARI4D focus are :

- Conventional areas (breeding, agronomy, crop protection, natural resource management, soil science, agricultural engineering)

¹Industry Strategic Science and Technology Plan (ISP). Operationalization Guidelines. Policy Advocacy Group (PAG) Working Paper No. 2013-02

- Frontier areas (biotechnology, nanotechnology, ICT, sensors application in agriculture, geo-referenced decision support systems)
- Other areas of development such as systems (farming, cropping, integrated), policy, value chains, agricultural technology business planning, incubation, etc.

Targets

Targets set to be addressed directly or indirectly through agricultural development include the following:

- Food and nutritional security (by increased agricultural productivity and production; genetic enhancement, and/or value-added processing of foods to mitigate malnutrition and under-nutrition)
- Poverty reduction (by enhancing the farmers' incomes)
- Reduced environmental degradation (by adopting measures such as biocontrol, bioenergy, conservation agriculture, biosafety and other environmental safeguards/applications)
- Any other major target for inclusive growth and development

Institutional Roles, Responsibilities and Partnerships

The convergence approach of national agencies in the country is a strategy to harness all efforts for the sector of concern. PCAARRD's partnership with DA, DENR, and the Commission on Higher Education (CHED), which is composed of the different State Universities and Colleges (SUCs), for example, is vital in realizing the goals of the sector. Some examples of the convergence approach exemplified by the national agencies are:

- The Secretaries of DA and DENR and representatives from the academe (CHED/SUCs) working on the AANR sector are Vice-Chairs, and members, respectively, of the PCAARRD Governing Council (GC). The GC is PCAARRD's highest policy-making body whose main task is to provide a stable link between national development goals and PCAARRD's S&T programmes and objectives. It ensures the sustained relevance and responsiveness of the National Agriculture, Aquatic and Natural Resources Research and Development System (NAARRDS) to critical issues and exigencies in the AANR sector. The GC also provides policy guidance initiatives for a more efficient and effective S&T system.
- The participation of all stakeholders, including representatives from various national agencies such as DA, DENR, and CHED/SUCs, during PCAARRD's corporate planning process is crucial in identifying the issues, challenges and opportunities confronting PCAARRD in the performance of its mandates and functions. Also integral is the consideration of other plans led by other national government agencies *vis-à-vis* PCAARRD's CorPlan as part of its environmental scanning process. This ensures that inputs are gathered from DA, DENR and CHED/SUCs. In addition, the CorPlan is also reviewed and presented for approval of the GC.
- The SUCs and the regional offices/stations of DA and DENR are also members of the PCAARRD NAARRDN/Regional Consortia. The NAARRDN/Regional Consortia are composed

of national multi- and single-commodity and regional R&D centers, cooperating stations and specialized agencies. PCAARRD supports and actively advocates its programmes/projects and activities to member-agencies of the NAARRDN/Regional Consortia that implement PCAARRD's programmes/projects. The DA, DENR and CHED/SUCs are always part of the consultations in crafting PCAARRD's major programmes/projects.

- PCAARRD supports the different SUCs and agencies under DA and DENR by providing funds in implementing their priority programmes/projects. For example, the Philippine Rice Research Institute (PhilRice) of DA is one of PCAARRD's partners in implementing S&T initiatives on rice. One of the on-going programmes is Enhancing Rice Production and Post-Production Efficiencies through Improvement and Use of Appropriate Mechanization and Post-Harvest Technologies. This programme is also being implemented by the Philippine Center for Post-harvest Development and Mechanization (PhilMech), another DA agency. For livestock, R&D programmes are also implemented with the Philippine Carabao Center (PCC) of DA. The Ecosystems Research and Development Bureau (ERDB) of DENR is also one of PCAARRD's implementing partners/agencies. One of the projects currently being implemented is the Rubber, Coffee and Cacao: Building Site Matching Functions for Improved Upland Development. PCAARRD has also been supportive in the implementation of DENR-Region 13's Action Programme on the Establishment of Commercial Plantations and Efficient Utilization of the Wood Products in CARAGA Region. SUCs are also tapped to implement programmes/projects of PCAARRD. For example, the Mindanao State University (MSU) has been very active in implementing programmes particularly on seaweeds. The Sultan Kudarat State University (SKSU), on the other hand, is actively involved in the implementation of R&D on Halal Goat Production. The Visayas State University (VSU) has also been implementing various programmes on abaca, dairy buffalo, jackfruit, coconut, and vegetables, among others. These are some examples of the wide-reach of PCAARRD in working with the SUCs by implementing the Council's programme/projects to address relevant issues and concerns of the AANR sector.
- In terms of dissemination or rolling out information or technologies to the countryside and capacitating development workers, PCAARRD partners closely through the consortia with the SUCs, the Agricultural Training Institute (ATI) of DA, and LGUs.

PCAARRD maintains around 30 active international and 122 local partnerships and linkages. Most of its local partners are implementing agencies of PCAARRD-funded and monitored programmes and projects. For international partners, collaborative activities under their respective work plans of cooperation are implemented. Maintaining and strengthening its engagement with regional consortia members is also one of the strategies to innovate on the partnerships of PCAARRD. Optimizing linkages and diversifying on collaborative modalities, on the other hand, are also among the resource generation strategies of PCAARRD.

Infrastructure and Financial Investments

Aside from implementing the Facilities Development Programme of PCAARRD by member-agencies of the NAARRDN, PCAARRD is also building an Innovation Technology Center (ITC) to provide a venue for showcasing the country's R&D outputs to the public.

Major Challenges and Opportunities

In the PCAARRD CorPlan 2012-2016, we have identified thematic areas that are challenging the AANR sector such as poverty reduction, competitiveness, climate change, natural resources degradation, human resources depletion, and globalization. These are pressing and existing challenges that are usually common in the Asia-Pacific region. It is worthy to note some specific challenges (Buendia, 2012) the country is experiencing such as:

- R&D agenda and activities are done by several agencies (government agencies [DA and its Regional Integrated Agricultural Research Centers [RIARCs], DENR, etc.], SUCs), and each of these agencies has its own M&E mechanism for R&D investment. Unfortunately, there is no agency which monitors R&D expenditures or capacity nationwide, hence conducted individually by institutions concerned. This, however, in a way, reinforces the relevance of PCAARRD in providing the central direction in terms of where these R&D investments should be provided.
- R&D takes a back seat. R&D investment on agriculture, although a national priority, is not an immediate priority. It comes after other pressing needs and concerns. This translates to very low levels of R&D investment by the government with support from the private sector. It also implies that there is a slim chance in leveraging R&D to accelerate development if R&D investments continue to be a low priority for the government.
- R&D remains underfunded and there is no clear appropriation for R&D. Our gross expenditure on R&D is not much. In fact, it is one of the lowest in Southeast Asia at 0.12 per cent of GDP in 2009, while our per capita spending in R&D amounts to only USD 3.4 in purchasing power parity terms, according to the United Nations Educational, Scientific and Cultural Organization (UNESCO). The total budget provided for R&D in 2009 was only P5.382 billion or only 0.07 per cent of GDP (Palmones, 2010) - despite the UNESCO recommendation of 1.0 per cent of the GDP (Palmones, 2010). For DOST, for example, the total 2009 R&D budget was only P3.269 billion pesos or only 0.04 per cent of the GDP (Palmones, 2010; Hamlin, 2011).
- There is the urgent need to strengthen the capacities and opportunities of R&D personnel. There is a significant number of 'ageing' researchers and a few number of R&D personnel with advanced degrees and training.
- However, there are also opportunities which PCAARRD is capitalizing on. One of the important drivers of opportunities is the ASEAN Economic Integration which prioritizes the R&D and S&T sectors in its agenda. This move towards deeper integration will benefit the mobilization and utilization of the country's own knowledge pool, and not just strengthening and presenting R&D collaborative opportunities. Among the opportunities, for example, is PCAARRD's unique role in the AANR system. With the consolidation of the then Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) and the then Philippine Council for Aquatic and Marine Research and Development (PCAMRD) into PCAARRD, more priorities were taken in with the expanded area of focus of PCAARRD, which is the AANR sector. Aside from R&D agenda prioritization and coordination, all national priorities and activities are anchored on President Benigno Aquino III's Social Contract with the Filipino People, and these

priorities under the Social Contract unify and provide the roadmap for the R&D sector. We are also strengthening financial management of R&D for a more efficient and effective financial management system - more supportive and facilitative for government R&D and extension activities in the country.

Looking Ahead (short to medium-term)

PCAARRD will continue to implement the ISP because it is a framework aimed at raising the quality of R&D outputs. It is hoped that PCAARRD maintains its understanding of its changing environment so that reforms can be implemented immediately, and the institution can adapt and can effectively seize R&D investment opportunities as they come for the AANR sector.

18. Country Status Report: Papua New Guinea

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Basic Information

Indicator	Particulars
1. Name of the Country	Papua New Guinea
2. Reporting Agency	NARI
3. Value of GDP in Local Currency (PGK in billion) ^{\$}	36.138 (2013 est)
4. Value of GDP in USD ^{\$} (billion)	16.150 (2013 est)
5. Value of Ag. GDP in Local Currency (PGK in billion) ^{\$}	9.974 (2013 est)
6. Value of Ag. GDP in USD ^{\$}	4.457 (2013 est) Figures calculated above were based on the exchange rate of 2013 where USD 1 = 0.4469
7. Ag. GDP as % of GDP ^{\$}	27.6 (2013 est)
8. Population	7973121 estimation for 2015 with an annual growth rate of 3.1% (base year 2011- Census conducted and population was at 7275324)

Sources: Bank of Papua New Guinea website and World Bank Mirror data

Current Policies

According to the World Development Report 2008 (World Bank 2007), agriculture offers great promise for growth, poverty reduction, and environmental services. Evidence from other countries such as India, Ghana or Latin America shows that growth in agriculture GDP is at least twice as effective in reducing poverty as GDP growth in other sectors. This is in particular true for agriculture based countries such as Papua New Guinea (PNG) where there is little evidence of any significant contribution of the mineral and petroleum sector to improvements in rural living standards despite its importance in the national economy. In PNG, the majority of its population (>80%) earns their livelihoods in rural areas and depend on agriculture supported by fisheries and forestry for their food, income and employment and will do so for many more years to come. More than 90 per cent of rural people are semi-subsistence smallholder farmers who produce crops and livestock for their own consumption and barter (subsistence) and sell for cash in markets. A small percentage engages in fully commercial activities. Some, on the

other end of the spectrum, are considered true subsistence farmers, mostly in isolated areas in the country. Agricultural systems are highly diverse and closely adapted to the wide range of agroecological zones. The agriculture sector in PNG has still a large untapped potential to assure food security, increase incomes and absorb much of the incoming labour force in gainful employment. (NARI SRF, 2011-2020).

The agricultural sector continues to be the social safety net of PNG society (MTIP 2, 2016-2017). This sector employs about 50 per cent of the working age population of the country and provides income earning opportunities and subsistence for 85 per cent of the population who live in rural areas. The sector contributes about 27.1 per cent of the nation's GDP. While an estimated 30 per cent of the land in PNG is suitable for agriculture, only 2.2 per cent is currently being utilized for commercial agricultural production. In addition, productivity and efficiency in PNG's agricultural sector is low due to poor farming practices, compared to other countries. Poor infrastructure and market access are also contributing factors (MTDP1, 2011-2015).

The PNG government developed a long-term development strategy 'Vision 2050' (NSPTF 2009). As an important strategy to drive the development agenda for the country, the Vision 2050 has identified the need to shift from the current reliance of the economy on the mining and energy sectors to broad-based economic growth dominated by agriculture, forestry, fisheries, ecotourism and manufacturing. It envisages for a 70:30 per cent reorientation of the structure of the economy towards a renewable resource base. This message is reflected through to other key national planning documents including the Development Strategic Plan (DSP) 2010-2030 (DNPM 2010b), Medium Term Development Plan (MTDP) 2011-2015 (DNPM 2010a), and National Agricultural Development Plan 2007-2016 (MAL 2006).



The MTDP1 2011-2015 emphasizes the need to improve production and productivity and diversify products that would lead to creation of job opportunities and increase income of farmers. Over time this should transform at least 70 per cent of the subsistence agriculture based population to small and medium primary agriculture enterprises by 2030 which is a key Development Strategic Plan (DSP) 2030 deliverable.

The draft PNG National Food Security Policy 2015 provides a framework on how the country can attain sufficient, safe and nutritious food. The mission of the National Agriculture Development Plan (Department of Agriculture and Livestock (DAL), 2007a) is for improving the quality of life of PNG's rural population through increased agricultural productivity, sustainable growth and quality production coupled with integrated planning and sustainable environmental management.

In April 2014, the National Strategy for Responsible Sustainable Development (StaRS) was formally adopted by PNG Government and launched as the guiding paradigm for the design

of all future development plans. The Government adopted the new MTDF-g 2016-2017 in May 2015, as the new development road map built on the platform of sustainable development. This is only a two year plan as the intention is to bring the MTDP planning in line with the regular government cycles of five years.

The MTDP2 aims to increase the country's human development index (HDI) rating in 2016-2017 towards it being in the top 50 countries on the HDI by 2050; and achieve this by and through becoming a world leader in responsible sustainable development modality of growth. Building on this goal the MTDP 2 asserts some key priorities of the agriculture sector. These are;

- Institutional capacity building
- Access to land for productive agriculture
- Development of supply chains linking producers to markets
- Provision of extension services
- Mitigation strategies against pests and diseases
- Enforcement of CODEX standards
- Utilization of economic corridors
- Research and developments the primary strategies for the development of the agriculture sector

Strategies

The PNG NARI and the National Agricultural Research System (NARS) in PNG have adopted the Agriculture Research for Development (AR4D) paradigm, as the over-arching approach for guiding its planning and implementation processes. AR4D is embedded within the agricultural innovations system framework (Mbabu and Ochieng 2006; Rajalahti *et al.*, 2008; Anandajayasekaram and Gebremedhin 2009). It is gaining momentum globally such as its application in the CGIAR reform process (CGIAR 2011). The importance of agricultural research based on science and technology, knowledge creation and information exchange for development is undisputed. However, there is a growing sense that 'business as usual' in agricultural research, i.e. the linear model of 'generation, transfer and adoption of technology' is not achieving the desirable results in catalyzing agricultural change to impact on the lives of smallholder farming and rural households. It requires integrated and collective actions of all stakeholders to improve technologies, policies and institutions involved in production, processing and marketing (NARI SRF, 2011-2020).

The NARI strategy and results framework (SRF): Within a broad strategic planning framework, the chosen AR4D paradigm shapes the vision, mission, outcomes and impacts of an organization. The challenge for public funded institutions such as NARI under this paradigm is to reform its organizational arrangements and processes in such a way that it changes from a supplier of technologies and knowledge to a facilitator of innovation. This is the approach in which all types of knowledge (including scientific knowledge and technology)

are applied to achieve desired social and economic outcomes (Daane *et al.* 2009). This requires an adjustment of the scope and scale of an organization to include the various dimensions of agricultural research covering social and economic aspects that integrate technological, institutional and policy solutions and various disciplines (Fig. 1).

It is also important to align the organization's strategic objectives with sub-sector, sector and national development goals and to ensure adequate linkages between short-term projects and medium-and long-term development objectives within the organization (Mbabu and Ochieng 2006). The cascading logic has been used by the Institute throughout its strategic planning process and also in developing a Strategy and Results Framework (SRF) as a tool to develop those linkages (Fig. 2).

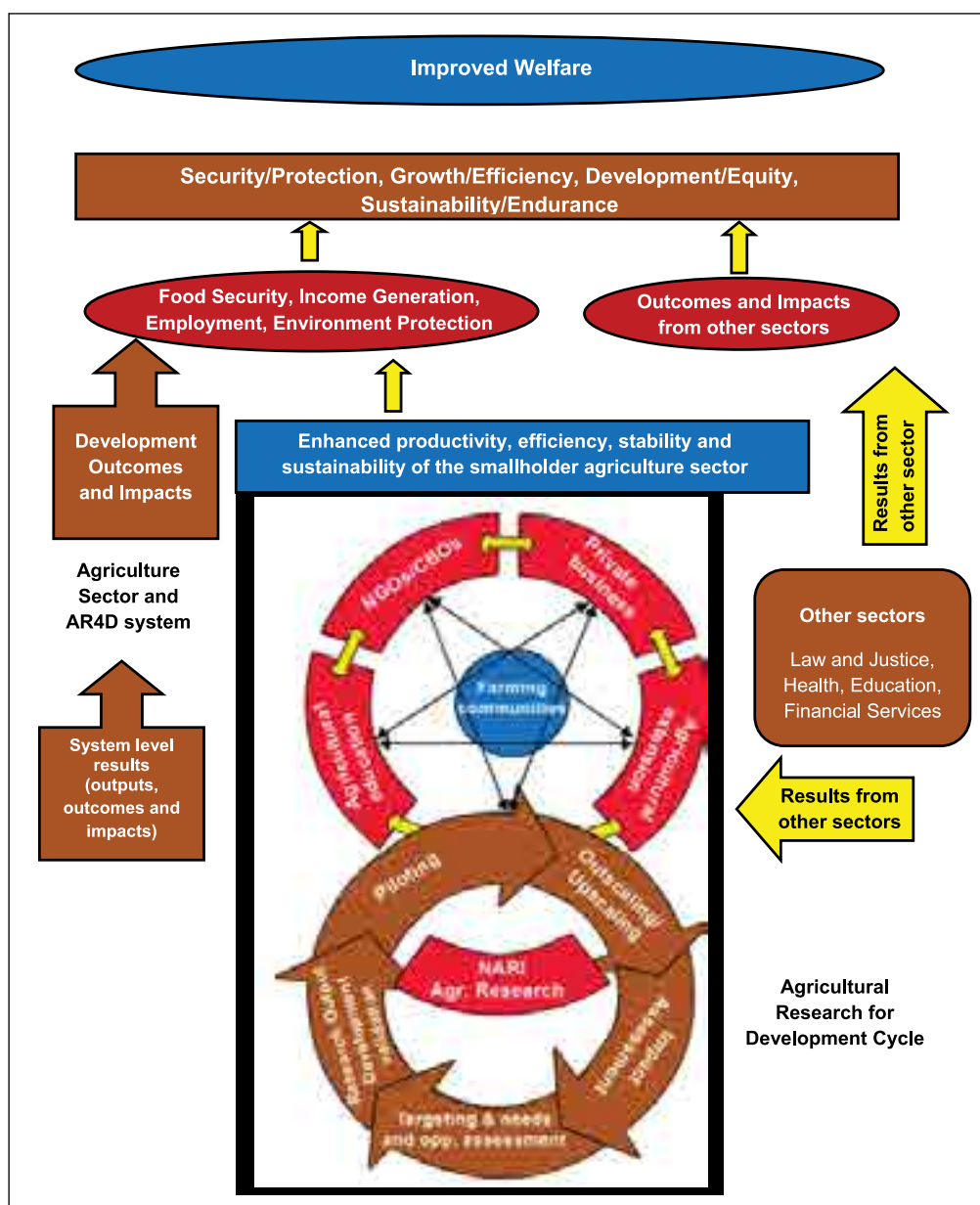


Figure 1. Agricultural research for development and linkages to other sectors (Komolong *et al.* 2011)

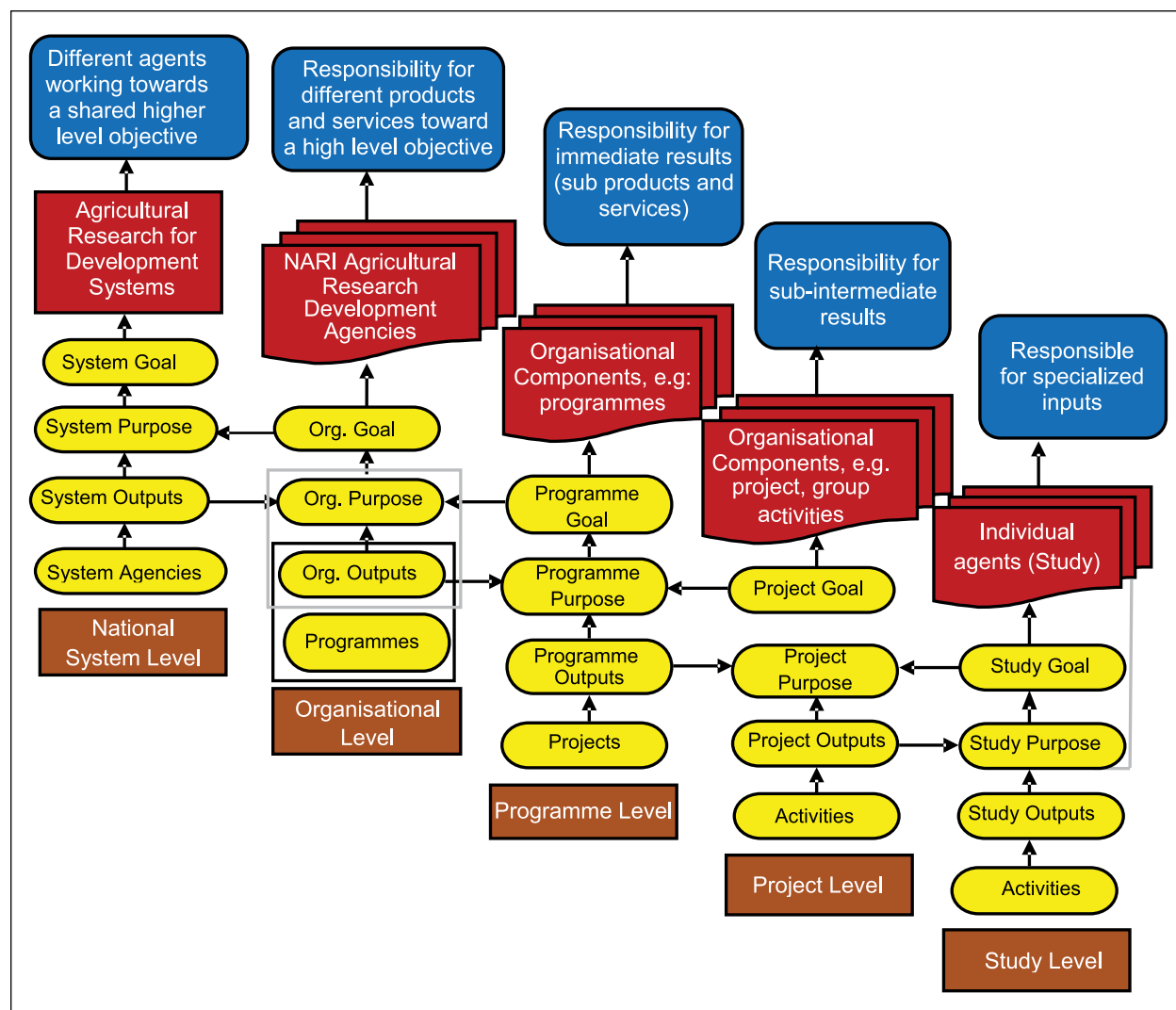


Figure 2. Interconnected levels of operation in AR4D system (Adapted from Mbabu and Ochieng 2006)

Pathways to development impact: NARI Strategy and Results Framework (SRF), an integral mechanism of AR4D, is intended to provide overall strategic direction to NARI's efforts so they are focussed along the research to development pathway in response to client needs, and consistent with current and medium term development priorities of target communities. Results-based management (UNDP 2002) is the driving force behind NARI's institutional culture and practice in order to improve management effectiveness and accountability. The SRF outlines the results to be accomplished at different levels of the hierarchy in addressing constraints, opportunities and aspirations of smallholder farmers and rural communities in the country. The results are planned so as to lead collectively to enhanced productivity, efficiency, stability and sustainability of the smallholder sector and eventually to contribute to an improved welfare of families and communities that depend wholly or partly on agriculture for their livelihood.

As mentioned above, the SRF outlines the results at different levels to be accomplished by the Institute. Results in general include outputs, outcomes and impacts. A generalized pathway to development impact is depicted in figure 3.

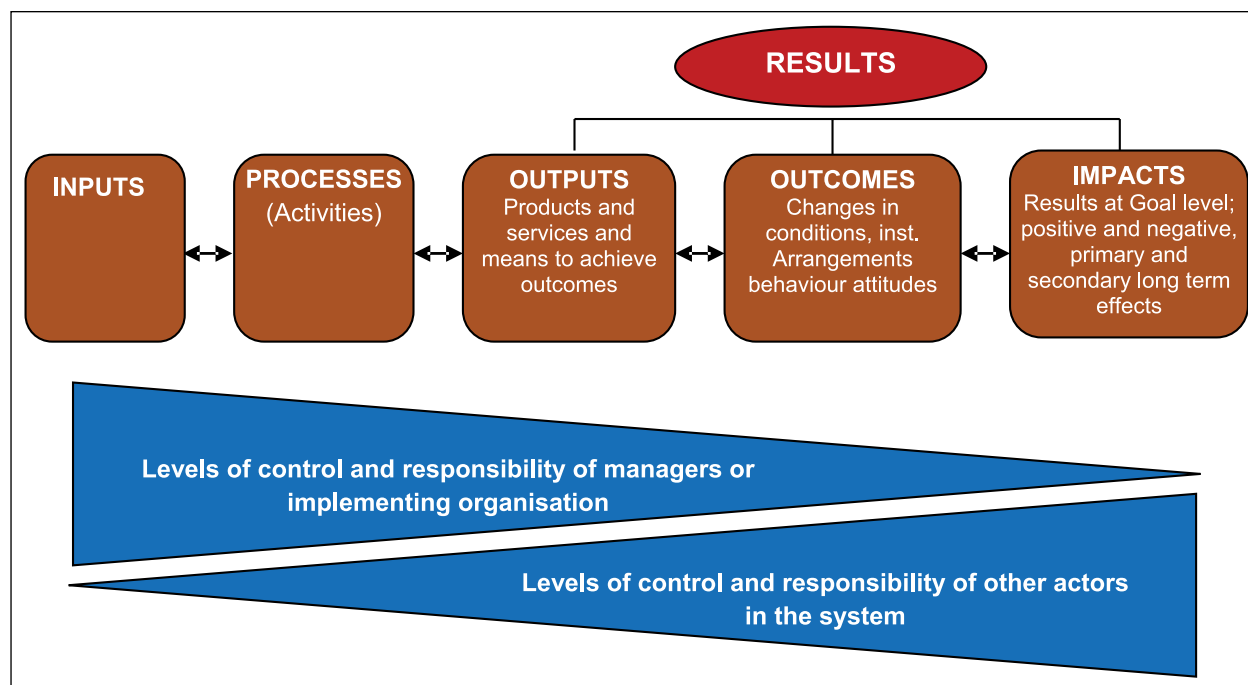


Figure 3. Pathways to development impact

The NARI SRF is based on the cascading logic (Fig. 2). It is recognized that different types of outputs and associated outcomes and impacts are generated at various levels of the organization. NARI is committed to catalyze and effect changes in the lives of farming communities but the pathway to long-term development impact is very complex and not always a linear process. Achievement of research outputs such as new or improved technologies, practices and knowledge, services, policy advice, capacity building, etc. Are much under the control of NARI and its partners. However, the achievement of system level outcomes and impacts requires the participation and contributions of target individuals, communities and the system in general (Figs. 1 and 3). Many sophisticated, synergistic, complementary and iterative processes are required to contribute effectively to development outcomes and impacts (Fig. 1).

NARI SRF planning process: The NARI SRF planning process involved five consultative workshops over the three year period from 2007 to 2010 with participation by a wide range of NARI staff and key stakeholder representatives from other agricultural research organizations, farmers, provincial extension officers, non-governmental organizations and universities. A NARI Strategic Planning Task Force took lead in the process to compile agriculture sector information, develop concepts, synthesize results coming from the different workshops and draft the Strategy and Results Framework document.

The core of the SRF is the results framework comprising of desirable results at the organizational goal and strategic objective level as well as at the level of thematic programmes and sub-programmes. It is considered that challenges and opportunities of farming communities are much influenced by their bio-physical and socioeconomic environment which is highly diverse in PNG. Therefore, geographic information system (GIS) methods were used as part of the strategic planning process to identify and depict spatial similarities and differences in agriculture and classify the country into agricultural development domains (ADD) (Omamo

et al., 2006). Clusters of those domains were then used to conduct a constraints and objective tree analysis to identify possible areas of intervention by NARI through AR4D that will contribute to achieving NARI's mission in line with its mandate and create impact at smallholder farming community level. Further information on the ADD approach in general and in the NARI context can be found in Omamo *et al.* (2006) and Komolong *et al.* (2011) and NARI, SRF, 2011-2020.

Key indicators of success are defined at the different levels to monitor implementation of the SRF and to assess achievements of the strategic objectives at various levels such as system- and development-level outcomes and contribution to development impacts (NARI SRF, 2011-2020).

NARI strategy and results framework (goal and strategic objective): Following from the NARI Vision and Mission, the NARI institutional Goal and Strategic Objective (SO) as stated in the NARI Act 1996 were reaffirmed during the strategic planning process.

Goal: Improved welfare of rural families and communities who depend wholly or partly on agriculture for their livelihood

Strategic objective: Enhanced productivity, efficiency, stability and sustainability of the smallholder agriculture sector

The NARI goal and strategic objective are well aligned with the sector and national long term development objectives (as depicted in Fig. 4). The role and potential of agriculture in overall national development and the various broad-level constraints and opportunities faced by farming communities in PNG are recognized in the SRF. In this context, NARI is focussing on enhanced food and nutritional security, increased cash incomes, increased gainful rural employment and a sustainable resource base as desired development impacts so as to contribute to improved welfare of rural families and communities. The key driver to achieve this will be the enhancement of productivity, efficiency, stability and sustainability of the smallholder agriculture sector as stated in the Institute's SO.

Development of institute strategies: The institutional goal and SO constitute the first and second level of planning in the SRF. At these levels the Institute expects to generate important development outcomes for the sector contributing to the expected development impacts. Indicators of success for such outcomes and impacts at these levels are shown in figure 5.

A key to enhancing productivity and efficiency of the sector and improving food security, income generation and employment in a sustainable manner requires a good understanding and recognition of the challenges and opportunities in the sector, especially those faced by smallholder farming communities. Major constraints, threats and opportunities affecting productivity of the sector were identified as part of the strategic planning process and are summarized below. Detailed information on the issues can be found in Komolong *et al.* (2011) and NARI (2010).

Opportunities for development of sector: Huge potential exists to increase both the biological productivity and production capacity of most indigenous and staple crops, fruits and nuts, vegetables and livestock species through simple breeding and biotechnology methods and focussing on the following:

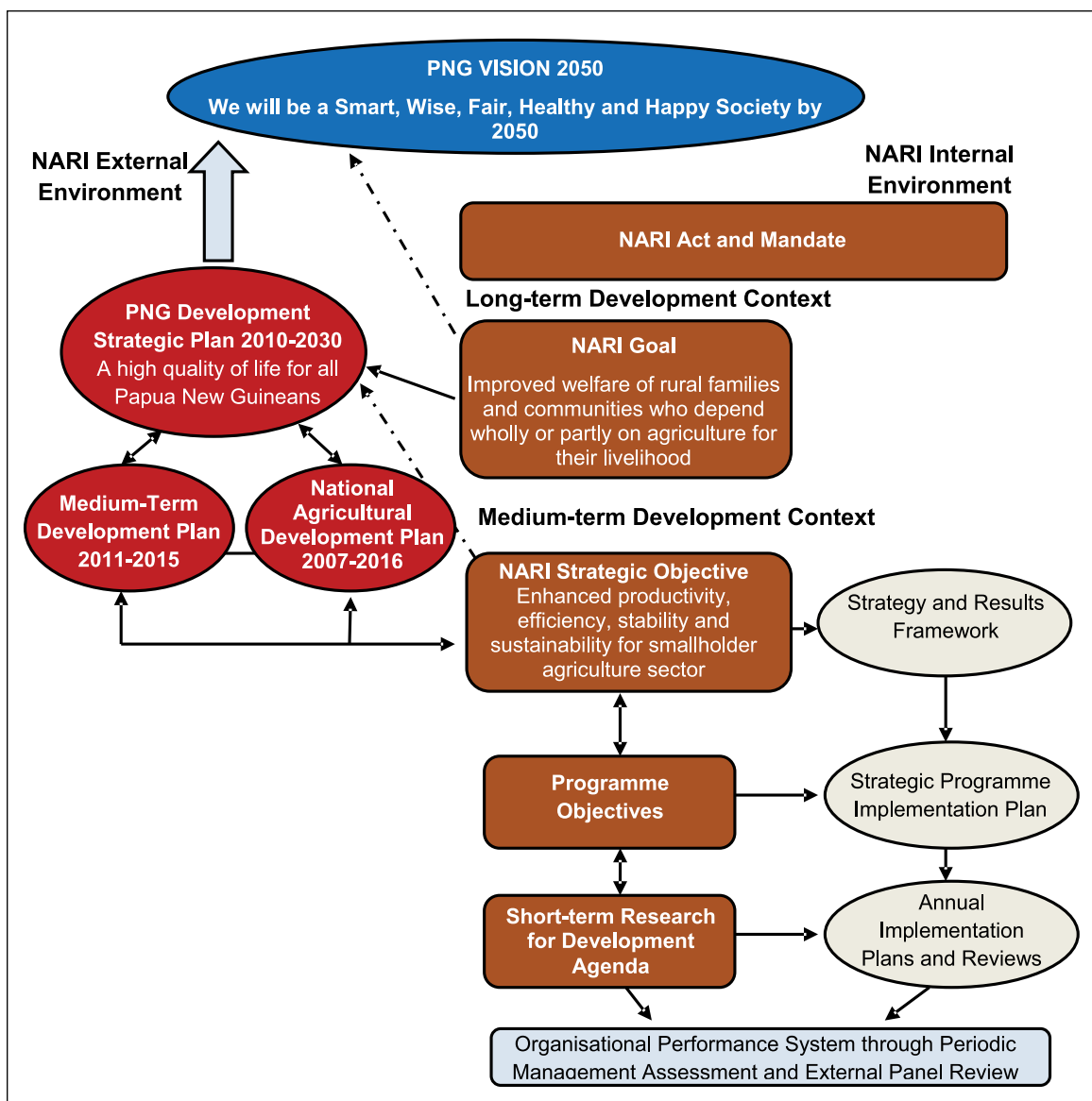


Figure 4. NARI contribution to sectoral and national development

- Enhancing supply of agricultural commodities to urban and rural markets
- Domestication and commercialisation of indigenous nuts, fruits and other crop (e.g. galip, okari, pau, marita and pitpit) and livestock species and exploring niche markets for such indigenous products
- Exploring value-addition and product diversification of crops and livestock to expand market demand and profitability for many commodities and enterprises
- Primary source for expansion of future productive employment for the large number of youths entering the workforce
- Golden opportunity for investment of revenue from the Liquefied Natural Gas (LNG) and other resource projects in developing the agriculture sector, in general, and innovative agriculture, in particular

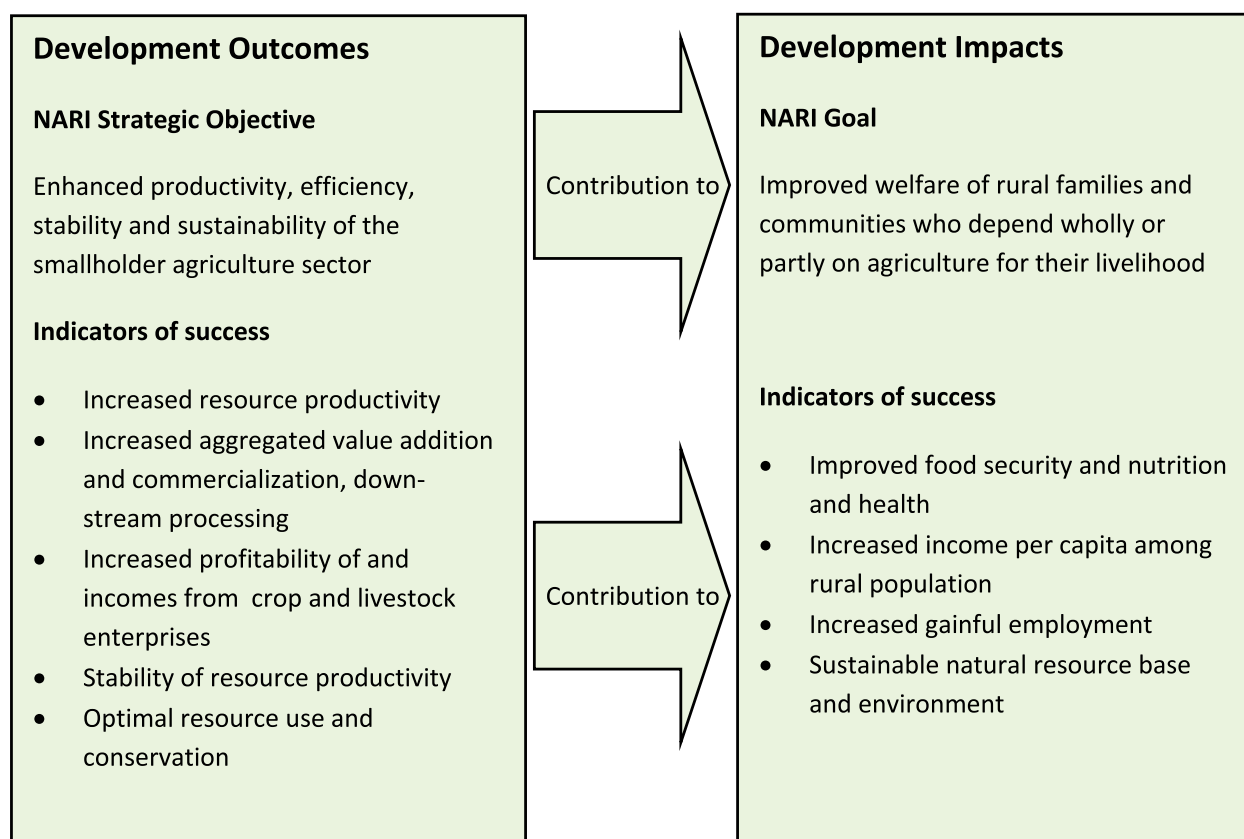


Figure 5. Contribution of development outcomes to development impacts - NARI goal and strategic objective and indicators of success

- Increased temperature in the high altitude highlands due to climate change can enable farmers there to grow new crops to improve food security/nutrition and increase income
- The increasing food demand both domestically and internationally can propel PNG to use its clean soils and water to grow and supply organic and quality food, especially to Asia and Europe. The MPDP2 specifically states the goal that PNG should support large scale agricultural enterprises and smallholder growers more generally to meet domestic and international needs (MTDP2 2016-2017). It further states that a promotional programme to be undertaken seeking foreign investment in production and processing

Based on the above considerations, institute level strategies were defined. In other words, the institute strategic objective will be accomplished through the following four major strategies:

- Productivity, efficiency and stability of agricultural production systems improved
- Enabling environment (policy, markets, and institutions) for sustainable agricultural development influenced
- Use and sharing of information and knowledge in the agricultural sector effectively enhanced
- Efficiency and congenial institutional environment for effective AR4D enhanced

These strategies are to be accomplished by NARI's major programmes that the Institute will be focussing on in the medium-term to generate system-level outcomes and development impacts (Fig. 1). Figure 6 shows how the four programmes relate to and complement each other in contributing to the achievement of the Institute strategic objective.

The four programmes are considered necessary and sufficient to accomplish the institute strategic objective but are mutually exclusive in delivering results independently towards the institutional SO. However, there are also synergies and complementarities.

Specific Focus

In PNG, the research focus is to improve food and nutrition security, increase income generation opportunities for rural farming communities and improved agricultural resilience through use of new and better technologies, strategies, policies, communication, etc. to manage their natural resources.

Commodity boards have been established to serve farmer needs in each respective industry (NADP 2007-2016). Coffee research is conducted by Coffee Industry Cooperation (CIC) situated in Goroka, Eastern Highlands Province, serving the coffee growers, throughout the country. The tree crops research on oil palm, cocoa and coconut is conducted in the lowland

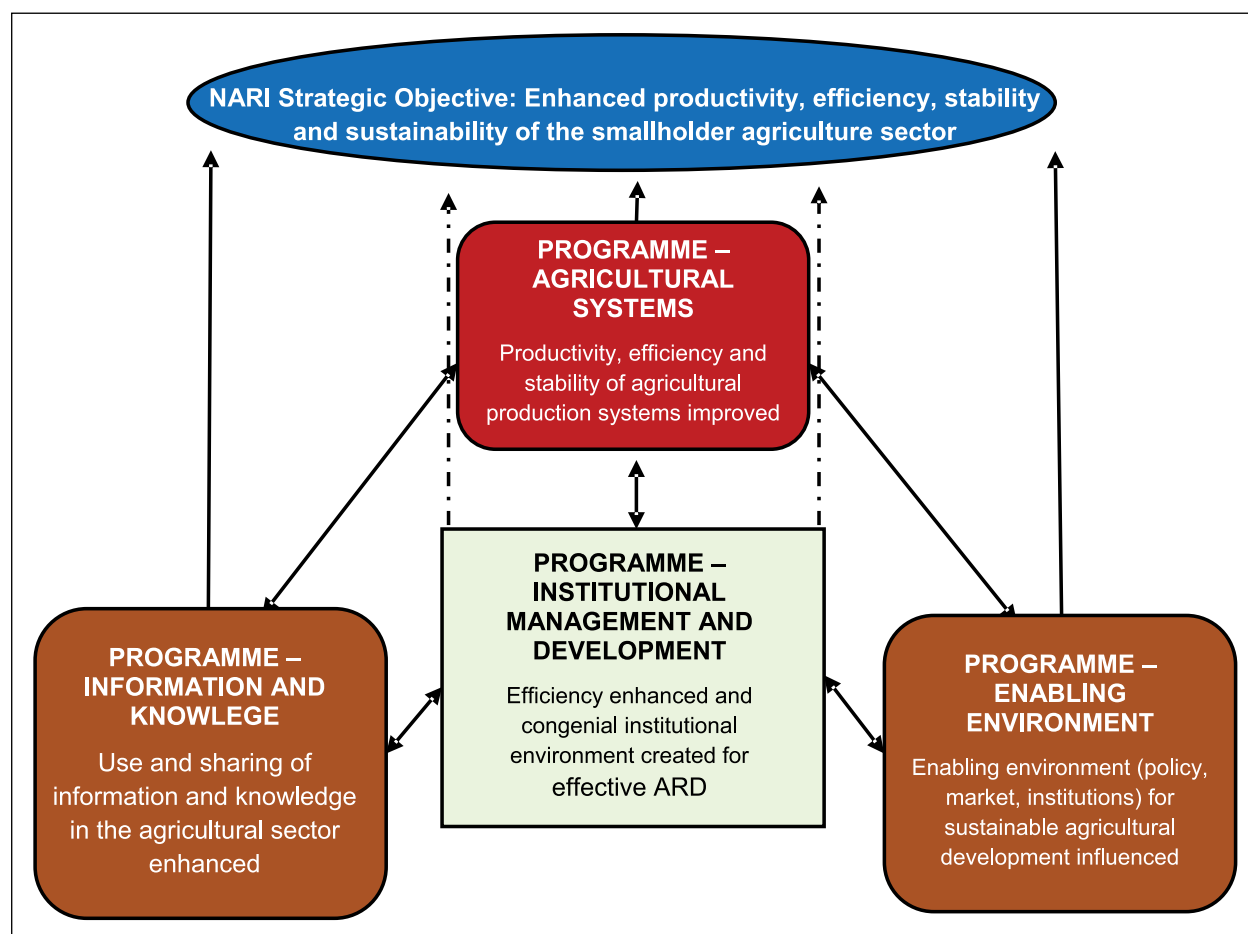


Figure 6. Synergies and complementarities of NARI programmes

areas and are concentrated in the Southern, Mamose and New Guinea Islands regions of the country. Oil Palm Research Association (OPRA) station is located in Kimbe, West New Britain Province (WNBK); Cocoa and Coconut Institute (CCI) is based at Tavilo for cocoa research programmes while coconut research programmes are located at Murunas in Madang and NARI has research stations located at Kerevat in East New Britain Province (ENBP), Bubia in Morobe Province, Aiyura in Eastern Highlands Province, Tambul in Western Highlands Province and Laloki in Central Province.

Development of NARI's institute strategies: The institutional goal and strategic objective constitute the first and second level of planning in the SRF. At these levels the institute expects to generate important development outcomes for the sector contributing to the expected development impacts. Indicators of success for such outcomes and impacts at these levels are shown in figure 5 (NARI SRF 2011-2020).

A key to enhancing productivity and efficiency of the sector and improving food security, income generation and employment in a sustainable manner requires a good understanding and recognition of the challenges and opportunities in the sector, especially those faced by smallholder farming communities. Major constraints, threats and opportunities affecting productivity of the sector were identified as part of the strategic planning process and are summarized below. Detailed information on the issues can be found in Komolong *et al.* (2011) and NARI (2010).

In NARI, major priorities have been identified in response to constraints and opportunities affecting agricultural productivity and development in various Agricultural Development Domain (ADD) clusters (NARI 2010; Komolong *et al.*, 2011). The priorities are:

- Quality planting materials and livestock breeding stock
- Value chains for priority crops and livestock
- Breeding for crop varieties and livestock breeds tolerant to drought, excess moisture, salinity and frosts conditions
- Improved and sustainable land and soil fertility management practices
- Integrated management strategies for economic pests and diseases including safe and appropriate use of pesticides but with emphasis on deployment of resistant crop varieties and livestock breeds, cultural and biological control methods
- Small to medium scale farm mechanization
- Effective integration of crops, livestock and aquaculture systems
- Suitable policy, market, institutional arrangements for sustainable agricultural development.

Priorities for Agricultural Research and Innovations for Development (ARI4D)

Currently, NARI is focusing on production and productivity of Food crops, Livestock, markets/ value chains and management of natural resource for small holder farmers. The NARI Strategic Programme Implementation Plan 2011-2020, defines the project portfolios planned. The three project portfolios to be targeted in the next 4-5 years are;

PNG preparedness to cope with climate change induced stresses (drought, frost), excess moisture and salinity): Climate associated disasters such as droughts, frosts, flash floods and salt water incursions are imposing serious constraints on food security in PNG. There is a serious El Nino induced drought currently affecting the country since April, 2015. These events have increased in frequency and strength in recent decades, and it is now vitally important that rural communities have contingency measures in place to cope with these recurring climate induced stress events. The aim of this project is to promote multiple and simultaneous pathways in climate vulnerable pilot areas of PNG that will i) identify and promote new and traditional production and supply base of nutrient-rich foods; ii) emphasize greater community involvement as part of institutional capacity development for implementing food security and climate change adaptation initiatives; iii) build climate resilience in cross-sectoral development, as these are important factors for food production and trade; iv) widen the role of information, education, and communication; and v) create safety nets and emergency and disaster response systems. Climate change adaptation remains a current need for smallholder farming communities and there is a considerable investment by NARI in this area already. It has generally been recognized as a priority area by GoPNG policy and strategy documents as well as in the donor community and continued support should be forthcoming.

Promoting commercialization of smallholder livestock and fish production in PNG:

The Livestock Project addresses the growing domestic demand for meat through capacity building and promotion to support semi-commercial production of pigs, goats, sheep, ducks and inland pond fish by adopting a nucleus or cluster business model in which participating farmers in a locality organize themselves to better access input and output markets as well as essential services. The initial major thrust of the project will be to rehabilitate the existing livestock breeding and distribution farms, and then set up a few new farms of NARI at Labu, Tambul, Keravat, Laloki and Aiyura to also serve needs for conservation of the genetic resources. It will then expand the breeding stocks for research and dissemination to participating livestock and fish farmers. Selected breeding stock of pigs, goats, sheep, ducks and fish will be distributed to a total of 1400 market-oriented smallholder farmers. The project will be implemented in collaboration with national DAL, provincial DPIs and, where appropriate, development NGOs. The project will target either existing or potential semi-commercial livestock farmers who have interest to farm pigs, goats, sheep, ducks and fish, have the resources and courage to run commercial livestock farms and serve nearby major markets. These farmers will be associated with the nearest NARI breeding and distribution farms for input delivery and technical advice.

Domestication, commercialization and development of canarium (galip) nut industry:

Galip nut (*Canarium indicum*) is an indigenous resource, unique to only a few countries in the Pacific with a proven potential to become an important crop for income generation for smallholder farmers, cooperatives or large plantation operators. It is well aligned with the 'green growth' aspirations expressed in 'The Strategy' and has potential to generate a range of medium enterprises (MEs) and small medium enterprises (SMEs) involved in production, processing, marketing, etc. The project will address critical issues in research and development of an effective value chain of the nut products (kernel and oil) building on previous achievements funded by donor agencies (EU, ACIAR). The project will extend research work in production,

processing and marketing along the value chain to validate and pilot protocols and processes to ensure that farmers supply consistently high quality nut-in-shell and processors produce primary products (kernel and oil) in conformity with quality standards and suitable for shipping to domestic and export markets. Marketing arrangements as well as policy and institutional environments will also be investigated.

Targets

Relevant government policies have been set to ensure that progress is made on improving food and nutritional security, poverty reduction and reduced environmental degradation. The recent MTDP2 Goal is to support large scale agricultural enterprises and smallholder growers more generally to meet domestic and international needs.

NARI's contribution to food and nutrition security, income generation, sustainable development etc as outlined in the SRF is to productivity enhancement and more efficient production. As the El Nino-Southern Oscillation (ENSO) becomes more frequent in Asia Pacific, crops with tolerance to drought/frost, excess moisture and salinity are being developed for testing. Processing of PNG traditional staples are pursued to enhance marketability and storage. Introduction of small to medium farm mechanization is keenly pursued to improve labour productivity and reduce drudgery to households and farm tasks, particularly for women farmers.

Per capita income of Papua New Guineans is PGK 2000 (World Report, 2007). Forty per cent of PNG's population earning less than PGK6 (USD 2) per day. Poverty reduction is addressed through projects that will develop agricultural value chains of both fresh and processed food products. R4D continues in Commodity Boards to increase production and productivity of coffee, cocoa, copra, oil palm and rubber. PNG NARI continues research to develop value chains in food crops and livestock. Examples are the projects on galip commercialization and smallholder livestock commercialization.

The MTPI2 gives the targets for PNG's commodity tree crops in 2017 (Table 1).

Table 1: Key indicators and targets for the agriculture & livestock sector

Indicators	Baseline*		Targets 2017
	Value	Year	
Coffee production (60 kg bags)	911,598.0	2013	1,000,000
Oil Palm production ('000 tons)	630.0	2013	750
Cocoa production ('000 tons)	56.0	2013	60
Copra production ('000 tons)	129.0	2013	150
Proportion (%) of GDP in agriculture	27.1	2013	30
Growth rate of agriculture real value added (%)	0.5	2013	4

*Sources: MTDP RMF Pocketbook 2013/2014; Asian Development Bank Key Indicators 2014

However, table 1 does not give targets for food crop and livestock production, natural resource management and sustainability. NARI aims to address long-term impact by undertaking strategies like improving value chains and linking farmers to markets; generating business opportunities in production, processing and marketing. Furthermore, NARI primarily looks for low cost options for farmers, such as crops resistant or tolerant to abiotic or biotic stresses rather than varieties that require high inputs.

Biocontrol for major weeds and pests in PNG have been developed to minimize use of harmful chemicals. Some important agricultural weeds and pests have been successfully bio-controlled are water hyacinth, chromolaena weed, micranthia, diamond die-back moth. Work has started to test new biocontrol agents for *Mimosa pigra* weed, and African tulip spathodea. The current outbreak of phytoplasma on coconut bogia coconut syndrome (BCS) is a concern. However of more concern to NARI is phytoplasma on banana and other food crop hosts. It is hoped that the current ACIAR project on BCS will provide in depth understanding on the ecology of this pathogen, its spread and possibly the bio-control of vectors. In view of the damage by a stem boring weevil *Ectatorhinus magicus* on *Canarium indicum* (galip) at Keravat, NARI will take up work to understand this weevil and explore natural enemies in PNG, given the potential of galip nut as an emerging industry.

Institutional Roles, Responsibilities and Partnerships

Agricultural Policy is prepared by Department of Agriculture & Livestock (DAL) and approved by the National Executive Council (NEC) for implementation. In implementing agricultural research, development and extension, the following agencies and partners play crucial roles: National Agricultural Research Institute (NARI), Coffee Industry Cooperation (CIC), Oil Palm Research Association (OPRA), Cocoa and Coconut Institute (CCI), Livestock Development Corporation (LDC), National Department of Agriculture and Livestock (NDAL), PNG University of Technology (UNITECH), University of Natural Resources and Environment, University of PNG, Fresh Produce Development Agencies (FPDA), Provincial Divisions of Agriculture and Livestock (PDAL), Department of National Planning and Monitoring (DNPM), Department of Treasury, Non Government Organizations (NGOs), and National Agriculture Quarantine and Inspection Authority (NAQIA).

The recently concluded ARDSF Project (2007-2012) promoted collaboration among the NARS through regular meetings of the chief executive officers (CEO's) to develop and agree on common outcomes and on sharing of skilled human resources and facilities etc. to achieve them. It was based firmly on the notion that agricultural research must be development oriented (AR4D) and should benefit society at large to justify itself.

Infrastructure and Financial Investments

PNG has moderate infrastructure for agriculture research in the NARS and the Universities that research and teach agriculture. These include NARI, CCI, CIC, OPRA, PNG UNITECH and University of Natural Resources and Environment (UNRE). NARI and UNITECH provide basic chemistry services and both operate biotechnology laboratories for teaching and research.

Current investment in AR4D in PNG is inadequate to attain the kind of development impact that the nation envisions in its long-term strategies. According to the World Bank (2007) investment in agricultural development should be around 10 per cent of agricultural GDP to move the nation from agriculture-based economies to transformed economies, i.e. >400 million Kina per annum using 2009 real agricultural GDP of around 4.6 billion Kina (Treasury 2010). Investment in agricultural research, science and technology should be two per cent of agricultural GDP (i.e. 80 million Kina per annum). Current investment in the sector and AR4D is approx K140 million (or only 3% of the agricultural GDP) and less than 30 million Kina (only 0.6%) in agricultural research. Therefore, there is vast scope to attract additional investment in AR4D (NARI SRF 2011-2020).

Major Threats and Constraints to Productivity of the Sector

- Limitations to further expansion of arable land due to mountainous landforms and major limitations to soils (salinity, inundation, extreme stoniness, and anion fixation)
- Declining soil productivity due to shortening of fallow periods and low rate of replenishment under existing farming systems
- Inadequate ability of farmers to manage increasing occurrence of natural disasters such as prolonged droughts, floods and threats; increased risk of saltwater inundation, excessive rainfalls and associated soil erosion; and effects on soil fertility from adverse and unpredictable impacts of global climate change
- Increasing incidence of complex and new pest and disease problems in crops and livestock
- Poor access to improved planting (seed) materials and breeding stocks
- High losses and low profitability in marketing of traditional staple crops due to their perishable nature with a high weight/volume and low value
- High cost of and poor access to agricultural inputs, credits and supplies
- Low labour productivity, underemployment and low wages
- High degree of drudgery in performing daily tasks in agriculture especially for women
- Threats to labour productivity from serious level of malnutrition combined with the high incidence of communicable diseases such as Malaria, Tuberculosis, the growing HIV/AIDs epidemic
- Threats to labour availability in certain rural areas because of mining and petroleum projects
- Low institutional capacity, particularly in agricultural extension
- Inadequate access to information, knowledge and improved agricultural technologies and practices
- Lack of a conducive policy environment on health, education, community development, agricultural inputs, markets and promotion of alternate income generating opportunities
- Non-conducive policy environment on land use security and mobilisation of customary land for agricultural development

- Non-conducive cultural practices and values including gender imbalance in accessing benefits and participation in decision-making processes
- The investment in agriculture is very low (at 2% of GDP) when it should be 10 per cent (WDR 2008). Ideally, PNG needs K400 million which is 10 per cent (of Kina 4 billion Ag. GDP) to be ploughed into agricultural research and production
- National food security is being threatened with population growth rate at 3.1 per cent while the food production rate at one per cent (Bourke and Harwood, 2009)
- Limited and ineffective agricultural extension capability has resulted in decreased output in the rural sector (Bourke and Harwood 2009)
- Poorly developed agricultural marketing and supply chains results in large waste of fresh produce (up to 25%) and a decline in the price received for goods (Bonney *et al.*, 2012)
- PNG farmers are mostly subsistent with low production and productivity. The target is to transform 70 per cent subsistence farmers into small/medium progressive agricultural entrepreneurs in the next 15 years (DSP 2030)

Looking Ahead (short to medium-term)

Currently in NARI, three project portfolios in the Strategic Programme Implementation Plan (NSPIP 2012-2020) are being actively implemented. They are:

- PNG preparedness to cope with climate change induced stresses (drought, frosts, excess moisture and salinity)
- Promoting commercialization of smallholder livestock and fish production in png
- Domestication, commercialization and development of canarium (galip) nut industry in PNG

Other project portfolios being implemented as well are seed systems, crop pests and disease biocontrol, food post-harvest and processing, marketing and value chains development, farm mechanization and gender mainstreaming.

In the medium-term, the 10 year NARI's Programme Implementation Plan 2012-2020 and Strategy & Results Framework 2011-2020 provide the platform for AR4D on the opportunities for development of the agricultural sector and major threats and/or address constraints to productivity of the sector.

According to the MTDP2 2016-2017, the current government is committed to the following: i) increased capitalization of national development bank; ii) priority attention to rehabilitation of cash crops, fresh food storage, infrastructure, research and restructuring of commodity boards; and iii) a promotional programme to be undertaken seeking foreign investment in production and processing. Hence, the key strategic priorities for the MTDP2 are:

- Improvement of institutional capacity
- Improvement of access to land
- Development of key supply chains to link producers to markets
- Provision of appropriate extension services

- Development of coping and mitigation strategies for pests and diseases and climate change
- Funding of research and development
- Enforcement of CODEX marketing standards; and
- Utilization of economic corridors for agricultural development

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19. Country Status Report: Republic of Korea

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Basic Information

Indicator	Particulars
1. Name of the Country	Republic of Korea
2. Reporting Agency	Rural Development Administration (RDA)
3. Value of GDP in Local Currency	1429.4 Trillion Won ¹
4. Value of GDP in USD	1.781 Trillion USD ²
5. Value of Ag. GDP in Local Currency	44 Trillion Won ³
6. Value of Ag. GDP in USD	≈ approx. 26 Million USD ⁴
7. Ag. GDP as % of GDP	2.3 ⁵
8. Total Population of ROK	≈ approx. 50 Million ⁶
9. Population of Farmers	2,847 thousand people ⁷ (5.7% of the total population)

Current Policies⁸

- Research development in relation to agricultural science and technology
- Dissemination of developed agricultural science and technology and provide extension services
- Enhance competitiveness in the agricultural products industry, improve welfare system for the farmers, and promote revival of rural area
- Educate farmers and nurture professional farmers

¹2013 Ministry of Agriculture Food and Rural Affairs/Bank of Korea (Nominal GDP)

²2015 CIA FACTBOOK

³Internal documents prepared for the annual national inspection for 2015

⁴Convert #5 into USD with 2015.09.16 currency rate

⁵2015 CIA FACTBOOK

⁶2013 Ministry of Agriculture Food and Rural Affairs

⁷2013 Ministry of Agriculture Food and Rural Affairs

⁸Advertising brochure of RDA Green technology shared with the public

Strategies⁹

Innovation of agricultural science technology

- Establish research system in tune to farmers' needs
- Lead the growth of the agricultural sector by strengthening basic and source technology
- Improve added value in agricultural sector by vitalizing convergence researches
- Nurture scientists and researchers and build laboratories equipped with high technology
- Promote utilization of intellectual properties

Establishment of network to share agricultural knowledge

- Establish a knowledge circulation system that connects to policies and the market mechanism
- Establish a regional based knowledge dissemination system
- Plan/implement projects which can solve the problems occurred in the agricultural sites
- Apply strict evaluation criteria on large scale strategic project plans
- Establish a system to utilize a roadmap for agricultural science technology
- Conduct detailed analysis on outcomes and diagnosis on efficiency of R&D with stricter standard

Strengthening ties for international cooperation and capacities responding to global tasks

- Strengthening responding capacities for future tasks (issues such as climate change, energy, natural resources, food security)
- Work for international cooperation to respond global tasks
- Strengthen ties for international joint researches and cooperative projects

Establishment of a smart organization by settling down systems for internal and external cooperation which link to national R&D strategies together

- Connect national R&D strategies to national basic plans
- Expand investments on R&D for agricultural science technology
- Link goals in agricultural sector to overall plan in agricultural product R&D
- Strengthening cooperation systems among government departments and local R&D organizations
- Foster creative and first class researchers

⁹Official Website of RDA→Introduction of the organization→Major plans and overall 6th R&D plan p.24, p.32

Specific Focus¹⁰

Stable provision of food

- Stabilize production of food resources using rice paddy
- Enhance self-sufficiency rate of upland crops
- Improve functions and added values for crops

Strengthening competitiveness of agricultural sector

- Nurture new breeding and increase productivity in horticulture
- Improve added value and stabilize production of Ginseng
- Study on production environment of horticulture and herbs and promote utilization

Secure a new growth engine based on biotechnology

- Utilize agricultural biological resources
- Research on basic and source technology for agricultural bioengineering
- Preserve and utilize genetic sources (including livestock)

Realization of sustainable agriculture and farming

- Research on applicable technology for climate change and preservation/maintenance of agricultural environment
- Secure safety for agricultural products
- Improve added value on agricultural products and industrialization for food

Priorities for Agricultural Research and Innovations for Development (ARI4D)¹¹

Lay out production foundation for low land crops in order to respond to the food crisis actively

- Develop not only high quality rice breeding but also develop different varieties for wheat, and improve quality management system for rice and wheat
- Expect to increase self-sufficiency rate of upland crops as the productivity is increased and expansion of consumption technology is developed
- Establish the foundation to produce environmental friendly agricultural products and increase the farming land use efficiency by increasing arable land use

¹⁰Basic project plans for internal education of RDA p. 13-17

¹¹Summary of official website of RDA, internal documents national strategies for 2015

Strengthening agricultural competitiveness

- Improve competitiveness for horticultural products and herbs and nurture new breeding in order to expand the export market (dissemination of new varieties for strawberries, roses, chrysanthemum, orchid, etc. will reduce the cost paid for royalties)
- Stabilize production and improve added value of Korean Ginseng, medicinal plants, mushrooms and etc. through new breeding production/processing technology development
- Develop environmental friendly cultivation technology and manage precise and intensive greenhouse farming
- Develop diseases and pest management/control technology for horticultural products
- Increase productivity of livestock and establish a production system for high quality livestock products using state art technology such as IT, BT, etc.

Secure a new growth engine for future based on biotechnology

- Utilization of agricultural bioresources such as sericulture, apiary (beekeeping), insects, micro-organism, etc.
- Research on new material development and commercialization of bioengineering technology for agriculture
- Build up the foundation to take an advantage in the seed industry through the researches on basic and source agro bioengineering.
- Obtain useful microbial resources
- Secure technological standard to assess safety of genetically modified (GM) products
- Lay out the foundation for seed industry (golden seed project) by establishing a utilizing system of collected/preserved livestock genetic information and resources.

Sustainable agricultural development

- Stabilize supply of livestock products through safe and environment friendly livestock production
- Level livestock industry environment up to advanced countries
- Manage soil and nutrition of rice paddies, and establish the foundation to utilize information on agricultural environment
- Secure high standard of safety for agricultural products by forging a scientific agricultural production management system
- Establish agricultural infrastructure system by applying cutting edge technology such as automation of agricultural product processing lines, energy saving technology, improve safety net for farming
- Enhance added value of agricultural products through food industry and functional food development

- Develop climate change adaptive technology for agricultural sector in order to build up foundation for sustainable supply of agricultural products
- Develop various agricultural industries in the rural area to deal with changes in the rural area and strengthen support and technological assistance to vitalize community management in rural region
- Secure creative human resources for agricultural industry and improve competency to expand multifaceted view for competitiveness
- Focus on education to foster core competencies to address changes and risks management

Strengthening collaboration with internal community

- Expand the cooperation ties for joint tasks within the international community, help developing countries to eradicate poverty and hunger problems, and strengthen beneficial cooperation to transfer Korea's agricultural technology to abroad
- Achieve state of art technology in tune to international standard and address global issues through efficient international cooperation
- Share and contribute Korea' experience and knowledge on eradication of poverty to the international community which makes Korea to participate as a donor country in the world

Targets¹²

- Stable food supply to the public
- Lead the national growth by strengthening agricultural competitiveness
- Create and secure a new growth engine based on biotechnology
- Realization of sustainable agricultural and rural development
- Maximize vitalization of rural area and agricultural sector using regional based resources
- Secure 'agricultural competitiveness' in preparation for the era of the free trade agreement (FTA)
- Establish smart organizations

Institutional Roles, Responsibilities and Partnerships¹³

RDA affiliates (4)

- National Institute of Agricultural Science (NAAS)
- National Institute of Crop Science (NICS)
- National Institute of Horticulture and Herbs (NIHH)
- National Institute of Animal Science (NIAS)

¹²Official website of RDA

¹³Advertising brochures for initiatives and official websites of affiliates

International Research Institution for Cooperation

- Wageningen University Research Institute (WUR), The Netherlands
- Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), Brazil
- United States Department of Agriculture - Agricultural Research Services (USDA/ARS), USA
- National Agriculture and Food Research Organization (NARO), Japan
- Chinese Academy of Agricultural Science (CAAS), China
- International Organization, Country
- The World Vegetable Centre (AVRDC), Taiwan
- Centro Internacional de la Papa (CIP), Peru
- International Livestock Research Institute (ILRI), Kenya
- International Rice Research Institute (IRRI), The Philippines
- Centro Internacional Mejoramiento de Maize y Trigo (CIMMYT), Mexico
- Bioversity International, Italy

Roles and responsibilities

- Carries out cooperative tasks with international organizations to develop technology together
- Address/analyse internationally controversial issues such as climate change and participate international conferences
- Carries out cooperative tasks with advanced countries such as USA or the Netherlands

International technology cooperation initiatives

- Asian Food and Agriculture Cooperation Initiative (AFACI), 12 member countries (Bangladesh, Cambodia, Indonesia, Thailand, Kyrgyzstan, Laos, Mongolia, Myanmar, Nepal, The Philippines, Sri Lanka, Vietnam, Multi-lateral): working on joint research projects to disseminate and develop agricultural technology, dispatch advisory committees for extension services, pursue sustainable agricultural development and secure food security, research on genes of plants and livestock, transfer technology for capacity improvement. Example – nurture insect-resistance breeding of mung bean, nurture locally adaptable vegetable complex and provide cultivation and breeding technology for maize growing.
- Korea-Africa Food and Agriculture Cooperation Initiative (KAFACI), 17 member countries (Morocco, Senegal, Ghana, Cote d'Ivoire, Nigeria, Cameroon, Gabon, Angola, Tunisia, Sudan, Ethiopia, DR Congo, Uganda, Kenya, Comoros, Malawi, Zimbabwe, Multi-lateral): run various projects based on country/ regional/ trans-African continent, Assist 'on the job trainings' for three months to member countries, develop technology to increase productivity in plants, horticulture, and livestock sectors. Example – assisting installation of greenhouses and assisting technology to produce disease-resistance potato.

- Korea-Latin America Food and Agriculture Cooperation Initiative (KOLFACI) 12 member countries (Bolivia, Costa Rica, Republic of Dominica, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, Panama, Paraguay, Peru, Columbia, Multi-lateral): carry out various projects in conjunction with the needs of each country, and organize agricultural business projects across the Latin American countries. Example – assisting production of seed potato and distribution system.

KOPIA project

- Korea Project on International Agriculture (KOPIA), 20 member countries (Mongolia, Cambodia, Uzbekistan, Ethiopia, Kenya, Algeria, Senegal, DR Congo, Uganda, Sri Lanka, Myanmar, Thailand, Vietnam, The Philippines, Republic of Dominica, Ecuador, Brazil, Peru, Bolivia, Paraguay, Bi-lateral): develop breeding and technology which meet the needs of each country and condition, share agricultural knowledge and experiences through pilot programmes with local farmers among the member countries. Example – rice seeding using a guide line, improve harvest rate for tomato, cultivate disease resistance watermelon and melon, improve research ability through exchange researcher programme and sending advisory committees (advisory researchers: 120 people, foreign researchers through training programme: 150 people), meeting with experts and advisory committee, evaluate operation system and conduct project monitoring.

Infrastructure and Financial Investment

Research Institute¹⁴

Total budget of 1,238,6 billion Won of which 10,80,9 billion Won for projects and 1,577 billion Won for basic expenses and labour.

- National Institute of Agricultural Science with 504 personnel
- National Institute of Crop Science with 345 personnel
- National Institute of Horticulture and Herbs with 329 personnel
- National Institute of Animal Science with 323 personnel
- Regional Agricultural Development Institute with nine personnel
- Regional Crop Research Institute with 54 personnel
- Regional Agricultural Technology Centre with 156 personnel

Human resource pool

- The number of scientists and personnel for extension services trainers: Total scientists are 1,165 while extension services personnel are 97 in number
- Academic qualifications of scientists and extension workers: Out of a total of 1,165 scientists 837 are with Ph.D. degree, 241 with Master degree, 81 with Bachelor degree and six are with two year college studies

¹⁴For 1, 1-1 and 1-2 0910_ RDA basic statistics for projects_v4 (internal document) p.44, p.46

Investment status¹⁵

- i) Government-led R&D for technology development involving Rural Development Administration (RDA), national institutions, universities and private institutions with all approximate budget of 29,460 thousand, USD approximately 2,946 for the purpose of:
 - ◆ Basic and source technology
 - ◆ Technology to address fluctuating rice price
 - ◆ Improve productivity of agricultural products
 - ◆ Dr. Woo Jang-choon Project
 - ◆ Pesticide for non-major field crops
 - ◆ Research on permission and registration system
 - ◆ Develop technology using insects
 - ◆ Develop technology for urban farming
 - ◆ Research on health and safety for farmers
- ii) Technology development to enhance competitiveness in preparation for the FTA involving RDA, universities and private institutions with a budget of SD approximately 17.64 million USD
 - ◆ Enhance competitiveness for the international market
 - ◆ Develop technology for food processing storage and safety
- iii) Establish climate change adaptive system involving RDA, universities and private institutions with a budget of approximately 17.64 million USD
 - ◆ to produce stable and sustainable food in response to climate change
 - ◆ Develop renewable energy which can be applied to the agricultural sector
- iv) Develop new varieties that are locally adaptive involving RDA, national institutions and private institutions with a budget of approximately 20.13 million USD
 - ◆ Strengthen competitiveness in International Union for the Protection of New Varieties of Plants (UPOV)
 - ◆ Expand competitiveness in the international market through wide spread of new varieties
- v) Develop ICT convergence industrial model involving RDA, local agricultural research institute, technology centres, private institutions with a budget of 27.70 million USD
 - ◆ Reduce the cost for management and energy increase productivity
- vi) Develop safe and echo-friendly production technology involving RDA, universities private institutions with a budget of approximately 19.30 million USD

¹⁵No. 1 and No. 5: Introduction to agricultural R&D system and projects in Korea by Dr. Kim Doo-ho, PPT slides

- ◆ Secure safety of agricultural products and livestock products from the production to consumption
- vii) Develop technology to add values for agricultural/livestock products with RDA, universities and private institutions for realization of income increase in agricultural and livestock industry by creating added value to agricultural and livestock products with a budget of 12.28 million USD
- viii) Bio-Green 21 for the next generation with RDA, universities and private institutions (lead development in the agricultural sector using biotechnology) with an approximately budget of 42,890 USD
- ix) Vitalize regional based agricultural researches with universities and private institutions in order to (improve regional based research facilities and research equipment) with a budget of 22.35 million USD
- x) Utilization of technology with corresponding markets (provide customized assistance for each stage from the entering stage to the high technology market) with a budget of 7.4 million USD

Major Challenges and Opportunities¹⁶

Major challenges to address

Decrease of farmers as the agricultural sector is diminishing and increase of aged farmers

- Decrease farmers: ('00) 8.6% → ('11) 6% →, ('22) 4.5% (Expected statistics)¹⁷.
- Aged farmers: ('00) 21.7% → ('11) 33.7% → ('22) 43.5%¹⁸.
- The share of the agricultural sector in total GDP: ('70) 23.2% → ('90) 6.8% → ('10) 2%
- *Production value (Hundred Million won): ('00) 318,290 → ('11) 413,580 → ('22) 463,530

Income stagnation/decrease of farmers due to growing cost for raw materials, machineries and unbalanced trade terms

- Farming income per household (thousand won): ('08) 30,523 → ('11) 30,148 → ('22) 46,810
- Agricultural income per household (thousand won): ('08) 9,654 → ('11) 8,753 → ('22) 9,550

Decrease in trade balance of Korean agricultural products due to lowered or no tariff based on multilateral and regional trade agreements for the international trade

- - ('00) Δ6,825 → ('05) →10,860 → ('10) →19,907 → ('11) Δ25,493 (Million USD)

¹⁶Summary of 6th R&D plan for mid and long term

¹⁷Ibid P18

¹⁸ibid

Trend change in the market agricultural product consumption as more consumers prefer safe food and dietary change of Koreans from rice-oriented eating habit to various multi grains intake including wheat

Opportunities

- Growth of bioeconomy
- Strengthen agricultural R&D cooperation system between central and local governments
- Obtain state of art technology for 7 different agricultural sectors (36 core technologies) in the world
- Policy change to embrace various fields
- i) Establish information access system for national soil environment (soil.rda.go.kr)
- ii) Establish comprehensive nation-wide disease and pest control management system (npms.rda.go.kr)
- Strengthen regional/international cooperation ties and promote the international academic conferences
- Prepare measures to assist people returning to farms or rural area

Looking Ahead¹⁹ (2013-2022)

Establish the basis for agricultural science technology with a budget of 1,097 hundred million won (24.2%)

- Preserve environment for sustainable agriculture
- Utilize and commercialize agricultural biological resources
- Secure safety for agricultural products
- Automate of production line
- Reduce energy consumption
- Research on core and source technology in agricultural bioengineering and agricultural safety and health
- Industrialize agricultural food
- Enhance added value for agricultural product
- Collect/Preserve/Utilize genetic resources

Stabilization of food supply and develop technology to enhance added value for agriculture with a budget of 660 hundred million won (14.6%)

- Stabilize production using rice paddies
- Increase self-sufficiency for upland crops

¹⁹ibid pp.25~pp.34

- Enhance functions and added value for crops
- Increase usage of arable land
- Produce environmental friendly crops

Improve in quality for horticulture and develop technology to boost added value with a budget of 789 hundred million won (17.4%)

- Increase productivity and nurture new horticultural breeding
- Stabilize production of Korean Ginseng and enhance added value
- Research on cultivation environment for horticulture and utilize /commercialize horticultural crops

Improve quality of livestock product and develop technology to increase productivity with a budget of 668 hundred million won (14.7%)

- Secure genetic resources of livestock
- Develop new material
- Increase productivity of livestock
- Produce environment friendly livestock products

Develop core strategic technology with a budget of 700 hundred million won (15.4%)

- Conduct joint research to utilize/commercialize bioengineering technology and climate change adaptive technology

Other with a budget of 621 hundred million won (13.7%)

- Research on various areas such as regional agriculture, agricultural management and international cooperation for agricultural technology

20. Country Status Report: Sri Lanka

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Basic Information

Indicator	Particulars
1. Name of the Country	Sri Lanka
2. Reporting Agency	SLCARP
3. Value of GDP in Local Currency* (LKR in billion)	3506.664
4. Value of GDP in USD* (in billion)	24.011
5. Value of Ag. GDP in Local Currency (LKR in million)*	353 799
6. Value of Ag. GDP in USD* (in million)	2700.000
7. Ag. GDP as % of GDP*	9.900
8. Land Area (km ²)***	65,610.000
9. Population (2012)****	20,277,597.000

*3, 4, 7 - Source: www.tradingeconomics.com:World Bank

**5, 6 - Source: Central Bank Annual Report 2014

***8 - Wikipedia, the free encyclopedia

****9 - Census of Population and Housing 2012, Department of Census and Statistics, Sri Lanka

Sri Lanka is a tropical island country with a land area of 65,610 km² and population of 20,277,597. Sri Lanka is located in the tropical belt close to the equator between 5°.55' - 9°.50' longitude and 79°.42' - 81° - 52' latitude. The topography varies from flat lowland to a mountainous region up to 2,500 m altitude. Mean annual temperature ranges between 20°C-28°C while mean annual rainfall varies between 1,000 mm-3,000 mm. On the basis of rainfall and temperature pattern, the country is divided into 4 regions, namely, arid, dry, intermediate and wet zones.

Agriculture in Sri Lanka

The agriculture sector in Sri Lanka is divided into several sub-sectors according to the main commodity groups. Those are food crop sector, plantation crop sector, forestry sector, livestock sector and fisheries sector. At present 65 per cent of the available land is under cultivation, of which 40 per cent is under paddy cultivation, 38 per cent under plantation crops and 22 per cent under other crops. More than 70 per cent of the population in rural areas is dependent on

agriculture as their main source of income. Plantation crops, Forestry, Fisheries and Livestock contribute 10 per cent to the GDP of the country (Production Plan 2016-2018).

Currently, this sector contributes to about 11.1 per cent of the Gross Domestic Product (GDP) and 30 per cent of the employment. Although the contribution of agriculture to the GDP is its contribution to the social and economic development, employment opportunities, health of the population, food security is higher compared to the industry and services sectors (Central Bank Annual Report 2014).

Agriculture Research in Sri Lanka

Considering the importance of the agricultural research, Government of Sri Lanka has established research organizations based on different commodities and disciplines, namely, agriculture, veterinary, livestock and fisheries. Faculties of the National Universities also carry out research in agriculture and allied areas in agriculture.

During the period 1900-1912, Sri Lanka started the production oriented agricultural research with more emphasis on plantation crops and establishing Rubber Research Institute (1910), Tea Research Institute (1918), Coconut Research Institute (1928) and Sugarcane Research Institute (1984). The Department of Agriculture (DOA), established in 1912 is the main agency involved in non-plantation crop research, mandatory to more than 100 crops, dispersed over four main research institutes; Rice Research and Development Institute (1994), the Horticultural Crop Research and Development Institute (1994), Field Crops Research and Development Institute (1994), and Fruit Research and Development Institute (2012). In 1970s and 1980s, the research system was expanded to include other aspects of agriculture with the establishment of the Hector Kobbekaduwa Agrarian Research and Training Institute (1972), the research division of the Department of Export Agriculture (1973), and the National Aquatic Resources Research and Development Agency (1981).

Sri Lanka centralized and consolidated their agricultural research with the establishment of the Council for Agricultural Research Policy in year 1987 by the Parliamentary Act No 47. The National Agricultural Research System of Sri Lanka, therefore, was established in 1987 with the establishment of the Council for Agricultural Research Policy.

The 12 R&D institutions of the NARS are Department of Agriculture, Department of Export Agriculture, Forest Department, Department of National Botanical Garden, Coconut Research Institute, Rubber Research Institute, Sugarcane Research Institute, Tea Research Institute, Veterinary Research Institute, Institute of Post-Harvest Technology, Hector Kobbekaduwa Research & Training Institute, and National Aquatic Resources Research and Development Agency. These organizations were established in different years under the different ministries and based on commodity/crops except Institute of Post-Harvest Technology and Hector Kobbekaduwa Research & Training Institute which are based on discipline/subject areas.

Current Policies Adopted in Agriculture R&D

The fundamental challengers facing the agriculture in Sri Lanka are to increase domestic food production to feed the population and reduce the importation costs. Keeping in view these two

facts the agriculture policy and the agricultural research policy were prepared. These are the two key policies which have implications for agriculture research for development.

The National Agricultural Policy, (NAP) of Sri Lanka: Currently, the Agricultural Policy for the country is being formulated by the Ministry of Agriculture in consultation with Sri Lanka Council for Agricultural Research Policy (SLCARP), Agriculture R&D Institutes and all relevant stakeholders, to merge with the vision of the present Government. The National Agricultural Policy (NAP) succeeds and builds on the National Agricultural Policy (2007) and the National Plantation Industry Policy Framework, Ministry of Plantation Industries (2009).

This document presents the National Agricultural Policy Statement for the agriculture sector, and provides the indicators of alignment with relevant sectors. The Agricultural Policy is based on the view to build a nation with an agricultural sector of environmentally prudent, economically productive, nutritionally sound and secured food production.

The NAP has taken into consideration the National Nutrition Policy of Sri Lanka (Ministry of Health, 2010), National Land Use Policy, Ten Year Development Policy Framework of the Fisheries and Aquatic Resources Sector (2007-2016) (Ministry of Fisheries and Aquatic Resources Development), National Energy Policy and Strategies of Sri Lanka (Ministry of Power and Energy, 2008), Policy and Procedures for ICT Usage in Government (e-government policy) (Information and Communication Technology Agency of Sri Lanka, 2009) and the Information and Communication Technology Plan for Sri Lanka 2011-2016 (Ministry of Telecommunication and Information Technology, 2012), National Policy on Drinking Water (Ministry of Water Supply and Drainage, 2010), Livestock Master Plan: A strategy for livestock development for self-sufficiency (Ministry of Livestock and Rural Community Development, 2011), the National Climate Change Policy of Sri Lanka, the National Climate Change Adaptation Strategy for Sri Lanka (2011-2016), and the National Action Plan for Haritha Lanka Programme, the National Science and Technology Policy (National Science and Technology Commission, 2008) and the Science, Technology and Innovation Strategy for Sri Lanka 2011-2015 (Ministry of Technology, 2010) and Tourism Development Strategy 2011-2016 (Ministry of Economic Development, 2011).

The National Agriculture Research Policy, (NARPOL) of Sri Lanka: The agriculture research policy was formulated by the SLCARP (2012-2016) with the aim to achieve an overall growth of the agriculture sector and meet the changing demands of the overall economy to formulate and implement the agricultural research policy that will help build on synergies in the agriculture and non-farm sectors and complement a sustained growth in the agriculture sector.

The requirement for the national agriculture research policy for Sri Lanka is to ensure uniformity in decision making with respect to agriculture research focusing on national agriculture research plan, priorities and create conditions necessary to overcome the major gaps to enhance the prospects of facing the challenges of agriculture in an effective manner (National Agricultural Research Policy 2012-2016).

The NARPOL 2012-2016 has taken into consideration the existing policies such as the overall policy directive of the Sri Lankan Government in relation to agriculture (2010), the National Agriculture Policy (2007), National Livestock Development Policy (2007), National Fisheries and Aquaculture Policy (2006) and the Physical Planning Policy and Plan (2006-2030).

Strategies Adopted for Implementing the National Agricultural Policy

The NAP is formulated with the three element pillars for the agriculture sector which are: assuring food security, ensuring environmental sustainability and developing economic opportunity.

Key strategy areas and policy interventions identified in the NAP are:

Increased production and productivity: Recommended to be implemented through production and productivity, input management and technological advancement. In production and productivity, appropriate (good) agricultural practices, land productivity and land use planning, crop zoning and diversification, integration with other sectors (plantation crops, fisheries, animal husbandry, etc.), urban agriculture and home gardening, have been considered. In case of input management strategies, seed and planting material, mechanization, fertilizer (use efficiency) and pesticides are considered and under technological advancement, national and international collaboration, research and development, technology exchange and knowledge sharing, cooperation and partnerships, information management (e-based agriculture) and adaptation of new technology are considered.

Ensured food safety: Organic agriculture, natural agriculture, good agricultural practices (GAP), plant protection, safe use of agrochemicals and dairy production are recommended for implementation under ensured food safety.

Socio-economic aspects: Farmer empowerment and consumer health and satisfaction are considered for implementation.

Environmental friendliness: Natural resource management and climate change adaptation, soil conservation, water management, agriculture climate forecasting, disaster risk reduction are recommended.

Agribusiness: Affordability, marketability, profitability, supply chain and value chain management, post-harvest technology, value addition and public private partnership are recommended to be implemented.

Knowledge management: Education, extension and capacity building are identified.

General statements: Legal and regulatory framework will be implemented through the Acts and Orders, Regulations and Circulars. It is stated that the legal and regulatory framework that supports the NAP should be subjected to regular review and adjustment to take account of changing patterns of production and demand and national economic capacity.

Strategies adopted for implementing the National Agricultural Research Policy: The NARPOL has identified thrust areas which are; i) legal and regulatory, ii) institutional framework and coordinating mechanisms, iii) priority setting, iv) finance and resource mobilization, v) capacity building, vi) knowledge management, vii) technology transfer, viii) sustainable use of biodiversity and natural resources and ix) international cooperation.

To address the identified thrust areas NARPOL has presented guiding principles which are as follows:

- Sustainable development and poverty alleviation are the first and the overriding practices

- Concept of green economy can significantly address current challengers and deliver economic development activities and multiple benefits to the society
- Transforming the agriculture sector to drive pro poor growth and national development is given highest priority in policy directives
- Nationally coordinated demand driven agriculture research is the key to achieving national food security and economic stability
- Building up of human resources and institutional capacity is of paramount importance in achieving national development goals

Specific Focus

The NARP is founded on the following principles and values and has derived its objectives and the key strategy areas and policy interventions based on the principles:

- Agricultural practices must be environmentally sound, nationally appropriate, socially acceptable, and economically viable
- Safety must be considered and integrated throughout the production cycle
- Benefits must be distributed fairly to both farmers and consumers
- Consumption and production must be sustainable
- Ecosystem stability must be ensured
- Traditional knowledge and practices must be respected in the development of farming systems
- Effective governance must be ensured through the integration of agriculture, water resources and other environmental components to the maximum extent possible

The NARPOL has focused on addressing the issues pertaining to the following thrust areas:

- Legal and regulatory
- Institutional framework and coordinating mechanisms
- Priority setting
- Finance and resource mobilization
- Capacity building
- Knowledge management
- Technology transfer
- Sustainable use of biodiversity and natural resources
- International cooperation
- Policy statements have been given to address issues pertaining to each of the identified nine thrust areas

Priorities for Agricultural Research and Innovations for Development (ARI4D)

One of the mandated functions of SLCARP is to formulate agricultural research priorities. Therefore, SLCARP has identified ten thrust areas for agricultural research. These are, plant breeding; plant protection; plant biotechnology; socioeconomics and policy analysis; agriculture machinery and equipment; postharvest technology and human nutrition; floriculture; livestock, aquaculture and fisheries; natural resources management; organic agriculture and forestry.

The national priorities are formulated by the 10 national committees appointed under each subject area and in consultation with the National Agricultural Research System. The priority documents are prepared for a period of three or five years depending on the requirement at national level and are updated periodically. The priority documents are used as a tool to prepare research programmes annually to be incorporated into the National Agriculture Research Plan compiled by SLCARP which finalizes the research projects to be funded by the General Treasury of Sri Lanka

The following national priorities are identified in plant breeding research formulated for the period 2011-2016:

- Plant genetic resource management and utilization
- Development and recommendation of varieties with desirable characteristics for irrigated and rainfed conditions
- Development of varieties for unfavorable conditions in irrigated and rainfed cultivation
- Development and recommendation of varieties with desirable characteristics
- Increasing availability of high-quality seeds and planting materials
- Development of varieties for food/beverage industries
- Reduction of cost of cultivation
- Improvement of quality characteristics
- Development of bi- and poly-clonal seeds for drought prone and low productive areas in different growing regions
- Increasing timber productivity
- Improvement of biofuel tree species

The national priorities in plant protection (2014-2017): This document provides national strategy on plant pathology, weed science, entomology, hematology and action plan for national plant disease management, weed management, agricultural entomology and nematology in respect of cereal crops, field crops, vegetable, root and tubers, fruits, floricultural crops, plantation crops as well as plantation forestry. In this document all areas of current relevance in respect of climate change, information communication and quarantine aspects have been included.

The national research priorities (2011-2016): Agricultural biotechnology has identified research priorities on productivity improvement, improved varieties, production of quality planting material, quality improvement, development of disease diagnostic tools and conservation of endangered crop wild relatives in respect of plantation crops, food crops and export agricultural crops. Improvement of production of milk and milk products, vaccines, improvement of nutrient

availability have been identified in livestock and poultry. In case of fisheries, improvement of production and processing of in land and marine fish, development of resistant brood stock of prawns, marker assisted selection for right growth rate of fresh water fish and prawn brood stock are identified. Other areas identified include addressing regulatory issues and enhancing the use of microorganisms.

The national priorities in socioeconomic research in agriculture (2012-2016): This document presents six main thrust areas:

- Competitiveness in agriculture
- Natural resource management and environmental sustainability
- Technology generation, transfer and related services
- Agricultural inputs, marketing, processing and value addition
- Agricultural trade
- Employment, labor use, institutions and rural development

The national priorities in postharvest technology and value addition research in agriculture (2011-2015): This document has identified, research priorities and strategies for postharvest research and development. Value addition has been identified for fruit and vegetables, grains and oilseeds, spice crops and the fisheries sector. In this document, postharvest technology gaps and solution framework for fruit, vegetables and the grain sector is presented.

The national priorities in floriculture (2012-2016) : The following research priorities are presented:

- Identification/ improvement/ production of novel ornamental plants and cut flowers to the industry
- Mass propagation of quality planting materials
- Developing new crop management and production techniques
- Post-harvest technologies to improve vase life of the products
- Pests and diseases control methods
- Management of pest and diseases of cut flower varieties
- Managements of leaf spot and leaf blight of cut foliage varieties (especially in palm varieties)
- Development of sustainable cost effective cultivation methods for different agroecological zones
- Development of cut flower and foliage industry as micro enterprises to upgrade the income of the housewives

National research priorities in agricultural machinery and equipment (2015-2019): This document presents agricultural mechanization priorities as follows:

- Land preparation
- Crop establishment
- Crop management

- Harvesting
- Post-harvesting
- Residue/waste management and pollution control
- Machinery and equipment for livestock, aquaculture and fisheries
- Machine and equipment for nursery management and mushroom cultivation
- Quality control safety and related aspects of agricultural machinery & equipment
- Recommendations to policy changes/improvements
- Recommendations for policy changes in human resource and research development

National research priorities in livestock, aquaculture and fisheries (2012-2016):

This has identified animal breeding and reproduction, animal nutrition, animal health, fisheries and aquaculture, animal products, processing their economics and marketing forming systems and animal (livestock) welfare.

National research priorities in plantation forestry (2013-2018): This document has identified the thrust areas as:

- Establishment and management of plantation forests while ensuring
- Sustainable land use
- Improve value chain system in forest plantation sectors
- Biodiversity conservation
- Impacts, adaptation and mitigation of climate change (CC) in forestry
- Joint participation in plantation forestry
- Socio/environmental aspects and investor related aspects of the surrounding plantation forest industry
- Strengthening policy and legislative framework

National research priorities in natural resources management for the period (2012-2016) has identified:

- Food security
- Green economy
- Water security

National research priorities in organic agriculture (2015-2020): The research priorities have been identified under broad thematic areas, along with specific issues and research strategies. The thematic areas are:

- Productivity improvement in organic agricultural systems through sustainable land improvement
- Develop scientific basis for indigenous organic measures
- Making available quality inputs at an affordable price

- Post-harvesting, processing and value addition
- Quality aspects of organically based products
- Certification, marketing and trading promotion
- Life cycle analysis of organic farming systems
- National policy on organic agriculture

Targets

Food and nutritional security: To ensure food and nutritional security, the government of Sri Lanka has prepared 'The Production Plan 2016-2018', with production targets for years 2016-2018. The document details production targets for paddy, maize, groundnut, mung bean, soybean, onion, chilies, potato, cowpea, black gram, millet, turmeric, ginger, vegetables and fruits. In addition, this document provides production targets for the livestock sector to increase the consumption of animal protein by 40 per cent and local production of vaccines, milk production and fisheries. Further, the production plan which has taken into consideration coconut production, improving the livelihood of farmers, natural resources management and facing challenges due to climate change, public private partnerships, increasing the participation of women and youth in agriculture and knowledge management. Pertinent production targets to achieve food and nutritional security are presented on table 1.

Table 1. Production targets 2016-2018

Crop	Annual requirement	Annual production	Target targets	Strategies
Paddy	2.27 mt	2.71 mt	To increase the productivity from 4.1 to 5 mt/ha	Better management practices, introduce suitable varieties and technology, improve the nutritional value of rice, introduce more rice based products, cultivate in abandoned lands, traditional rice varieties to be cultivated in low country wet zone
Potato	160,00 mt	80,000 mt	To reduce import of potatoes by 35%	High quality seed production, establishment infrastructure for storage
Vegetables	1.5 mt	1,011,683 mt	To reduce post-harvest losses up to 10%	Continuous production of vegetables throughout the year and encourage inter seasonal vegetable production. Ecofriendly vegetable production, value addition and preservation; vegetable production in wet zone under rain covers
Fruits	-	916,527 mt	To increase production and reduce post-harvest losses	To make available nutritive fruits in the market; encourage inter cropping with fruit crops; establish commercial cultivation of fruits and introduce inter-seasonal cultivations of fruits; island-wide programmes for control of fruit fly; establish fruit processing units; and fruit trading under international linkages

Contd...

Table 1. Contd...

Crop	Annual requirement	Annual production	Target targets	Strategies
Milk	750 ml	334 ml	To increase production by 20%	Develop collecting centers and milk processing centers to enhance the milk industry; training farmers on quality standards and small scale milk farm industries; and promote fresh milk consumption among school children and youth

Poverty reduction: This has been discussed in the Production Plan 2016-2018. The farmers of this nation fall in the low income group. The level of acceptance for the farmers by the society and the poverty of the farmers have reflected badly on the agriculture sector, therefore the three year production plan has proposed the following.

Strengthen agriculture insurance policies, loan facilities with low interest rates; develop entrepreneurship of farmer community by technological skill development and establishment of farm corporations in order to build up a new generation of farming community with a higher purchasing power and social recognition.

Reduce environmental degradation: The agriculture sector of Sri Lanka aims to reduce environmental degradation through efficient use of soil and water oriented crop cultivation to withstand the long-term effect of climate change, sustainable land management systems, management of agricultural practices, and conservation of biodiversity and introduction of environmentally friendly systems for livestock management.

Institutional Roles, Responsibilities and Partnerships

In Sri Lanka, the R&D institutes of the agricultural sector are dispersed under several ministries. The sole mandate of Research & Development institutes is to conduct research and transfer technology to the stakeholders. The authorities who are involved in policy studies for the agricultural sector are mainly ministries of agriculture, plantation industries, fisheries and aquatic resources development, social services, welfare and livestock development. The SLCARP, as the sole organization for agricultural research policy formulation, works in partnership with other ministries in its functions.

The line ministries of the Research & Development institutes and the SLCARP have established linkages with relevant public and private sector organizations to work in partnership. Technical cooperation has been established through memoranda with agriculture councils such as the Indian Council of Agricultural Research and the International Research Institutions such as International Rice Research Institute (IRRI).

Infrastructure and Financial Investments

The infrastructure of the research institutions in the agriculture sector of Sri Lanka requires further development, for strengthening laboratory facilities and ensuring efficient maintenance systems. The available infrastructure and human resources are given in table 2.

Table 2. Infrastructure and human resource of the R&D institutes in agriculture.

Institute	Scientific-research staff	Physical infrastructure			IT facilities				
		Labs	Workshops	Auditorium/ conference hall	Library	Computers	Printers	Scanners	Other
Coconut Research Institute	38	9	1	1	1	34	9	1	
Socioeconomics Center, Department of Agriculture	17	5	-	-	1	29	7	1	
Farm Mechanization Research Centre, Department of Agriculture	4	1	1	1	-	9	2	0	Multimedia
Fruit Crop Research & Development Institute, Department of Agriculture	26	5	1	1	-	15	3	1	
Horticultural Crop Research & Development Institute, Department of Agriculture	24	8	-	1	1	16	9	1	
Natural Resources Management Centre, Department of Agriculture	11	2	-	-	-	37	7	0	
Hector Kobbekaduwa Agrarian Research & Training Institute	38	5	-	4	1	111	38	13	
Institute of Post-Harvest Technology	21	3	1	3	1	20	16	2	
National Aquatic Resources Research & Development Agency	55	5	1	3	1	125	67	3	
Plant Genetic Resources Centre	9	6	-	2	1	25	18	3	
Rice Research & Development Institute	43	5		3	1	50	25	10	
Rubber Research Institute	35	8	1	3	2	112	75	8	
S.L. Council for Agricultural Research Policy	8	-	1	1	1	28	11	3	
Seed Certification Service	17	5	-	2	-	46	13	2	

Contd...

Table 2. Contd...

Institute	Scientific-research staff	Physical infrastructure			IT facilities			
		Labs	Workshops	Auditorium/conference hall	Library	Computers	Printers	Scanners
Sri Lanka Accreditation Board for Conformity Assessment	10	-	-	1	-	15	16	1
Sri Lanka Institute of Nano Technology	36	7	2	2	1	60	18	4
Sugar Cane Research Institute	23	2	1	no	1	48	27	2
Tea Research Institute	72	11	1	7	3	155	87	15
Veterinary Research Institute	32	2	11	1		76	37	2
Total	519	89	11	36	16	1011	485	72

Source: Annual Science & Technology Review, NASTEC 2015 IT Facilities

It is observed that, in most of the research institutes, there is no major deficit in the research cadre, however, skill development for research cadre during the period 2016-2018 has been given high priority by SLCARP.

In respect of financial resources, funding for agricultural R&D in Sri Lanka is available from a variety of sources, including Sri Lankan government, foreign and local donors, CESS, development banks, producer organizations, and the private sector, along with internally generated revenues through the sale of goods and services. The general treasury, under the purview of the Ministry of Finance is, however, the main funding organization, which is responsible for developing and executing the government's public finance policy, economic policy and long-term planning. Funds are provided on annual basis and the financial year is 1st January to 31st December each year. Mainly two types of funds are provided; annual budget and funds for special development project. However, financial value (budget) of most of the projects was less than 500 million in agriculture sector during 1990-2012.

National Science Foundation (NSF), SLCARP, National Research Council (NRC) and University Grant Commission (UGC) also provide local funding for Agricultural Research. The international institutions like Food and Agricultural Organization, (FAO), Japanese International Cooperation Agency (JICA), Norwegian Aid for Research and Development (NORAD), International Fund for Agricultural Development (IFAD), International Food Policy Research Institute (IFPRI), Swedish International Cooperation Development Agency (SIDA), Korean Project for International Agriculture (KOPIA) and United Nations Development Programme (UNDP) etc. have also, provided grants from time to time. Major R&D projects were funded by different banking institutions such as World Bank, and Asian Development Bank.

Major Challenges and Opportunities

The focus on agricultural research conducted by the National Agricultural Research System is driven by the immediate goal of increasing food production to ensure food security. However the persistence of poverty, hunger, malnutrition, dependency on imports and environmental challenges as well as increased dependency on the external inputs is the major challenges the agriculture sector is faced with.

Sri Lanka is blessed with the necessary agroecological conditions required for agriculture. The land of the country is suitable for cultivation. Therefore, with the necessary inputs in terms finances, further skill development where necessary for the researchers, the scientists and other stakeholders will be able to achieve the expected production targets for this country for the period 2016-2018.

Looking Ahead (short to medium-term)

At the moment SLCARP or the Sri Lankan Government does not have a single document which can be considered as a road map for agriculture sector.

The agriculture R&D system in the country will be guided by the expectation of the production Plan 2016-2018. The production plan has been formulated with the following main objectives:

- To make the country self-sufficient in local food production and save the huge foreign exchange that spent on importing staple foods
- To make available nutritive foods by reducing agrochemical and adopting ecofriendly practices

- To achieve food security by management of additional food reserve
- To introduce crop productive programme based on agroecological zones
- To increase productivity by adapting suitable technologies through production process
- To establish a counter active coordination among local food produces, schooling population and public societies
- To provide quality inputs for food producer and establish an effective production methodology
- To achieve success for the overall progress of the country in the agriculture sector

To achieve these objectives related to food production in the next three years, a representation from all partners in agriculture has to be in a task force. For this purpose, support of students, youth and security forces will be included. Practical models and workshops will be held in schools, universities and farmer training centers. For exchanging research outcomes, collaboration among universities, government institution and private sector will be promoted.

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21. Country Status Report: Taiwan

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Introduction

Agriculture is considered fundamental to sustainable development of a nation and agriculture sector is the basis for national economic development. During the 1950s and 60s in Taiwan, the Republic of China, agriculture contributed massively to commodity, civil society and country economic development, occupying more than 30 per cent of the total gross domestic production (GDP). Today the majority of local farmers embrace modern technologies as part of their farming operations as in many developed countries. Although the services and manufacturing have overtaken agriculture and its GDP has gradually reduced to less than two per cent recently (Table 1), the agriculture sector remains one of the few bright spots domestically. With the progress in science and technology, agriculture in Taiwan is transforming from an industry of labour, technique and knowledge-intensive to intelligent-reliable and efficiency-accountable activities looking towards the so-called 'Agriculture 4.0' phase. To reach such goal, Taiwan is now striving to build up a whole new type of agricultural value chain for 'intelligent' production, handling, processing, and marketing that investment in research and innovation is essential and necessary.

This paper introduces the efforts that Taiwan authority has made in consolidating and reinforcing the policies and research strategies on issues of food security, environmental protection, climate change, and the promotion of the rural economy. Other emphasis such as restructuring the current agriculture to cope with the world economic trend will also be mentioned. The strengthening of the effectiveness of agribusiness management and the efficient utilization of natural resources are among directions to ensure the development of the sustainable agriculture in Taiwan.

Table 1. The agriculture gross domestic product (GDP) as share of total GDP in Taiwan (2012-2014)

GDP		2012	2013	2014	Average
Total	Billion NTD	14686.90	15221.20	16084.00	15330.70
	Billion USD	464.60	481.50	508.80	485.00
Agriculture	Billion NTD	242.40	255.80	296.10	264.80
	Billion USD	7.70	8.10	9.40	8.40
Agriculture GDP as share of total GDP (%)		1.67	1.70	1.88	1.75

The US Dollar exchange rates for calculation are referred to the rate on December 31, 2014

Current Policies

To achieve a specific outcome or fulfill a given goal in agriculture, government usually implement certain designated agricultural policies with directional strategies and measures based on the integration of the research evidence and the latest facts. The current agricultural policies can be summarized into ‘three pillars’, namely, innovative agriculture, sustainable agriculture environment, and international competitiveness enhancement in Taiwan. These policies will be implemented from the following five aspects/strategies:

- Value-adding and upgrading for agriculture
- Restructuring and integrating the related primary, secondary and the third industry together to innovate the agricultural policies
- Promoting agricultural product safety management and improving local production and consumption
- Safeguarding sustainable utilization of agricultural resource and ecological sustainability; and
- Strengthening farmer organizations and facilitating farmer welfare

The final goal is to create and increase the new value-chain value of agriculture. Further, multi-functional databases from wide spectrum of the areas of agriculture are as supplementary to advance agriculture. Green scientific technologies are also employed to bring about a new agricultural production environment as well as to assist food production in sustainable ways. Collectively the above-mentioned intentions are to promote Taiwan’s agriculture toward green and the service and innovation-oriented development.

Strategies

Taiwan agriculture is in a high development stage adopting improved technology and innovative thought in crop diversification and management. Recently, there is less than three per cent population engaged in agriculture with lower than two per cent share in total GDP. Overall, productivity and competitiveness of the sector are in high point. Nevertheless, the agricultural sector development strategies have being reviewed and revised by government on a periodic basis according to the approved policies as guidance for stimulating, leading and directing progressive agricultural growth and development. As rolling projects, major integrated research programmes are evaluated yearly. Still, the final goal can only succeed with full commitment and determination by all stakeholders.

In composing the aforementioned strategies, prioritized issues have been identified and problems have been defined in the agricultural sector so that causes and solutions are bridged on a one-to-one basis and implemented in a phased manner. The current components of the measures in respective strategies are as follows:

Value-adding and upgrading for agriculture

- Industrialization of agriculture technology to establish agriculture cloud and to expand markets domestically and overseas in facilitating the industrialization of newly invented agricultural technology

- Introduction and assistance of agriculture enterprises set in Pingtung Agricultural Biotechnology Park to provide agriculture cloud platform as in-time service that connects to the satellite fishing supply chain in aid of the development of ornamental fish industry
- Conduction of overseas services of agricultural technology and enforcement of intellectual property protection to enhance international trade of agricultural products and protect intellectual property for a better competitive strength
- Participation in international organizations and strengthening international cooperation to proactively participate in international organizations, such as Asia-Pacific Economic Cooperation (APEC), Inter-American Tropical Tuna Commission (IATTC), and South Pacific Regional Fisheries Management Organization (SPRFMO), and to strengthen international agricultural cooperation and collaboration on critical environment and natural resources exploitation and in reducing barriers to trade

Restructuring and integrating the related primary, secondary and the third industry together to innovate the agricultural policies

- Adjustment of tillage system and reactivation of farmland programmes to reactivate the fallow land for organic farming or cultivating import substitution crops
- Implementation of the ‘Small Landowners Big Tenants’ and ‘Golden Agricultural Corridor’ programmes to set up agricultural grouping production zones in production and trade and to facilitate the new type of protected cultivation under intelligent facilities for enhancing agricultural output value
- Encouragement of agro-tourism to well plan and develop regional leisure agriculture to meet increased demand for outdoor recreation
- Enrichment of rural regeneration and industry incubation projects to carry out different levels of training courses and cross-industrial collaboration to give help or support rural regeneration and agribusiness incubation
- Reconstruction of new agricultural industry value-chain to shepherd local agricultural industries in manufacturing safety products from field to table and to set smart marketing plan that enhance customer confidence towards high-quality and safety agricultural products.
- Education and assistance of young farmers to integrate experience from case studies into existing training programmes help to foster young farmers

Strengthening agricultural product safety management and improving local production and consumption

- Construction of food safety responsibility mechanisms to promote public and private inspection and certify systems ensuring quality and safety of agricultural products
- Reinforcement of agricultural product safety management to reinforce a series of products producing, handling and processing systems, such as good manufacturing practice (GMP), certified agricultural standards (CAS), taiwan good agriculture practice (TGAP) and traceable agriculture product (TAP), supervising fertilizers, pesticides and animal medicines use
- Intensification of rice management to ensure quality rice supply and safety

- Promotion of local products consumption to reduce 'food miles' that cut down food-related greenhouse gas emission and be more environmentally-friendly in food production, processing, and transportation

Promoting sustainable utilization of agricultural resources and ecological sustainability

- Improvement of farmland management system to more appropriately classified, utilized and managed farmlands maintaining soil fertility and water quality
- Amelioration of irrigation management and subsidy policies to safeguard irrigation infrastructure and facilities and to provide financial aid to farmers that have suffered severe losses from natural disasters
- Strengthening the protection of forest plantation and wild species to strengthen the conservation and management of forest resources and ecological integrity
- Reinforcement of watershed management and disaster prevention to proactively conduct research on strategies of adaptation and mitigation to cope with climate change and to solve complex multi-facet optimization problems of irrigation water supply and watershed management

Strengthening farmer organizations and facilitating farmer welfare

- Strengthening the activities of farmers' associations to regularly revise relative regulations of farmers' associations to improve their ability in farming and farming management services
- Increasing the competitiveness of farming/agribusiness to promote research activities on technology improvement and to provide agricultural designated loans for farmers in need to raise the quality of agricultural products and services
- Facilitation of farmer welfare to constantly adjust the regulations of Farmer Health Insurance and implement policies such as the Agricultural Natural Disaster Implementation Rules to promote the welfare of farmers

Specific Focus

Agriculture is a bio-based industry, also an industry the national people rely on living. In addition to limited by natural resources and environment, the development of agriculture is also confined by social change and conditions of international community. Six focal points are highlighted for agricultural research and innovations while together can empower agriculture sector to fulfill multifunction and multiplex purposes for a country.

Breeding of new plant or animal varieties: To improve international competitiveness, conventional and modern biotechnology methods should be integrated with related complementary databases in the breeding programmes for improved varieties.

Frontier areas for agricultural genome technology platform: To accelerate plant and animal breeding, complete genome information framework and technology platform are necessary to enhance the accuracy of functional analysis, inspection of epidemic diseases, identification of pests and plant/animal varieties, and so on.

Animal and plant health management: To predict the outbreak of severe pests and diseases, complete plant/animal pest and disease information platform need to be established and linked to big data. As to vaccine studies, introduction of innovative technologies such as reverse vaccinology or proteomics can help to develop new multivalent vaccines.

Recycling agricultural waste: The reducing, reusing, and recycling of agricultural wastes helps prolong resource life cycle. Investment in research and development (R&D) of renewable energy and waste cycling technologies is the first concern.

Functional agricultural products: Studies on functional agricultural product in Taiwan mainly focus on building a complete value chain of high-value functional products and developing competitive functional products. Apart from export concern, it is hoped that local consumers to gain better health on consumption of higher quality functional products.

Intelligent agriculture (e.g., agricultural facilities, mushroom cultivation, agricultural machinery, and aquaculture model factory): For intelligent production and digital service, sensing technology, internet of things (IoT), and Big Data analysis would be integrated together in agricultural production systems to not only reduce labor demand and production cost but also provide high-efficiency and high-productivity innovative operations and management.

Priorities for Agricultural Research and Innovations for Development (ARI4D)

Conventional areas (breeding, agronomy, crop protection, natural resource management, soil science, agricultural engineering)

- Crop production system with low energy consumption, low greenhouse gas (GHG) emission, and effective water utilization
- Ecological and environmental recovering technologies
- Biological germplasm collection and preservation and breeding to adapt to climate change
- Sustainable management and utilization technologies for forestry resources and its products
- Tracing techniques and rapid quantification analysis for local agriculture, forestry, fishery, and livestock products
- Breeding and propagation technologies of ornamental fish and medical model fish and high-quality aqua-germplasm preservation
- Basic research on crop physiology
- Irrigation system regarding ecology and basin modulation and evaluation
- Eco-friendly agricultural production techniques for individual region
- Evaluation of the ecological and agricultural impacts caused by climate change solutions planning

Frontier areas (biotechnology, nanotechnology, information and communication technology, sensors application in agriculture, geo-referenced decision support systems)

- Inspection and management systems of marine resource comply with international standards

- Monitoring and pre-warning technologies of agricultural ecosystem and natural resources
- Innovative technologies to filter out the natural allergens and toxic constituents within food ingredients
- Biomaterials and health-care products
- Important agricultural cloud databases
- Livestock production management system with information and communication technology (ICT) and automation
- Molecular epidemiology database for important domestic animal infectious diseases
- Informatics system, interface, and equipment to support agricultural management
- Databases of biological and genetic resources
- Databases for agriculture, forestry, fishery, and livestock products in response to market demand
- Techniques for rapid safety evaluation in production areas

Other areas of development (farming, cropping and integrated systems, agriculture policy, value chains, agricultural business planning, incubation, etc.)

- Utilization of farmland resources by integrating fallow land reactivation with informatics and environment evaluation
- Agricultural verification system under sustainable-environment principles
- Farmland exploitation and impact assessment mechanisms and guidelines to avoid environmental damage
- Inspection, verification, tracing and management systems for agriculture, fishery, poultry, and livestock products
- Mutual-benefit communication model on agricultural issues with mainland China
- Food safety information display system and related detection technology

Targets

- Improving R&D capacity and capability by integrating cross-domain technology and expertise into research programmes and projects
- Ensuring sustainable environment by working together environment protection, ecosystem restoration, and reasonable resource utilization
- Enhancing industrial competitiveness by strengthening innovative and value-added R&D along industry value chain
- Assuring food safety in response to increased customer demand and food security to provide safe and nutritious foods to meet dietary needs and food preferences of local consumers

Institutional Roles, Responsibilities and Partnerships

It is not possible to accelerate agricultural R&D without the participation and partnership of research sector, industry and farmers. Therefore, a complete R&D network of a community/country should include all stakeholders. In Taiwan, the research system includes governmental agencies, academic institutions, individual famers, farmers' associations, and agricultural enterprises plus international organizations (Fig. 1). The majority of research institutions in areas of agriculture are funded or supported by the government. There are four research institutes, seven district agricultural research and extension stations, and five specialized research stations under the Council of Agriculture (COA), the government agency in charge of crops, forestry, fishery, and livestock industry's development as well as the national food security affairs. In crop research, as indicated in figure 1, Taiwan Agricultural Research Institute (TARI) acts as a hub of the R&D network. The outputs from the strategic basic studies of TARI are the inputs for district agricultural research and extension station to generate materials, varieties and technologies of farming operations at farm and enterprise level.

As the leading crop research agency under COA, the research personnel at TARI retain its competitiveness in the local market with their strong educational background (Table 2). Entry to TARI research job is highly competitive relative to entry to a university. More than 95 per cent of TARI's employees engaged in research work hold a Ph.D. or M.S. (Master of Science) degree.

Table 2. The educational background distribution of personnel at Taiwan Agricultural Research Institute

Year	Ph.D.	Master Degree	Bachelor Degree	Total
2012	84 (41.4%)	109 (53.7%)	10 (4.9%)	203 (100%)
2013	85 (42.3%)	107 (53.2%)	9 (4.5%)	201 (100%)
2014	85 (43.5%)	101 (52.1%)	8 (4.1%)	194 (100%)
Average	85 (42.6%)	106 (52.9%)	9 (4.5%)	199 (100%)

Major Challenges and Opportunities

Like climate and weather conditions, challenges and opportunities vary considerably from year to year and industry to industry. Building a solid information and technology foundation to support the development of agriculture is the rule of thumb. Those have prepared sound strategies and measures to dynamically respond to incidents of industry or stimulants of environment will have more options available for a timely solution to the impact. Strategies/measures at local or national level should at least include key information and technologies with applicable action plans. With that, it will be given an opportunity to gain improvement rather than a challenge to put at risk.

Major challenges facing Taiwan today include climate change and deterioration of natural environment, energy shortage, changing global economic environment, low food self-sufficiency ratio and unbalanced food supply and demand, ageing of agricultural workers, and limited agricultural enterprises development. Some related issues for each challenges are:

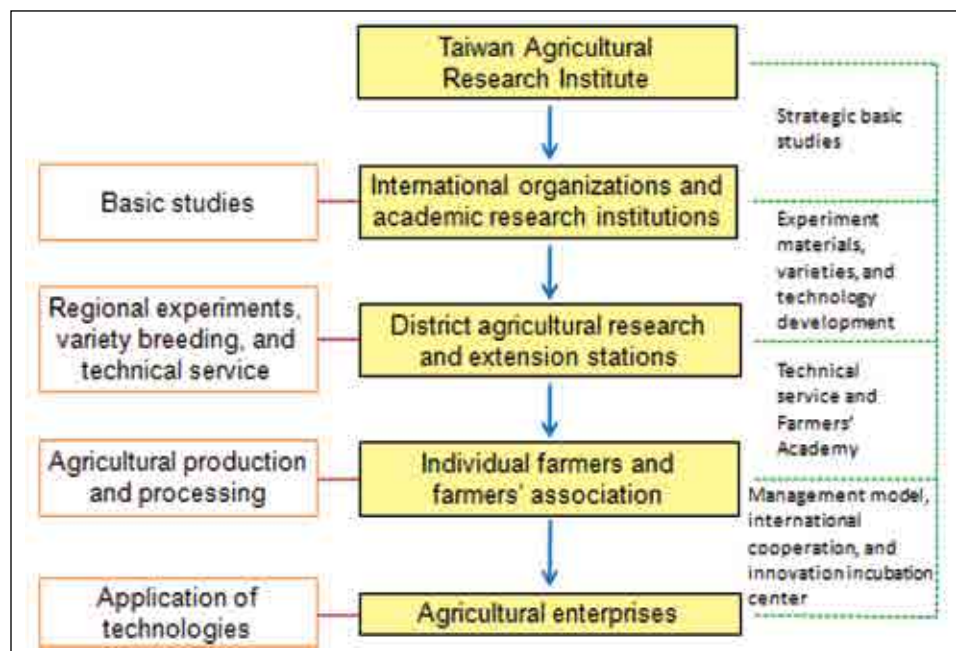


Figure 1. The cooperation framework of governmental organization, individual farmers, farmer's associations, academies, and agricultural enterprises

- Climate change and deterioration of natural environment, such as land and water resources preservation, sustainable environment and biodiversity, decrease use of chemical pesticides, and improved high-quality crop production system
- Energy shortage, such as recycling agricultural wastes, energy saving and carbon reduction, and intelligent agriculture development
- Changing global economic environment, such as fostering human resource, international cooperation, and remove export trade barriers for agricultural products
- Low food self-sufficiency ratio and unbalanced food supply and demand, such as application of agricultural genome technologies and building intelligent agricultural production system
- Ageing agricultural workers, such as rural regeneration, new industrial value chain, youth for farming, and high level farmers training
- Limited agricultural enterprises development, such as industry assistance, industrialization of research findings, and incubation of new agricultural enterprises

In spite of the high development stage, there are positive signals in the agricultural sector. All agriculture sub-sectors (crops, forestry, fishery, and livestock) have been making steady progress in terms of production volume and/or production value. Productivity and farmers income continue to grow positive. There is considerable potential for increase in quantity and quality of fruit, vegetables, flowers, and mushrooms, particularly with better knowledge and improved technologies. Investment in agriculture, agribusiness, rural development, and environmental protection by Government and the private sector has maintained a regular tempo along with the formulated policies and plans recently. Government expenditures on the agricultural sector are increasing, both capital and recurrent expenditures.

The overall opportunities and related issues for agricultural development toward positive directions are identified as follows:

- Improved ICT and biotechnology, such as intelligent agricultural production system, application of Big Data and set up analysis platform, and uses of genomic technologies
- Diversified consumer demand, such as food and agriculture education and development of functional food
- Food safety demand, such as reducing chemical pesticides use, improving agricultural product tracing system, and animal and plant disease precaution and prevention systems
- Awareness of eco-friendly trend, such as developing the biofuel industry, encouraging agro-tourism, and recycling agricultural wastes
- New agricultural management model, such as specific agribusinesses models and cross-domain collaboration

Concluding Remarks

Most policies in Taiwan are supportive of agriculture and are implemented with complementary strategies and measures. However, a few policies aimed to tackle a more rational approach of farmer subsidies and farmland uses are hindered by the combination of various factors, such as lack of supporting legislation, poor party coordination, and the influence of interest groups and lobbyists on Congress members. In overall, any new policy or research plan for agricultural sector need to avoid not to get bogged down by administrative or legislative constraints.

Agricultural policies are implemented by periodic plans in Taiwan generally, including three-year, four-year, six-year, and multi-year plans. Currently, two-year planning is considered as short-term plan while four-year planning concerned as medium-term plan. During the past decades, agriculture has been able to growth consistently due to high credibility in agricultural policy and good strategic plans that are mostly feasible and applicable to real-world as well as in line with agricultural strategies/measures. Looking ahead, the vision of Taiwan's agriculture is to establish agriculture become a young, dynamic and highly competitive industry in order to increase farmers income and make Taiwan's agriculture as a lifestyles of health and sustainability (LOHAS) model.

As the conclusions of the paper, some aspects are highlighted for further references:

- Agricultural industrial competitiveness are strengthened by innovations and value adding R&D
- Capacity and capability of agricultural R&D can be improved by integrating cross-domain knowledge and technologies and international cooperation
- Sustainable environment for agriculture based on the fulfillment of environment protection, ecosystem restoration, and reasonable exploitation and utilization of resources
- The integrity of agricultural systems is realized by the sustainable agricultural development, and investment in research is the exclusive route leading to the goal

22. Country Status Report: Thailand

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Introduction

The National Economic and Social Development Board (NESDB, 2014) reported that the GDP shares of agriculture decreased to 124,394 million Baht in the second quarter of 2015 from 124,713 million Baht in the first quarter of 2015. The average GDP from agriculture in Thailand averaged to 102,673.59 million Baht from 1993 until 2015, reaching the highest at 132,548 million Baht in the fourth quarter of 2013 and a recorded lowest at 66,849 million Baht in the second quarter of 1993 (Figure 1).

The percentage GDP shares from different sectors is shown in figure 2. The highest share of GDP comes from the manufacturing sector (48.21), followed by transportation sector (17.87), public administration (9.68), agriculture (9.22), utilities (5.77), construction (5.04) and mining (4.20).

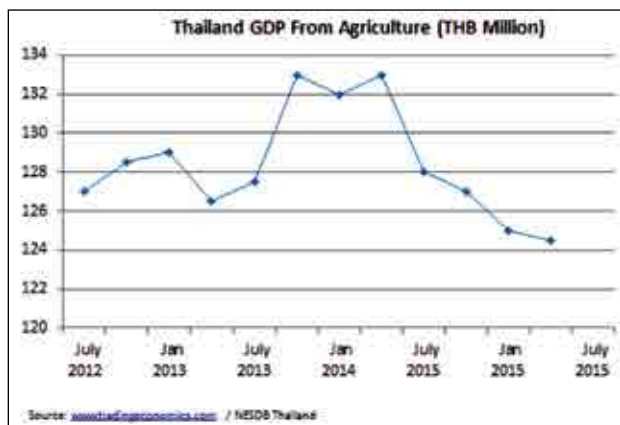


Figure 1. Thailand GDP from agriculture (THB million)

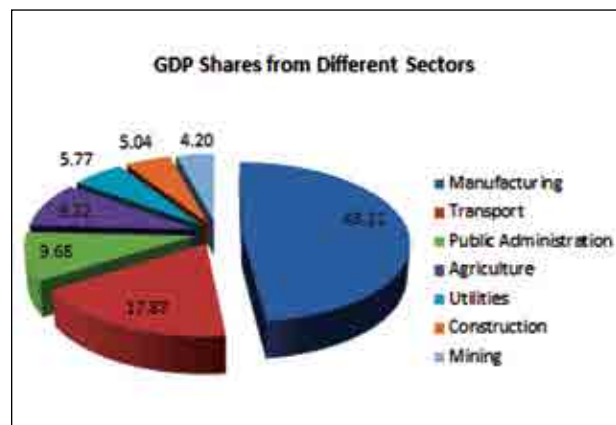


Figure 2. Percentage GDP shares from different sectors

Current Policies

Thailand is at present on its Eleventh National Economic and Social Development Plan (11th NESDP 2012-2016). The policy emphasized on strengthening of the agricultural sector to foster food and energy security with emphasis on management of natural resources. Under the 11th NESDP, the country's development was emphasized on building resilience at the family, community, society, and national levels under the sustainable development concept as outlined

in the Sufficiency Economy Philosophy of His Majesty, the King of Thailand. It also featured specific development factors based on human, social, physical, financial, natural resource, environmental and cultural assets. The goals are to utilize these assets i) to create a society of quality by building the intellectual basis for generating resilience in citizens and the society, ii) to achieve a green economy where knowledge and Thai identity will be used to restructure the economy based on innovation, iii) to connect effectively with the regional and global economies, iv) to foster sustainability in the agricultural sector and prosperity in the food and energy sectors, v) to sustainably manage natural resources and the environment, and vi) to reinforce good governance and harmony in all sectors and at every level.

Policies relevant to the agriculture sector are implemented on the following strategic trusts:

Strengthen the agricultural sector and security on food and energy

- Reinforce natural resources as the foundation of the agricultural production: Productive arable lands are conserved and small farmers were given support and given the right to own farmland. Land are used efficiently and promote sustainable farming.
- Increase agricultural productivity: Research and development are emphasized while agricultural production was modified to be suitable to sociogeographical conditions. Controls on imported chemical fertilizers and pesticides are strictly enforced. Agricultural practices that preserve biodiversity and are suitable for the climate and the environment are promoted, while basic services for agricultural production improved. The development of science and technology for agriculture becomes essential, including support for technologies for production that are climate resilient and friendly to the environment.
- Increase the value of agricultural commodities along supply chains: Value addition for local products and services in agricultural products, food and energy is being supported. The private sector is encouraged to collaborate on research and development while farmers and firms apply knowledge, technologies and innovations that are environmentally sound. Food quality and standards for farm products relative to production systems are upgraded to meet international standards. The efficiency of logistic management in the agricultural sector is also improved.
- Creation of job and income security for farmers: An income insurance system, together with crop insurance, are developed to cover all farmers. Fairness for farmers and stakeholders in the contract farming system has been encouraged. Farmers are empowered to make their careers in agriculture. Agricultural institutes and community enterprises becomes a major mechanisms for supporting self-reliance. Small farmers who are adversely affected by free trade agreements are strengthened in order to maintain their living conditions.
- Enhance food security and develop bioenergy at household and community levels: Farmers are educated to utilize sustainable agriculture following the Philosophy of Sufficiency Economy. Information regarding agriculture and food production are widely and continuously disseminated. Appropriate consumption behavior at individual and community levels, and creation of production and consumption networks among nearby communities are promoted. The zero waste approach in agriculture by utilizing farm residues to produce renewable energy is transferred to the communities.

- Establish bioenergy security to strengthen the agricultural sector and support national development: Research and development to increase the productivity of bioenergy crop production has been promoted. Efficiency in the bioenergy production and utilization related to the manufacturing and service sectors has been increased. A mechanism to regulate the price structure of bioenergy are also created, and the public awareness of the benefits of efficient energy use has been raised.
- Improve public management to enhance food and energy security: The participation of farmers, local scholars, the private sector and local communities in agricultural development planning is encouraged. Actions by government agencies at the central and local levels are streamlined and integrated. Food and energy databases are being developed that span production and marketing through consumption. Amendments to laws and regulations that affect agricultural development are made. International cooperation at bilateral and multilateral levels, particularly in the ASEAN community, should be encouraged in order to attain food and energy security.

Restructuring the economy towards quality growth and sustainability

- Utilize science, technology, innovation and creativity as fundamental elements in economic restructuring: This strategy is being addressed through adjustment of trends in trade and investment to respond effectively to emerging markets in Asia, the Middle East and Africa, as well as the domestic market. The service sector is also restructured to allow for higher value creation and to become more environmentally healthy based on innovation and creativity.
- Develop science and technology, research, and innovation as driving forces for sustained and inclusive growth: Economic restructuring has been emphasized in research and development, technology transfers and applications that lead to commercialization of innovation and improve the quality of life. The development of creative thinking and application of local knowledge are prioritized through public and private sectors partnership to create an improved environment that enables value creation by providing appropriate infrastructure and facilities thus encouraging technological development and innovation.
- Enhance the country's competitiveness through a competitive environment that is more free and fair: The country's competitive edge has been strengthened through development of financial and capital markets along with improvement in the workforce facilitating economic restructuring, wherein the development of science and technology, innovation and creativity becomes the key elements in economic restructuring. In addition, the development of high quality infrastructure and logistic systems are being enhanced to have efficiency in the domestic and international connectivity that is consistent with international standards. The issue of energy security is also vital, and advocates on the development of clean energy and alternative energy sources, leading to overall improvement in energy efficiency. Reform of the legal framework, rules and regulations that govern businesses also becomes essential in order to bring about healthy competition and enhance efficiency that is capable of meeting global changes and trends.
- Achieve stability through sound macroeconomic management: Financial management and monetary policies are imposed, and the role of the capital market are promoted to be consistent with development in the global financial sector. More effective budget allocation and management becomes crucial to prevent fiscal risks and enhance the

operational efficiency of state-owned enterprises. The private sector increased participation in infrastructure investment and providing public services are enhanced and the fiscal capacity of local government was built.

Creating regional connectivity for social and economic stability

- Develop connectivity in transport and logistic systems under regional cooperation frameworks: This is being achieved through the development of efficient transport and logistic services that meet international standards as well as improvement of rules and regulations governing the transportation of goods and people should also be accomplished. In addition, the capabilities of human resources in transport and logistic businesses should be enhanced. Economic connectivity along border areas and economic zones are increasing significantly, ensuring connectivity with domestic production bases.
- Develop investment bases by improving competitiveness in the region: This is being achieved through spatial development that improves connectivity with neighboring countries and South-East Asia, and is based on an integrated spatial development plan for mutual security and stability.
- Prepare for the ASEAN Economic Community: Preparations are continuously implemented through strengthening public-private cooperation to develop human resources in all economic sectors. Labour skill development and minimum standards for goods and services are required in order to prevent the import of low-quality products into Thailand and neighboring countries.
- Promote constructive international cooperation to support economic growth in ethical and sustainable ways, including cooperation with non-profit international organizations: International agreements under regional environmental cooperation frameworks adhere to the promotion of green production, consumption and services that lead to reduction of green house gas (GHG) emissions. The roles of non-profit international organizations are being promoted and the use of Thailand as an operational base for developmental cooperation in this region facilitated.
- Strengthen domestic development partners at the community level: This is being achieved by empowering communities and local governments to prepare for international and domestic changes. The development mechanism for formulating strategies are strengthened at the provincial and cluster levels, especially at border provinces, for cross border cooperation. Support also provided to enhance technical capacity and networks among Thai academic institutes in order to create close collaboration with other countries in this region.

Managing natural resources and the environment toward sustainability

- Conserve and create security for natural resource and environmental bases by safeguarding and restoring forest and conservation areas: A database system to organize information needs to be developed to serve as a tool for planning and management.
- Shift the development paradigm and redirect the country to a low-carbon and environmentally friendly economy: The country's production and consumption behavior are being restructured to prepare for a transition toward a low-carbon and environmentally healthy economy. Also, energy efficiency in the transportation and logistic sectors are being enhanced in order to reduce greenhouse gas emissions. Eco-cities are developed that emphasize urban planning and integration of cultural, social and ecological factors.

- Upgrade the ability to adapt to climate change: This is achieved by enhancing knowledge and management tools to handle and respond to challenges from climate change. Empowering the communities to prepare and cope with climate changes is enhanced.
- Ensure preparedness to respond to natural disasters: Maps and priority lists of risk areas are documented at the national, regional and provincial levels. Disaster management efficiency are being improved while database systems and telecommunication networks are developed. The development of science and technology in disaster management is vital for preparedness in natural disasters.
- Foster resilience toward trade measures associated with environmental conditions and climate change impacts: Surveillance and monitoring measures that are related to environmental conservation and that may have effects on international trade and investment are imposed. Conduct of research on the effects of environmental threats and develop strategic plans together with alleviating measures for relevant products and businesses are carried out. Firms are encouraged to consider the carbon footprint for export goods, together with provisions for incentives for new industries that will create an environment for sustainable development.
- Enhance the role of the country in international arenas as it relates to environmental framework agreements and international commitments: International agreements are studied to thoroughly understood and to monitor the status of negotiations and the positions in international arenas. The capacity of the government officials with negotiation skills and techniques are also strengthened. Moreover, cooperation within ASEAN and with major trading partners are being enhanced. The implementation of international agreements and commitments on natural resources and environment is supported.
- Control and reduce pollution: There are a number of initiatives to improve the efficiency of solid waste disposal and community waste water treatment. In addition, the management system for hazardous, electronic and infected wastes, and the development of warning systems and responses for toxic accidents are also established.
- Enhance the natural resource and environmental management system to be more efficient, transparent and equitable: Policy advocacy are geared towards empowering communities and to advocate their rights to gain access to and utilize natural resources. Amendments to legislation are made to address inequality among communities regarding access to and utilization of natural resources. Changes in government investment policies to facilitate conservation and restoration are imposed. An environmental tax is collected to provide incentives for efficient use of natural resources and pollution reduction. Ways and means to generate revenue from biodiversity are being explored. Databases, monitoring and evaluation systems are developed. Research support is given to establish an efficient management system for natural resources and the environment.

Policy Implementation Strategies

Action, knowledge, technology, innovation and creativity are major tools in driving development plans at all levels and in all segments of the society. Together with this, all development partners have collaborated through the cluster approach, and becomes responsive to problem solving and area development. Implementation guidelines are as follows:

- Promoting awareness among development partners of their roles in collaboration with the development process: Communication is emphasized to create common understanding and commitment among partners, including the political community.
- Collaborating on the Eleventh Plan with government policies, the Government Administrative Plan and other plans: Significant development issues in the plan are incorporated or integrated into government policies, the government administrative plan, specific plans and operational plans. Along this line, the Eleventh Plan is closely linked to the budget allocation strategy and the annual budget plan. Furthermore, it is also linked to development issues and guidelines addressed in the Eleventh Plan with community plans, local administrative plans, provincial plans and provincial cluster plans. The provinces are also encouraged to take major development issues and guidelines into account, in particular in their investment plans.
- Providing an enabling environment to enhance stakeholders' capacity: To increase overall productivity and improve the quality of life, research and development becomes an important tool for driving the country's development. Implementation of appropriate rules and regulations facilitate better management of the plan. In addition, information technology are used to assist communication and develop database management in order to encourage public participation in the development process
- Enhancing efficiency of development mechanisms to improve effective plan implementation at local, regional and national levels for better management: National committees and agencies are encouraged to integrate the plan's development issues and guidelines into their agendas. Provincial organizations serve to link, coordinate and act as clearing houses for top-down and bottom-up development issues for the private sector and for other agencies that collaborate in the implementation process
- Strengthening the stakeholders' capacity to contribute efficiently to the development agenda at every level: The potential capacity of all stakeholders are developed so they may take part effectively in the development process. The communities and local authority are empowered to strengthen their responsiveness and adaptability toward any changes. Academic institutions also play key roles in working with the community, local government, and provincial authorities and the role of the private sector has been enhanced for economic and social development.
- Developing efficient, transparent and participatory systems of monitoring and evaluation at all levels: To allow for the effective adjustment of the development process of the plan, continuous monitoring and evaluation are focused on objectives and targets set in both the overall and individual development strategies of the plan. Monitoring and evaluation systems are developed to measure the overall results of the plan as well as area based development issues. The Thai citizens are encouraged to participate in the public agenda, with emphasis on efficiency and transparency. Databases at provincial and local levels are also developed and linked with central databases and any others that are relevant.

Specific Focus

The specific focus of the Ministry of Agriculture and Cooperatives (MOAC) in 2015 emphasizes on finding a solution to alleviate farmer's hardships in four areas; i) price of agricultural commodities, ii) drought and income subsidies, iii) prevention of insurgency, iv) strengthening of the agricultural sector

To address these four areas, six Strategic Thrusts (ST) are being implemented:

Strategic Thrust 1: Production restructuring and development for rice, rubber and livestock

Strategic Thrust 2: Strengthening the agri-business capacity of cooperatives

Strategic Thrust 3: Strengthening the soil, water and land resources management efficiency

Strategic Thrust 4: Providing sustainable solutions to farmers' problems

Strategic Thrust 5: Enhance private sector's participation in the quality certification for agricultural commodities

Strategic Thrust 6: Alignment of the MOAC and farmers to the Digital Economy through Smart Office, E-Commerce, Electronic Network, and Electronic Platform

Priorities for Agricultural Research and Innovations for Development (ARI4D)

The MOAC set a vision for agricultural research innovations for development (ARI4D) 2015 into four strategic areas:

- Support the ASEAN and global market changes
- Adapt and mitigate climate change
- Solve the problem of labour shortage
- Build innovations in value adding of agricultural commodities into commercial level

Targets

The five-year Strategic Plan of Action (SPA) of the MOAC revolves around specific targets among others are:

- Growth in agricultural productivity
- Rural poverty reduction
- Food supply and nutrition through better access to food
- Economic sustainability
- A favorable environment for foreign and domestic investment and the growth of agribusiness
- Infrastructure development : Roads, irrigation and telecoms
- Agriculture research
- Rural education
- Provision of agricultural credits through institutional innovations
- Transition to a diversified rural economy

Institutional Roles, Responsibilities and Partnerships

The agencies under the MOAC are as follows:

Administration

- Office of the Minister
- Office of the Permanent Secretary for Agriculture and Cooperatives
- Kasetradhikarn Institute
- Bureau of Royal Rainmaking & Agricultural Aviation

Dependent departments

- Department of Agricultural Extension
- Agricultural Land Reform Office
- Department of Agriculture
- Rubber Research Institute
- National Bureau of Agricultural Commodity and Food Standards
- Office of Agricultural Economics
- Cooperative Auditing Department
- Cooperative Promotion Department
- Department of Fisheries
- Land Development Department
- Department of Livestock Development
- The Royal Irrigation Department
- Rice Department
- The Queen Sirikit Department of Sericulture

State Enterprises

- Dairy Farming Promotion Organization
- Fish Marketing Organization
- The Marketing Organization for Farmers
- Rubber Estate Organization
- Office of Rubber Replanting Aid Fund

Public Organizations

- Agricultural Research Development Agency
- Highland Research and Development Institute
- The Golden Jubilee Agricultural Museum

To enhance economic competitiveness and social well-being, the government has set-up the Thailand Research Organization Network (TRON) to systematically help identify, manage, and

ensure coordination among the research agencies on various research programmes. The network consists of seven research agencies:

- National Science and Technology Development Agency (NSTDA)
- Thailand Research Fund (TRF)
- National Science Technology and Innovation Policy Office (STI)
- Health Systems Research Institute (HSRI)
- Agriculture Research Development Agency (ARDA)
- Office of the Higher Education Commission (OHEC)
- National Research Council of Thailand (NRCT).

Infrastructure and Financial Investments

Investments in infrastructure development that drive agricultural progress could be classified into physical infrastructure, agricultural research and technology infrastructures, institutional infrastructures, and farmer's infrastructures.

- **Physical Infrastructures:** Roads, irrigation, energy, telecommunication, transportation, water supply and sanitation
- **Agricultural research and technology transfer infrastructures:** Agricultural research and development agencies, research center and stations, learning centers, demonstration centers, laboratories, etc.
- **Institutional infrastructures:** Market, bank, community based organizations, etc.
- **Farmer's infrastructures:** Health, technology transfer centers, micro-finance and credits, cooperatives, etc.

Major Challenges and Opportunities

Major challenges: Major challenges confronting the agricultural sector are the global changes and internal changes.

Global changes

- Changes in global rules and regulations have influenced the direction of future development
- A multi-polar economy in the new world order is increasingly important in shaping development
- Many countries are moving toward an ageing society
- Global warming effects climate change throughout the world
- The worldwide security of food and energy is under intense threat
- The vital role of advanced technologies in economic and social development, and human life

Internal changes

- Economic aspect
- Social aspect
- Natural resources and the environment
- Administrative aspect

Opportunities

- Thailand is a constitutional monarchy: The Thai monarchy is considered the heart and soul of the nation. His Majesty the King Bhumibol Adulyadej is a role model for living under the Philosophy of Sufficiency Economy. His life reflects the middle path toward sufficiency. His work holds benefits for all Thais.
- Strong policy advocacy on the development on knowledge, technology and innovation: Research and the development of science and technology are major driving forces of the country's progress. They have redirected the production system from dependence on natural resources, capital and low productivity labor to knowledge, science and technology with high productivity.
- Thai society maintains high values and culture: These factors contribute to social cohesion in Thai society and reduce the negative influences of modernization and conflicts. Thai people have applied the sufficiency economy philosophy to their daily lives, and their families have raised younger generations to recognize Thai values and identity.
- Agriculture is the main source of income and food security: It generates multi-functional benefits, such as, it is the source of job creation and food security, preserves the traditional way of life, alleviates poverty and reduces the effects of global warming.
- The local community is an effective mechanism for management and participation in developing a good quality of life and it links the society together for the welfare of all: It is the main force for developing and preserving the country's foundation. Self-reliant communities would lessen local economic, social, natural resource and environmental problems.

Looking Ahead (short-medium-term)

In drawing up the road map for agricultural development in Thailand, the situations and risks arising from domestic and global changes must be assessed and critically analyzed. Rapid fluctuations and their impacts regarding the economic and energy sectors and climate change have both positive and negative effects on the country's development. Thus the direction by which development is administered, which adheres to the sufficiency economy philosophy of His Majesty the King is to optimize benefits from the country's strengths and their potential for long term sustainability.

To strengthen and stabilize the domestic economy, the agricultural base and small medium enterprises (SMEs) will play key roles in the process. Moreover, Thailand would increase its connectivity to regional and global economies. The country has to be more proactive with respect to the ASEAN Economy Community (AEC) in 2015. Thailand would also comply

with its commitments under various cooperation frameworks and strengthen its resilience through development of its economic and social capital. Improvement along the infrastructure and logistic systems have to be further developed in accordance with the quality of human resources. The future of country development will comprise of knowledge, science, technology, innovation and creativity.

Development initiatives in Thailand would also progress towards balance and sustainability by strengthening and utilizing its capital endowment, through the following:

- Empowerment of social capital i.e. human, social and cultural toward a quality society. Resilience must be created at individual, family and community levels. Individuals should be able to adapt themselves to changes and have the opportunity to access resources and gain a fair share of benefits from development.
- Strengthening of economic capital, in both physical and financial aspects, by establishing a strong domestic economy through the application of wisdom, science, technology and creativity. Production that is environmentally beneficial and cooperation in regions are emphasized.
- Restoration of natural resource and environmental capital is focused on community, natural resource and environmental security as well as a low-carbon economy that is environmentally friendly. National preparedness is designed to cope with effects from climate change and natural disasters. Thailand therefore would play a greater role and participation in global forums related to climate change and trade and meeting environmental obligations.

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23. Country Status Report: Vietnam

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Basic Information

Name of the Country : Vietnam

Reporting Agency : VAAS

Value of GDP

Table 1. Gross domestic product at current prices by economic sector (*) from 2012-2014 (Bill. dong)

Year	Total	Economic sectors			
		Agriculture, forestry and fishing	Industry and construction	Service	Products taxes subsidies on production
2012	3245419	623815	1089091	1209464	323049
2013	3584262	643862	1189618	1388407	362375
2014	3937856	696969	1307935	1537197	395755

Source: GSO 2014

(*)Value added of economic sectors is calculated at basic prices

Table 2. Structure of GDP at current prices by economic sector from 2012-2014 (%)

Year	Total	Economic sectors (%)			
		Agriculture, forestry and fishing	Industry and construction	Service	Products taxes subsidies on production
2012	100	19.22	33.56	37.27	9.95
2013	100	17.96	33.19	38.74	10.11
2014	100	17.77	33.21	39.04	10.05

Source: GSO 2014

Vietnam has 90 million of population with annual growth rate of about 1.08 per cent, lower than average of ASEAN. The population living in urban areas accounted for 33.1 per cent; the population living in rural areas reached to 66.9 per cent. Vietnam is still an agricultural country with over 57 per cent population engaged as agricultural labour. By 2012, the proportion of Vietnam agriculture sector accounted for about 18 per cent of the total GDP. However, compared with the growth rate of the industrial and the service sectors, the agriculture sector is still left behind especially when the two remaining sectors have the average growth increase at 10.1 per cent/year and 6.5 per cent/year.

In 2010, investment in the agricultural sector accounted for 6.9 per cent of the total expenditure from the state budget, equivalent to 11 per cent of the total value of agricultural production. While the agricultural sector contributes 20.9 per cent of GDP, investment in the agricultural sector accounted for only 2.85 per cent of GDP. Vietnam's budget for agricultural sector investment is 11 per cent equivalent to 1.4 per cent of GDP, lower than the average of China, India, and Thailand, which are from eight to 16 per cent and those of other Southeast Asian countries, which range from eight to nine per cent. Until 2012, it is estimated that social investment rate for the agriculture sector decreases and just accounts for about 5.25 per cent of the total economic sector (GSO & MARD, 2012).

Total gross domestic products (GDP) in 2014 estimated an increase of 5.98 per cent compared with 2013. This growth rate was 5.42 per cent in 2013. This showed the trend of positive sign in the economy. In the growth rate for 5.98 per cent of the total economic sector of which agriculture, forestry and fisheries sectors accounted for about 3.49 per cent were higher than in 2013, contributed to 0.61 per cent of general growth rate; industrial and service sectors increased to 7.14 per cent and 5.96 per cent and were higher compared with the previous years.

Table 3. The growth rate of GDP from 2012- 2014

Items	The growth rate of GDP (previous year = 100) (%)			Contribution to the growth rate of sector in 2014 (percentage point)
	2012	2013	2014	
Agricultural, forestry, fisheries	2,68	2,64	3,49	0,61
Industry and construction	5,75	5,43	7,14	2,75
Services	5,90	6,57	5,96	2,62
Total	5,25	5,42	5,98	5,98

Source: GSO 2014

Value of agriculture, forestry and fisheries productions in 2014 estimated was estimated at Viet Nam Dollar (VND) 830 trillion, increased to 3.9 per cent compared with in 2013. Agriculture sector reached to VND 617.5 trillion, increased for 2.9 per cent; forestry sector accounted for 7.1 per cent; aquatic products reached to 6.8 per cent.

In recent years, agriculture, forestry and fisheries sectors are played very important role in resolving national economic, social problems. However, agricultural growth is mainly developed

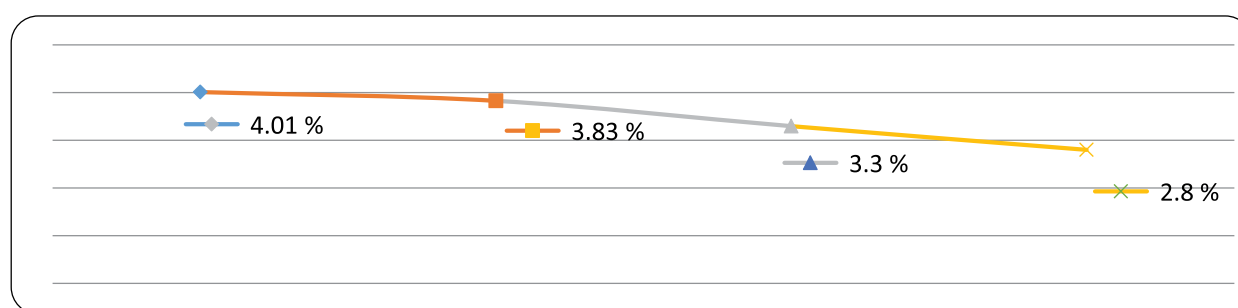


Figure 1. Agricultural GDP growth in the period 1995-2013 Source: GSO & MARD 2013

through increased cultivate surface, raised seasons based on the intensity of the input materials of production (labour, capital, chemicals input). This explains that agricultural GDP growth have reduced in the period growth of stage due to limited agricultural production resources, the competitiveness of industry and construction sectors in the use of land, water and reducing value due to low price.

Current Policies

In recent years, Viet Nam has introduced policies to develop research and development activities in agriculture that are consistent with the goal of modernizing the sector. At the VIIth Conference of Central Party Committee (CPC) No. 10, the Central Committee issued Resolution No. 26/2008/NQ-TW on agriculture, farmers and rural areas dated 5 August 2008, commonly referred to as the Tam Nong resolution. This is the CPV's current orienting document for agriculture, rural development and farmer livelihoods. It states that development in all three areas will be based on the market economy with socialist orientation. Both general and specific objectives to be attained by 2020 are laid out, including the following principal goals:

- To build up a comprehensively developed agriculture sector in a modern and stable manner with large-scale commodity production, high yield, good quality, better efficiency, high competitiveness, along with the development of industry and services in rural areas, to ensure food security
- To build up new rural areas with modern socioeconomic infrastructure; rational economic structure and production organizations, linking agriculture with the rapid industrial, service and urban development based on planning; stable rural society rich in traditional culture; enhancing the intellectual level and protecting the ecological environment
- To improve spiritual and physical life of rural residents; farmers are trained and act as the leaders in the rural community

Alongside Tam Nong, and prompted by the sharp rise in international food prices during 2007-09, Resolution No. 63/2009/NQ-CP to ensure national food security was issued on 23 December 2009. The objectives of the Resolution include: ensuring adequate food supply sources for immediate- and long-term national food security, meeting nutrition needs and putting an end to food shortage and hunger; improving food consumption structure and quality and stepping up intensive rice farming; and ensuring that rice producers earn higher profits. To meet these objectives, specific production targets for 2020 are set for a variety of products, such as protecting 3.8 million hectares of rice land to yield 41-43 million tons of rice, covering all domestic demand along with exporting about four million tons of rice per year¹. The achievement of these targets will be done through food production planning and rice land planning; infrastructure, scientific and technological development including construction of irrigation works and new dyke systems, construction of warehouses for food reserve and preservation, selection, creation and production of adequate plant varieties and animal breeds of high yield and quality, etc.; human resource training; consolidation of food

¹The other specific production targets are: increasing corn acreage to 1.3 million hectare and the quantity of corn up to 7.5 million tons; ensuring fruit trees planted area of 1.2 million hectare to yield 12 million tons of fruits; 1.2 million hectare of vegetables to yield 20 million tons of vegetable, producing eight million tons livestock meat; one million tons of fresh milk, 14 billion units of poultry's eggs

circulation and export system; renovation of the organization of food production forms; etc. In addition, it provides important measures to reduce production costs, increase incomes for rice farmer, ensuring the profit from rice production of over 30 per cent compared to the cost of production (Tran and Dinh, 2014a).

The overall goals for agricultural policy as set out in the Ministry of Agriculture and Rural Development (MARD) plan for the five years 2011-15 are to achieve sustainable development with high quality output; improve the living standard of people living in rural areas, especially the poor; and protect and effectively utilize natural resources and the environment. These high-level goals are refined into six key objectives, with specific targets and various actions and programmes for each objective.

- Achieve sustainable, high quality growth of the sector with improvement in productivity, quality and competitiveness of products
- Improve living standards and conditions of population living in rural areas, especially the poor
- Develop infrastructure to meet requirement of the agricultural production and serve people living in rural area
- Strengthen competitive capacity and international integration of the sector
- Use and protect natural resources and the environment in a sustainable and efficient manner
- Improve the government's managerial capacity of the sector in an efficient and effective manner

As a further move towards implementing Resolution No. 26, Decision No. 899/2013/QĐ-TTg approving the plan of restructuring the agricultural sector (often referenced to as Agricultural Restructuring Plan, ARP) towards improving value-added and sustainable development was issued on 10 June 2013. The long-term objectives for agriculture will be reflected in three sustainable pillars:

- **Economic:** maintain robust agricultural growth and improve sectorial competitiveness, primarily via advances in productivity, efficiency, and value addition, and better meet the needs and preferences of consumers
- **Social:** continue to raise farmer incomes and rural living standards, reduce the incidence and severity of rural poverty, and ensure household and national food and nutrition security
- **Environmental:** improve natural resources management, reduce impacts, contribute to get environmental benefits and improve capacities to manage weather-related and other natural hazards in the context of Vietnam

Within the framework of overall agriculture restructuring, the MARD and other official agencies at different levels have actively implemented restructuring plan and has achieved some initial results. MARD has issued related policies as follows: The action plan for implementation of the restructuring crops productions in the period of 2014-2015 and 2016-2020 period (Decision No. 1006/QĐ-BNN-TT dated 05.13.2014); The irrigation restructuring plan (Decision No. 794/QĐ-BNN-TCTL dated 21.04.2014) and the programme of implementation of the scheme to restructure the irrigation sector (Decision No. 802/QĐ BNN-TCTL dated 22.04.2014); The

plan of innovation of economic organization of agricultural cooperatives (Decision No. 710/QD-BNN-KTHT dated 10.04.2013).

In the restructuring agricultural sectors agenda, research/extension and science technology play a crucial role. The plan to promote the research and application of science and technology for agricultural restructuring (Decision No. 986/QD-BNN-dated 05.09.2014 of Science and Technology).

In order to facilitate the transformation and restructuring of agriculture in general and crop production, many policies have been implemented, including Decision No. 62/2013/QD-TTg dated 25 October, 2013 by the Prime Minister on policies to encourage collaborative development, linkages between production and the consumption of agricultural products and built large field, Decision No. 68/2013/QD-TTg dated 14/11/2013 of the Prime Minister on policy support to reduce losses in agriculture, the Decree No. 210/2013/ND-CP on policies to support enterprises to invest in agricultural and rural development, the Decision No. 580/QD-TTg dated 22 April, 2014 on policies on shifting from paddy to other crops cultivation in the Mekong Delta, the Decision No 01/2012/QD-TTg on 9 January, 2012 on policies supporting the adoption of Viet Gap in agriculture, forestry and fisheries.

Strategy

In December 2012, MARD set in place a strategy for the development of science and technology for agriculture and rural development over the period 2013-20². The strategy states that agriculture development is directed towards comprehensive, modern and sustainable growth with large-scale commodity production; rural development is associated with industrialization and urbanization, significantly increasing incomes and improving the living conditions of rural population, as well as protecting the environment. As for the agriculture sector, the strategy identifies the direction towards modern, efficient and sustainable development within the related productive subsectors. The programme of activities to support these strategies was approved in 2013 including research and development of staple crops, livestock husbandry and animal health, agricultural engineering and post-harvest technology, irrigation technology and research of policies on agriculture and rural development.³

Within agriculture: Ensure national food security; increase productivity, quality and competitiveness to increase added-value and exports; raise incomes and living standards of farmers. Enhance the application of modern sciences and technologies in production, processing and storage; use biotechnology to develop new crop and animal varieties and expand production processes and meet the standards of hygiene and food safety.

For crop sector: Develop large-scale commodity production; encourage the process of land concentration, develop commercial farms and agricultural enterprises specifically for each region.

For livestock sector: Promote industrial and semi-industrial productions, ensure quality and disease control.

²Decision No. 3246/QD-BNN-KHCN dated 27 December 2012, which was based on Decision No. 418/QD-TTg dated 4 November 2012 that set the overall strategy of science and technology in Viet Nam for the period of 2011-20

³Decision No. 1259/QD-BNN-KHCN dated 4 June 2013

For forestry sector: Develop appropriate land-use plan and strategies for productive, protective and special forests. The state invests and formulates comprehensive policies to manage and develop protective and special forests as well as ensuring decent livelihoods for forest farmers. Encourage organizations and individuals from all economic components to invest in productive forests; integrate forest production with processing industry from planning and investment proposals; mobilize revenues for forest production to develop forests and improve people's income.

For fisheries and aquaculture sector: Develop offshore fisheries together with ensuring national security and marine environment protection. Plan aquaculture development by focusing on products with competitiveness and high value. Build up a complete infrastructure in farming areas. Upgrade the fishery sector of Vietnam to the advanced level in the region.

For rural development: Undertake planning for rural development in association with urban development and the distribution of residential areas. Develop industry, services and handicraft villages in association with environmental protection. Develop and consolidate new rural villages with characteristics appropriate to each region; preserve and promote the indigenous and local culture of the Vietnam countryside. Promote the construction of rural infrastructure. Create a favourable environment to attract investment into agriculture and the rural sector, especially from labour-intensive small and medium enterprises. Implement effectively vocational training programmes for one million rural workers per year.

Priorities for Agricultural Research and Innovations for Development (ARI4D)

As for the whole agriculture sector, investment priorities should focus on rice, industrial crops, livestock and fisheries to promote the growth of the agriculture sector to the highest level. The priority of investments should focus on the following regions:

- Mekong Delta: rice, animal husbandry and fisheries
- Central Highlands: Perennial crops and food crops (beyond rice)
- Southeast: Perennial crops and food crops (beyond rice)
- Red River Delta: rice, livestock and fisheries

The priorities for agricultural research on the above regions have mainly focused on research on seeds, crops and livestock. In order to enhance the research capacity of the system, selection, delivery, manufacture and supply of plant varieties and animal breeds, plant varieties forestry, aquatic breeding towards industrialization and modernization, to increase productivity, quality, competitiveness and efficiency of agricultural production, forestry, fisheries and farmers' income in a sustainable way. Schemes under the decisions offering specific solutions for i) improvement of the system of planning research, production and seed supply from the central to the grassroots levels associated with the production of agriculture, forestry, fisheries, ii) investment in research on seed, iii) the credit support, iv) the state- owned commercial banks to create favorable conditions for organizations and individuals borrowing money to invest in production, and seed processing.

The main ongoing national research programmes are focusing on:

Seed improvement: important investments on the main staple food crops seed and livestock breeds.

Agricultural biotechnology: The commercialization of agricultural biotechnology has been a goal of the government for many years and is an integral part of the restructuring agenda that seeks to increase the utilisation of high technologies in agriculture and reduce the country's dependence on maize imports. All of the necessary regulations required for commercializing agricultural biotechnology were completed in early 2014.

National value chain for rice, coffee, mushroom: the research will be reorganized along each value chain including: seed selection, breeding, cultivation, post-harvest, value chain management, marketing, branding.

The national rice trademark: the national project will focus on the creating a national certification trademark for Vietnam rice in order to support the different Vietnam quality rice in international market with a clear standard set for rice quality.

Beside the conventional domain for research the frontier area of research like applying nanotechnology for fertilizers, applying Geographic information service (GIS) and ICT on agricultural management were also interested by government. The Innovative Technology Applying Fund managed by MOST finances for these applied research theme.

The value chain management, farmer organization management, agro-ecological farming practices will be crucial for Vietnam for enhancing competitiveness. This field of research is still under invested from government and need to be promoted in the future.

Targets

The targets of agricultural development have concentrated in restructuring agricultural sector. The objective of crop development policies is improving the efficiency of the crop business production to ensure certainly national food security, create jobs and increase income for crop production farmers, protect ecological environment and sustainable development.

The strategy sets specific targets of developing science and technology in agriculture and rural development to actually become a key driving force for the industrialization and modernization of agriculture and rural development; contributing 40 per cent to the value-added agriculture in 2015 and 50 per cent in 2020; high technology products of will represents 15 per cent of the agricultural product value in 2015 and 35 per cent by 2020.

Based on action plan and development strategies, the agricultural restructuring plan has specific objectives as follows:

- Sustain the growth, raise the efficiency and competitiveness by increasing productivity, quality, and added values; satisfying the demands of consumers in Vietnam and boosting exports. The growth of GDP of agriculture reaches 2.6-3 per cent during 2011-2015, and 3.5-4 per cent during 2016-2020.

- Improve income and living standards of rural residents, ensure food security (including nutrition security) in both the short term and the long term basis, and contribute to the reduction of poverty ratio. By 2020, income of rural households will increase by 2.5 times in comparison to 2008; 20 per cent of the communes meet the standards of new rural areas by 2015, and 50 per cent of communes will meet such standards by 2020.
- Enhance natural resource management, reduce greenhouse gas emission and negative impacts on the environment, utilize environmental benefits, raise capacity for risk management, enhance disaster preparedness, increase forest coverage to 42-43 per cent by 2015, and 45 per cent by 2020; contribute to the National Green Development Strategy.

Institutional Roles, Responsibilities and Partnerships

MARD has established a steering committee to assist the Minister to monitor the agricultural restructuring plan and different committees on sub-sectors restructuring including steering committee on coffee replanting; steering committee on sustainable development, steering committee on fruit production development in the southern region of the country, steering committee on tea sustainable development; steering committee restructuring paddy crops on land in the Mekong Delta; steering committee on VietGAP application in crop production, and steering committee on rice restructuring.

At the provincial level, many local governments have approved projects and plans to restructure the local agricultural sector, including crop production; some provinces have formed their own Steering Committees or working groups on agricultural restructuring.

Additionally, the state's role should strengthen in the linkages for agricultural production and general and detailed planning over the region, encourage the production of planned varieties, and modify the export policy which is too obsolete compared with other nations (criteria for production quality for export).

Infrastructure and Financial Investments

The impressive increases in agriculture production since the mid-1980s have been supported by national research efforts that have resulted in scientific solutions to help improve agricultural production. Research has contributed to the introduction of new plant breeds, diversification of crops, and improved pest and disease management (JICA, 2012).

Prior to 2005, there were 30 different agencies (28 research institutes and two universities) within MARD with separate research budgets. In order to achieve greater coordination these institutes were merged and reorganized into 16 agencies, including 12 research institutes and 4 universities since 2006. The Vietnam Academy of Agricultural Sciences (VAAS) was the biggest research institute under MARD. Since then the member institutes of VAAS has been expanded to 18 member institutes.

In total, the agricultural sector research has 10,895 staffs, including 600 Ph.D. and 1,800 Master degree holders. According to Organization for Economic Cooperation and Development (OECD) and World Bank (WB) innovation assessment in Vietnam (2014), the share of researcher per

millions population is more than 100 persons, lower than Thailand with 300 persons and Malaysia with 350 persons. The number of researcher working in Vietnam Agricultural sector represents about 15 per cent of total in the country.

The three-fold purpose of VAAS is to provide a comprehensive vision, strategic direction and oversight of agriculture research and development programmes; to conduct basic and applied research and foster the transfer of new technologies; and to provide post-graduate and professional training. In terms of research strategies, VAAS is focusing on the following eleven areas: develop basic research approaches that conserve and effectively utilize plant and animal genetic and other agricultural resources; efficiently apply agricultural biotechnology; select and develop animal breeds and crop varieties with high productivity, good quality, high resistance to biotic and abiotic stresses; implement Integrated Crop Management, Good Agricultural Practice and Hi-tech production technologies for the major cropping systems; ensure appropriate solutions to meet society's demand for food safety and food security; reduce postharvest losses; effectively use natural resources - soil, water and biodiversity; improve the agricultural environment; study on mitigation and adaptation to climate change; develop suitable agrarian systems based on integrated socio-economic approaches, household farming production, and appropriate policies; and study rural development.

Government funding for agricultural research is provided through MARD, MOST and provincial governments. Between 2000 and 2012, government expenditure on agricultural research increased from VND 153 billion (USD 10 million) to VND 822 billion (USD 40 million), an annual average increase of 11 per cent per annum in USD terms. Despite the impressive increase, funding as a percentage of GDP remains relatively low at around 0.03 per cent of GDP. In period 2008-2014, the governmental investment for research in MARD is 2,643 billion of vnd, represent 13 per cent of total national research funding from government. According to OECD and WB (2014), the share of investment for research by business sector and higher education is still small about 32 per cent. The limited funding means that much of the research has not met the practical requirements of farmers, business and science. Further, the rigid application of common policies and technologies across the country without considering local circumstances has wasted financial and human resources and discouraged product diversification. Finally, the lack of autonomy for and within research institutes does not create incentives for scientific research personnel, leading to a serious brain drain of agricultural scientists in Vietnam (OECD, 2015).

In order to boost the dynamic in the research system for attracting more research investment from society, the research institute start to be transformed to self-financing institute and more independent vis a vis government budget since 2013.

Major Challenges and Opportunities

Despite great achievements, agriculture sector is facing serious difficulties and challenges:

There is inconsistency in the awareness of the need to restructure agriculture in general and in particular in the area of cultivation of local officials. The cultivation restructuring in some cases is hindered by backward thinking in favor of quantity production, waste of land resources, water, substance abuse; lack of international integration, less concerned with the sustainability of

economic, social, environment. Some provinces have not mastered the local purpose, direction, content and measures of restructuring so they become confused in building projects, planning and implementing organizational restructuring.

The investments are limited both in public and private terms; funds for restructuring plans do not meet the requirements, especially funds for upgrading the infrastructure for production, such as transportation, irrigation. Lacking of stable market is among the big obstacles to conversion, scaling-up production; building successful models that are difficult to replicate the large production; The agricultural sector lacks science and technology breakthroughs (new varieties, new technological advances), technologies have not met the requirements of production and cannot improve the competitiveness of agricultural products.

Agricultural production causes adverse environmental effects, imbalance and depletion of natural resources (soil, groundwater, surface water, minerals, biodiversity, etc.). Weaknesses in the management of water resources and agricultural residues also cause increasing pollution and greenhouse gas emissions.

Applying technology science does not meet requirements for quality of agricultural products; although technology sciences have contributed to increase crop yields and livestock, the quality and commodity value have limited. Investment of technology science still focused on production stages, no paid attention to the market orientation, therefore, the quality of agricultural products does not to meet the needs of consumers.

For example, the result in recent years showed a raised crop yield but reduced export value for agricultural products (Table 4 & 5):

Table 4. Export price of major agricultural products

Agricultural products	2011	2012	2013
Rice	514	461 (- 10.3% vs 2011)	410 (- 11.1% vs 2012)
Rubber	3,954	2,792 (- 29.4% vs 2011)	2,356 (- 15.6% vs 2012)
Coffee	2,047	2,122 (+ 3.7% vs 2011)	1,500 (- 29.3% vs 2012)

Sources: MARD & MOIT, 2013

Table 5. Rice production in Vietnam

Indicators	2010	2011	2012	2013	2013/2010	2013/2012
Area (ha)	7.489	7.651	7.761	7.9	411	139
Production (ton/ha)	5.34	5.53	5.64	5.58	0.24	-0.06
Yield (1,000 t)	40.005	42.324	43.738	44.076	4.071	338
Export (1000 t)	6.886	7.087	8.016	6.766	-120	-1.25
Value (Million USD)	3.248	3.643	3.673	2.986	-292	-687
Price (USD/ton)	471.7	514	458.2	441.3	-30,4	-16,9

Source: MARD, 2011, 2012, 2013

For export groups in 2014, agricultural and forest products estimated at VND 17.8 billion, increased to 11.4 per cent accounted for 11.9 per cent. Although rice production and yield raised to 5.76 ton per hectare, export values were reduced to 27.7 per cent of rice products and 12.63 per cent of rubber products (MARD 2014).

Looking Ahead (short to medium-term)

The restructuring plan in Vietnam is viewed as a major turning point in agricultural policy. It signals an important change in emphasis from extensive development based on quantity to one focused on quality and efficiency improvement. It also identifies a changing role for the government from service provider to facilitator. Based on the perspective that sector restructuring should be in line with the overall national process of adopting the market mechanism and guaranteeing fundamental benefits for farmers and consumers, the state will play a supportive role in order to enable a favourable environment for the activities of social and economic sectors from central to local levels, promote public-private partnerships (PPP) and co-management mechanisms, and enhance the role of community organizations (FAO, 2013).

Some main actions which need to be prioritized for execution by agencies under MARD for restructuring the crop production sector by 2020 reflected in the overall plan for restructuring crop production sector are as follows:

- Reviewing master plans, restructuring public investment and building mechanism for monitoring the implementation of master plans
- Reorganization of production according to value chain and market development
- Enhancing scientific and technological research and agricultural extension
- Reform in institutions and organizations and developing human resources
- Upgrading infrastructure for developing the crop production sector
- Strengthening state management in crop production and completion of relevant policies and documents
- Renewal of plant protection activities
- Promoting international cooperation
- Disseminating, propagating, the implementation of the action plan for restructuring the crop production sector

The investment in agricultural research and extension is key strategy of Vietnam agricultural development to 2030. The national research programme is focusing in the conventional research domain like breeding, biotechnology. The investment was less in managerial sciences like value chain management, farmer organization, added value, marketing and branding. This requires more international cooperation with APAARI members in the future.

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