Strategy Paper

Need for Linking Research with Extension for Accelerated Agricultural Growth in Asia

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Executive Secretary, APAARI and Chairman, TAAS

Asia-Pacific Association of Agricultural Research Institutions (APAARI)

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Asia-Pacific Association of Agricultural Research Institutions (APAARI)

The Asia-Pacific Association of Agricultural Research Institutions (APAARI), with its headquarters in Bangkok, aims to strengthen the research capabilities of national agricultural research systems in the Asia-Pacific region, and to promote experience sharing among them in order to alleviate poverty, increase agricultural productivity and resource use efficiency, conserve/ protect the environment and improve the overall sustainability. The primary focus of APAARI is to enhance exchange of scientific and technical knowhow and information in agricultural research for development; assist in strengthening research capability of member institutions and promote cross linkages among national, regional and international research organizations. For details, please visit: www.apaari.org

Trust for Advancement of Agricultural Sciences (TAAS)

The Trust for Advancement of Agricultural Sciences (TAAS) was established on 17 October 2002 based on the decision of National Organizing Committee of 88th Session of the Indian Science Congress held at the Indian Agricultural Research Institute (IARI), New Delhi in January 2001 for harnessing the agricultural sciences for the welfare of the people. Its mission is to promote growth and advancement of agriculture through scientific interactions and partnerships. The major objectives are (i) to act as think tank on key policy issues relating to agricultural research for development (ARD), (ii) organizing seminars and special lectures on emerging issues and new development in agriculture sciences in different regions of India, (iii) instituting national awards for the outstanding contributions to Indian agriculture by the scientists of Indian origin, and (iv) facilitating partnerships with non-resident Indian agricultural scientists. The main activities include organizing foundation day lectures, special lectures, brain storming sessions/symposia/seminars/ workshops on important themes, developing strategy papers on key policy matters, promoting farmers' innovations and conferring Dr. M.S. Swaminathan Award for Leadership in Agriculture.

Need for Linking Research with Extension for Accelerated Agricultural Growth in Asia[1]

Dr. Raj Paroda

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The Asia region is rich in natural resources, human capital and indigenous knowledge and much faster progress can be achieved provided innovations are outscaled on farmers' fields for greater impacts. This strategy paper draws your attention towards issues concerning the need for linking research with extension to achieve much faster agricultural growth in Asia.

The Asia region is agriculturally vibrant. With 38 per cent of total agricultural land, it houses 80 per cent small holder farmers supporting 74 per cent of world's agricultural population. The region encompasses 39 countries, including 19 commonwealth members with two world's most populous countries, China (1.3 billion) and India (1.2 billion). With 3.5 billion people, the region accounts for about 58 per cent of the world's population. Agriculture (crops, livestock, fishery, forestry, and the associated natural resources endowments) is the main source of livelihood for nearly 2 billion people. The region is the largest supplier of the world's food and agricultural products. The region has witnessed several innovations in agricultural development. One of the most evident "Green Revolution" was brought out by a science-led synergistic

[1]Based on the address delivered as Chief Guest in the inaugural session of 16th Annual Symposium of the Department of Agriculture (ASDA 2014) at Kandy, Sri Lanka on 25th September, 2014

extension approach capitalizing genetic potential, irrigation, fertilizer, appropriate policies and farmers' hard work. This innovation led to an unprecedented transformation in food security and rural development in the region. Since mid-sixties, the Asian cereal production almost doubled – reaching nearly 1 billion tons, recording an annual growth rate of 3 per cent. The increased agricultural productivity, rapid industrial growth and expansion of the non-formal rural economy resulted in quadrupling per caput GDP, thus almost halving the level of poverty in the region. However, continuing to secure such gains is becoming a major challenge especially in the context of declining factor productivity, deteriorating natural resources, impact of global climate change and above all a fatigue in the existing extension system which is largely in the public sector. Hence, impact of innovations around natural resource management technologies is not all that evident as we noticed in case of miracle wheat and rice seeds during the Green Revolution period in South Asia in mid-sixties and seventies.

A. The Challenges Ahead

(i) Food Demand vs Small Farm Holdings

Food insecurity and poverty, accounting for two-third of the world's hungry and poor, exacerbated by the soaring food and fuel prices, global economic downturn and volatile markets have surfaced as major development related concerns in the region. The problem has further been intensified with sharp rise in the cost of food and energy, depleting water resources, diversion of human capital from agriculture, shrinking farm size, soil degradation, indiscriminate and imbalanced use of chemical inputs and overarching effects of changing climate. The per caput land availability for agriculture in the region (0.3 ha) is almost one-fifth of that in the rest of the world (1.4 ha). The region's agrarian landscape is predominantly smallholder farmers

(~80% of the world's small and marginal farmers). It is estimated that by 2050, the food grain requirement in the Asia region would be around 70 per cent more than the current demand. A low investment in agricultural research for development further complicates the problem. The future dependence on imported fossil fuels raises concern about price volatility and shocks, and supply disruptions in agriculture production. Therefore, ensuring the availability of and economic access to food, in both quantity and quality (nutrition), for the poorest of the poor in the developing countries of the region remains a daunting challenge. In this direction, the **'GCARD Road Map'** developed through interaction of diverse stakeholders from around the world in Monpellier, France in 2010 highlights the urgent changes required in Agricultural Research for Development (AR4D) globally, especially to address the needs of resource-poor smallholder farmers and consumers. It envisages major paradigm shift towards farming system's research with greater thrust on *"Innovations for greater impacts on small holder farmers" requiring partnerships among stakeholders and their capacity building*. In order to meet future food demand and to attain successfully the Millennium Development Goals (MDGs), especially in the context of world leaders meet on "Rio+20", it has been reaffirmed that improving efficiency and resilience of agriculture around the farming systems in developing countries would be the only way to move forward.

(ii) Poverty and Malnourishment

According to FAO, the number of undernourished people in the world has increased during the last decade and the number of hungry for the first time had crossed 1 billion mark. Almost two-third of the world's hungry (642 million) and 67 per cent of the world's poor have their homes in this region. The gains made in the 1980s and early 1990s in reducing chronic hunger have been lost and the hunger reduction

target of 50 per cent by 2015 under MDG now remains unattainable. Despite the fall in international food and fuel prices since late 2008, the prices in domestic markets in Asia have invariably remained 15- 25 per cent higher in real terms than the trend level-resulting in further distress for the poor. Beside poverty, the region is currently home to 70 per cent of the world's undernourished children and women. These numbers have remained stubbornly high and on the contrary, increased lately. During the past one year, the number of hungry specially in South Asia sub-region has increased by 10.5 per cent, thus derailing all the progress that we made after Green Revolution. Lack of economic access, not the physical access, is a major challenge today before the society, especially the policy makers, planners, scientists and those engaged in advisory services in the region.

(iii) Natural Resource Degradation and Climate Change

The ever increasing population growth is interlinked with fast declining and degrading land, water, biodiversity, environment and other natural resources which are 3-5 times more stressed due to population, economic and political pressures in the Asia compared to the rest of the world. The region has already reached the limits of land available for agriculture and hence no further scope exists for horizontal expansion. Inefficient use and mismanagement of production resources, especially land, water, energy and agro-chemicals, has vastly reduced fertility and damaged our soil health. Today, soils are both hungry and thirsty. To a greater extent, lack of political will and appeasement policies to provide free or relatively cheap inputs like seeds, fertilisers, water, energy etc. have further exacerbated the problem.

Moreover, while maintaining a steady pace of development, the region will also have to reduce its environmental footprint from agriculture. The reduction in water availability and

increase in animal and plant diseases will primarily affect poor countries and the small island states that have limited capacity to respond and adapt against such negative impacts. Regrettably, man-made disasters in some countries due to lack of political will and overexploitation of natural resources (like drying of Aral Sea in Uzbekistan due to overuse of water upstream by Central Asian countries) could even exacerbate the miseries of people around.

B. Opportunities to Harness

(i) Genetic Resource Management

Agricultural biodiversity is a key resource for achieving food and nutritional security. The Asia region has rich diversity of fauna and flora including agroforestry species and is the centre of origin of many important crops, livestock and forest tree species. This rich genetic resource serves as a gold mine for specific/unique traits to be harnessed for germplasm improvement, through breeding and biotechnology applications, and develop varieties/breeds possessing high productivity, better nutritional quality, resistance to biotic (diseases and insect pests) and abiotic (drought, frost, flood, salinity) stresses and high adaptation to climatic change variations. In fact, earlier Green Revolution was mainly due to exploitation of dwarfing and photo-insensitive genes in wheat and rice.

Accordingly, germplasm **conservation through use** can significantly help in achieving both sustainable agricultural growth and development in Asia. It is, therefore, necessary that each country builds an effective national agricultural research system (NARS) by involving all stakeholders, and have national action plans to conserve scientifically in the national Gene Banks all their valuable genetic resources for posterity. New science such as biotechnology including GM crops, ICT, nanotechnology, etc. offer ample opportunities to benefit farmers in future.

Fortunately, the new innovations in agricultural science like: single cross maize hybrids, including QPM, hybrid rice, hybrid sorghum, hybrid pearl millet and other crops, Bt Cotton, GM technology in corn, rice, canola, soybean, brinjal, etc. are available which need to be outscaled.

(ii) Innovations in Natural Resource Management

One of the main causes of slow growth in agriculture is relatively poor dissemination of emerging technologies relevant to the needs of smallholder farmers. Innovations in agriculture are needed now to meet the major challenge of increasing resource scarcity and bring in structural transformation in the socioeconomic context so as to reduce cost on inputs on one hand and improve the livelihood of resource poor smallholder farmers on the other. Therefore, in order to liberate the nations from hunger and poverty, while sustaining existing natural resources, the policy makers will have to have a renewed thrust and commitment for additional funding for agricultural research for development (AR4D). Without this, the task of achieving inclusive growth will remain elusive.

Innovations around good agricultural practices such as: conservation agriculture (CA), balanced use of fertilizers, small farm mechanization for resilience, micro-irrigation, integrated pest management, scientific land use for crop diversification, etc. would contribute considerably in arresting natural resource degradation, help in climate change adaptation and mitigation as well as increasing farm productivity and profitability. One such successful example in the region is of conservation agriculture (CA) in the Indo-Gangatic Plains, led by regional NARS (Bangladesh, India, Nepal and Pakistan) and facilitated by CIMMYT, which has led to a cost: benefit ratio of 1:19 (investments of US$ 3.5 million led to an output equivalent of US$ 64 million) through adoption of zero tillage for planting wheat over 2.5 million ha area already. The area under CA could easily be increased by almost four fold (10 million ha) provided concerted efforts are made in a mission

mode approach to outscale this innovation for greater impact. The another successful example of innovation is laser land levelling adopted recently over 2.5 million ha in north-west India, primarily due to custom hire service windows. In Haryana State alone, it has led to saving of 1 billion m^3 of water annually. Similarly, Direct Seeded Rice (DSR) in Basmati varieties has picked up very fast in the last 2-3 years. Replication of such success stories can help farmers greatly in similar ecological situations in other countries without reinventing the wheel provided knowledge is shared through effective extension system without any dissemination loss.

Recently, IFPRI has brought out an interesting publication entitled "Millions Fed", covering around 20 success stories from around the world, half of which are from Asia alone. Similarly, APAARI has also published around 45 success stories from Asia region depicting how developing countries have made much faster progress through outscaling of new innovations. Learning from such successes, many NARS have gained equally well like adoption of hybrid rice in India, the Philippines and Vietnam based on its spectacular progress in China. Similarly, story of baby corn in Thailand has been repeated in India. Success of IPM in rice in Indonesia has also been repeated in many countries. GM cotton technology has also been adopted very fast in China, India and Pakistan.

(iii) Harnessing other Potential Sectors

Horticulture

This region also has huge potential to promote horticulture. Most of the countries in the region have not paid due attention to this sector. We now need to diversify our food basket by producing more of vegetables and fruits. Also, the post-harvest losses happen to be high ranging between 10-30 per cent. This situation needs to be altered through application of processing technology, value addition, cold storage and rapid transportation.

Livestock

Besides crop productivity enhancement, strategies are needed to usher both White and Blue Revolutions in this region. This would need implementation of new production models to enhance contribution from livestock and fishery sectors. Mechanisation and automation of dairy farms, measures to provide good quality feed and fodder, provision of improved seed varieties for fodder crops, value addition of milk and meat products are some of the measures to enhance livestock industry.

Fishery

Fisheries is another potential sector which can help in achieving both food and nutritional security. The inland fish farms with adoption of modern technologies, managed by skilled human resource can make all the difference. The success story of Tilapia fish farming in the Philippines, Sea Bass in Israel, King Prawn in Thailand and India are some bright examples worth emulating. In fact, willingness to adopt new ideas have transformed typical fish farmers and even young professionals in the Philippines, Thailand, India and elsewhere into successful entrepreneurs.

(iv) Strengthening Collaboration and Partnerships

Green Revolution was an outcome of partnership between NARS, International Centers like CIMMYT and IRRI and extension system including progressive farmers. Regional and global networks and partnerships for knowledge sharing and enhanced capacity development of different stakeholders is a must for outscaling innovations in similar ecologies. It has been increasingly realized that under the changing scenario of production to consumption, the linear approach in technology development and deployment will not serve the purpose to address Millennium Development Goals (MDGs). Therefore, for inclusive growth in agriculture through large scale uptake of new technologies, a major paradigm shift in our approach

should be from R&D to AR4D, involving greater participation of all stakeholders. The past experiences from the regional organizations/programs like APAARI, SAARC, ASEAN, Rice-Wheat Consortium (RWC), Cereal Systems Initiative for South Asia (CSISA), etc. reveal that regional partnerships are important to catalyse faster adoption of new technologies mainly through sharing of success stories around good agriculture practices.

The Asia-Pacific Association of Agricultural Research Institutions (APAARI) has been instrumental, since its inception in 1990, in promoting regional cooperation for agricultural research and has organized a series of expert consultations on emerging issues concerning agricultural research for development (AR4D). Some of these had been on: food crisis and biofuel; productivity enhancement; biotechnology and biosafety; post-harvest management; conservation agriculture; climate change; women and youth, etc. From Sri Lanka, CARP had been an active member of APAARI from the very beginning in most of these initiatives. Similar partnership with DOA will prove beneficial in future.

(v) Knowledge Sharing and Capacity Building

APAARI has been supporting a major program known as Asia-Pacific Agricultural Research Information System (APARIS) under which more than 45 success stories from the Region, beside proceedings and recommendations of several expert consultations and workshops have been published and disseminated widely. We need to learn from each other's successes as well as failures to avoid reinventing the wheel and take full advantage of innovations and information that have made significant impact in similar ecologies elsewhere. Details of these success stories can be accessed from APAARI website: www.apaari.org

APAARI has also come out with some important regional declarations relating to AR4D such as: **Tsukuba Declaration**

on Climate Change, Suwon Framework on Agro-biodiversity, Bangkok Declaration on Strengthening Agriculture Research for Development, etc. All these have received considerable attention of policy makers and planners in many countries towards reshaping/reorienting both research and extension agenda for the benefit of resource poor farmers who badly need technical backstopping knowledge

C. Strategy for Linking Research with Extension

I believe our research should be sensitive to local needs and meet the aspirations of both farmers and consumers and there should be closer working relations between research and extension organizations. The scientists involved in basic, strategic, applied and adaptive research, together with subject-matter specialists, extension workers and farmers, should be seen as an integral component of knowledge dissemination and agricultural advisory system. The interface between research and technology transfer is indeed very critical for converting outputs into outcomes. In fact, we need to link "land-to-lab" and "village to institutions". This would require a paradigm shift from "top down" to "bottom up" approach for technology generation, refinement and adoption.

In the present context, the agriculture sector has to be more scientific oriented and technology driven. As stated earlier, almost all problems of contemporary Asia require inter-disciplinary, inter-institutional and regional rather than national solutions. Furthermore, research agenda of the institutions could be better organized for technology development and its dissemination. For agricultural research to make an impact, there must be strong linkages among researchers, extension agencies, farmers and other stakeholders. In all the institutions, the technology transfer programs need to be the integral part of technology development in order to empower farmers with proper knowledge. Hence, farmer participatory research has to be given major focus now.

(i) Indian Extension System– an Example

I will dwell upon efforts made in India for linking research with extension which led to number of agricultural revolutions. Getting research and extension to work hand in hand has been a challenge over the past 50 years. From time to time, several experiments have been made to make extension system vibrant, effective and meaningful.

Agriculture in India is a State Subject. Accordingly, the States follow the Central Government (GOI) schemes launched from time to time. Built on the foundations of the Community Development Program started in 1952, public sector extension followed an evolutionary pathway. Intensive Agriculture District Program 1961-62, Intensive Agriculture Area Program 1964-65, the High Yielding Varieties Program 1966-67 and the Farmers Training and Education Program 1966-67 are some early, but significant developments leading to growth of agricultural extension in India. Undoubtedly, these programs created awareness on and paved way for acceptance and application of GR technologies. These, however, proved ineffective in serving the needs and aspirations of small and marginal farmers. This weakness - inherent in the early technology transfer system during the Green Revolution period - is believed to have widened the gulf between the resource-rich and resource-poor farmers.

In India, the agricultural institutions (ICAR Institutes & SAUs) in collaboration with Department of Agriculture take part in technology generation and its transfer to stakeholders. In sixties, the agriculture production situation was so critical that intensification of agriculture with the use of high yielding varieties became unavoidable. The program such as Integrated Agriculture Development Program (IADP), Intensive Agriculture Area Program (IAAP), National Demonstration (ND) and High Yielding Variety Program (HYVP) gained momentum. The sole purpose of these programs was of increasing crop yields by using modern means of production. This approach

though paid good dividend, generally failed to help especially the poor farm households. The emphasis was broadened from agricultural development to rural development and various programs like Small Farmers Development Agency (SFDA), Marginal Farmers and Agricultural Labor Development Agency (MFAL). Drought Prone Area Program (DPAP), Integrated Rural Development Program (IRDP), etc. were launched during seventies.

The most significant development took place under the World Bank project named as: Training and Visit (T&V) extension program, started in mid-1970s. The emphasis was on efficient technology transfer using promising research results. The system, however, proved little helpful to small farmers especially those in rain-fed areas. To bridge this gap and increase the reach of extension services, ICAR launched its Front Line Demonstration (FLD) programs such as: Operational Research Project (ORP), Lab to Land and National Demonstration (ND). ICAR also established Krishi Vigyan Kendra (KVK) also known as District Science Centres as an institutional mechanism for front line extension approach. Toady, ICAR has created more than 639 KVKs all over India. Later on, the need for technology appraisal, refinement and transfer was felt and Institutional Village Linkage Program (IVLP) based on participatory methodology was launched in selected locations under the ambitions World Bank, National Agricultural Technology Project (NATP) in 1998.

The approach has been reversed from "Top-Down" to "Bottom-Up". New institutional arrangements for technology dissemination through establishment of Agricultural Technology Management Agency (ATMA), at the district level has enabled better coordination and convergence of all rural advisory programs. Under the project, a state level Agricultural Management and Extension Training Institute (SAMETI) has been created to provide training to state extension functionaries. Of late, National Agricultural Innovation Project (NAIP) has

been implemented with an aim to give agricultural research/ technology generation system an explicit development and business oriented perspective through innovative partnership models.

Application of information and communication technology (ICT) in agriculture has also been promoted. ITC has spearheaded an Integrated Rural Development Program to empower farmers and raise rural incomes. The strategy of this intervention is broadly centered around information and knowledge dissemination, access to quality inputs and markets, generating supplementary incomes, and natural resource augmentation. Farmers are provided with critical information and relevant knowledge on farm productivity, prices and markets through ITC e-Choupal. This platform spearheaded by Indian Tabacco Company (ITC) enables access to quality inputs for better productivity besides expanding their reach to markets. Dedicated radio and TV channels are also in offing. Private sector has also come up to support farmers by empowering them with better technology and providing, farmers quality inputs. Also, use of smart phones has lately become popular to access knowledge by the farmers.

(ii) Need to Outscale Farmer Led Innovations

In the pursuit to enhance both agricultural production and income, the farmers do consistently try to make agriculture occupation more efficient and cost effective. In the process they have come out with numerous innovations around improved farming practices and better livelihood. Obviously, these innovations supported food security. The farmers identified a number of new/indigenous traditional crops and developed varieties with enhanced productivity and better quality through selection. Farmers also identified livestock breeds and developed technologies for low cost animal and fish rearing and processing, efficient horticultural practices, value addition, and better marketability of various farm products. In addition,

a number of farm implements and tools have been designed and manufactured by the farmers to increase operational efficiency and productivity. In this context, commendable work has been done by women farmers, especially in the area of germplasm conservation, post-harvest management and value addition which helped in enhancing the farm income. In fact, farmers are silently innovating, adopting the new practices and continuously improving them. Unfortunately, these farmer-led innovations, over generations, have neither been recognized nor documented. Also, the Intellectual Property Rights (IPR) on the innovations made by farmers have often lacked in the past. Value of traditional knowledge and its documentation has also remained unnoticed by scientists. As a result, many technologies developed by innovative farmers have not been reaped by other farmers. Efforts are needed to capture farmer led innovations in agricultural practices and blend them with modern science through refinement and validation in a participatory mode. The innovative farmers do need encouragement financial support for their creativity. Accordingly, Agriculture Innovation Fund/Board' be created at the national level to supplement the efforts of such farmers by awards/rewards and providing monitory assistance to them.

(iii) Linking Farmer to Market (LFM)

Agriculture is the only enterprise where prices are determined by others than the producer. To ensure competitive price of produce, role of middlemen has to be minimized and market forecasting systems have to be strengthened so that farmers can take right decisions on crop planning, production and sale of their produce. Recent studies made by USAID show that 50-70 per cent of smallholders are now transitioning from subsistence to commercial farming in several countries of Africa and Asia. In most of the South Asian countries, urbanization and industrialization are somehow not creating sufficient number of off-farm jobs to help accelerate agricultural commercialization. Overcoming the commercialization

barrier requires an upgrading process around investment in local infrastructure, strengthening of business services and improvement in farmer's skills through an efficient extension system. These investments have somehow not been visible. Also, in view of considerable decline in public extension services, over the last 2-3 decades, the farmers are unable to access vital technologies and services. Studies do convincingly show that income growth generated by agriculture is up to four times more effective in reducing poverty than growth in other sectors (Growth Commission, 2008). Therefore, income growth in agriculture needs to be stimulated further by linking farmers to markets. There is need to develop a sustainable model for marketing which should allow farmers to go for direct sale to consumers. Hence, value chain development involving farmers, direct sale by farmers, contract farming, organised retailing by farmers and establishment of Farmers' Associations, Self Help Groups, and or Companies will go a long way in achieving these goals.

- **Micro-financing:** Providing effective and efficient financial services in agriculture sector continues to be a challenge. The Food and Agriculture Organization (FAO) argues that poorly functioning financial markets may make farmers reluctant to adopt new practices and technologies and also reduce their risk taking abilities. Therefore, objectives of micro-financing can not be overlooked.

  Some flagship institutions in Asia such as Bank for Agriculture and Agricultural Cooperatives (BAAC) in Thailand; village banks (Unit Desas) of Bank Rakyat in Indonesia – BRI-UD; and Grameen Bank (GB) in Bangladesh have successfully demonstrated how to successfully supply loans and other financial services in rural areas. Such institutions need to be created on a large scale. However, there is a need to establish close relationship between finance and production, income distribution, empowerment and welfare. The happy situation is that several innovations

are being examined to make financial support available to farmers. In India, Kisan (farmer) Credit Cards (KCC) are being issued to all farmers to avail credit at low interest rates.

- **Policy Support:** The appropriate policies on provisions of subsidies on key inputs; promotion of efficient technologies such as conservation agriculture, innovations and improved varieties; and creation of institutions such as farmer cooperatives, self-help groups, farmers; club and formation of farmers' companies need to be inculcated in agriculture development plans. In the coming years, South Asian countries will need to foster long-term productivity policies by investing heavily in agricultural R&D, while introducing institutional reforms to create an environment so as to facilitate the adoption of new technologies.

  Although most of the governments are introducing farmers' friendly policies, yet I would emphasize upon having a relook on domestic Agriculture Policy in order to make it more effective for infrastructure development, risk management and easy credited availability. We also need policy to encourage farmer-led innovations and young entrepreneurs in agriculture.

(iv) Empowering Women for Inclusive Growth

It is well recognised that women empowerment is quite important for both agricultural growth and household nutrition security. Globally, about 43 per cent women are engaged in agriculture. In India, 60 per cent of farming operations are performed by women. Therefore, agriculture can be a primary driver for the empowerment of women around removing drudgery of farm women. Innovations improve their work efficiency but would also ensure overall household development and nutrition security. However, women in agriculture are invariably deprived of access to agricultural knowledge, credit, technology to overcome their drudgery

and market related services. Often, they are deprived of their rights to land and resources. All these adversely impact their performance. The State of Food and Agriculture Report of 2010-11 by FAO has already indicated that reducing the gender gap between male and female farmers could raise yields on farms by almost 20-30 per cent. As a consequence, it is expected that engendering agriculture would lead to reduction of undernourished people globally by 12-17 per cent. This in turn would translate into 100-150 million fewer hungry people. Hence, technology generation relevant to women farmers and its adoption should become an important agenda for future agricultural growth.

(v) Retaining Youth in Agriculture

Asia can reap the demographic dividend if attention is paid to create more and better jobs, improving the technical skills and education of youth, and providing efficient matching of labor supply and demand through regulations and mobility.

The ageing population of farmers and declining interest among rural youth to take up agriculture as a profession are challenges for agricultural sustainability not only in India but also in other countries of the region. A large section of youth invariably prefers to migrate to cities to seek employment, especially the Government jobs. Hence, a major challenge today is how to retain youth in agriculture, which certainly cannot be left unaddressed. The declining interest of rural youth in agriculture is directly related to existing poor physical amenities, socioeconomic conditions and lack of enabling environment. Economic factors such as low paid employment, inadequate credit facilities, low profit margins, and lack of insurance against crop failure are also discouraging youth to get engaged in agriculture. Social factors include public perception about farming, especially the parental desire that their children should opt out of agriculture. Environmental issues include poor soil health, non-availability of water for irrigation and climate change. Concerted efforts are still

needed to stimulate their interest further by expanding their horizon. Proper incentives for their involvement in agricultural education, research and extension and by linking them to the expanding markets will have positive effects in attracting youth in agriculture.

Earlier, seed, pesticide, fertilizer and farm machinery were the only potential sectors to employ agricultural graduates/rural youth. Now new opportunities are emerging in IT linked agri - extension, seed technology, biotechnology, food processing, cold storage, packaging, supply chain management, insurance and farm credit. Private sector and NGOs are also engaging the rural youth. In this context, we now need greater thrust on vocational training of youth (including female) for relevant skill acquisition and greater confidence building to serve as 'Technology Agents' as well as efficient knowledge/service providers on custom hire basis. It is high time that all out efforts are made at all levels to engage youth in multifarious activities around 'Plough to Plate' so as to make farming both attractive as well as lucrative profession. Knowledge based agriculture around secondary and speciality agriculture can obviously enhance opportunities for additional income for the youth.

D. Future Road Map: Need for a Paradigm Shift

The Success of Green Revolution was mainly due to holy alliance between researchers-extension specialists and farmers. The technology dissemination approach adopted was top-down and centered around individual farmers. Faster adoption of technology was also on account of miracle seeds of wheat and rice, promoted largely by the public extension system which over the years has become relatively weak. On the contrary, new innovations around natural resource management require bottom-up approach, involving farmer's participation, while ensuring confidence building among farming communities to take risk and make agriculture more scientific and resilient.

In the process, sharing of knowledge on good agricultural practices, without dissemination loss, and incentives for critical inputs becomes highly crucial to achieve future successes. Also partnership among key stakeholders become essential to promote growth in agriculture. In the process, care is also needed to overcome complacency that has crept in the public extension/advisory services.

Also, a paradigm shift is needed from present national agricultural research institute (NARI) system to that of the national agricultural research and extension system (NARES). This would require active involvement of stakeholders such as farmers, NGOs, private sector, scientists and policy makers. Another paradigm shift has to be in the extension approach towards translational research in order to ensure outscaling of innovations for greater impact on both higher productivity and income.

In this context, extension approach has now to be around farming communities rather than individual farmers. Also, Natural Resource Management (NRM) related innovations would require more lead time to assess the impact on farmers fields, unlike the impact of high yielding varieties on crop productivity. This obviously throws a new institutional challenge for needed reforms in existing extension system, which is mostly dependent on public organizations. Role of private sector, especially through involvement of youth and gender in agriculture, becomes most relevant in the present situation. Hence, empowering youth (both men and women) through vocational training and building a cadre of 'Technology Agents' to provide technical backstopping as well as custom hire services to the smallholder farmers will go a long way in liking research with extension for accelerating agricultural growth. In other words, we need to link now 'land with lab', the 'village with institute' and 'scientists with society' to ensure faster adoption of resource saving technologies that would benefit both producers and consumers. In the process, the

Agriculture Technology Agents will become "job creators and not job seekers" and provide on farmers door steps the best technologies as well as quality inputs. Another strategy could be to create 'Agri-clinics', where technology agents could join hands to ensure single window system of advisory services so that farmers need not run from pillar to post. In fact, a good farmer is more knowledge hungry and not dependent only on government subsidy.

The Way Forward

Agriculture in the Asia must liberate the region from twin scourges of hunger and poverty and that of malnutrition of children and women. The region must continue to feed the world with adequate food supply. Accelerated science and innovation-led agricultural growth must be inclusive and should address the needs and aspirations of resource-poor smallholder farmers in the Asia-Pacific region. Under the growing challenges of resource degradation, escalating input crisis and costs with overarching effects of global climate change, the major gains in food grain production would largely depend in future on a paradigm shift from integrated germplasm improvement to that of integrated natural resource management. The future AR4D efforts by NARS must now be reoriented towards farming system's approach involving farmers' participatory approach. Also, we need to employ more innovative ways for effective dissemination of knowledge and lay greater emphasis on outscaling innovations for needed impact on livelihood of small holder farmers. Henceforth, 'Farmer First' be the goal of all NARES in order to bridge the income divide between farmers and non-farmers and benefit equally the producers and consumers. To ensure this, the developing countries in the Asia-Pacific must enhance their investments **(almost triple)** in AR4D in order to address effectively the emerging challenges and ensure food, nutrition and environment security for all in the region.

Recent Publications (2010-2014)

A. APAARI

Expert Consultations/Meetings/Training Programs

1. 12th Asian Maize Conference and Expert Consultation on "Maize for food, feed, nutrition and environment security": Recommendations (2014)
2. Expert Consultation on Promotion of Medicinal and Aromatic Plants in the Asia-Pacific Region: Proceedings (2013)
3. International Conference on Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences: Proceedings (2013)
4. Training Workshop on Open Access Publishing Using Open Journal Systems: Proceedings (2013)
5. Foresight and Future Pathways of Agricultural Research Through Youth: Proceedings and Recommendations (2013)
6. Expert Consultation on Managing Trans-boundary Diseases of Agricultural Importance in the Asia-Pacific: Proceedings and Recommendations (2013)
7. Stakeholders' Dialogue on Biosafety Regulations in the Asia-Pacific Region Proceedings and Recommendations (2013)
8. Regional Consultation on Agricultural Research for Development : Proceeding and Recommendations (2013)
9. Regional Consultation on Collective Actions for Opening Access to Agricultural Information and Knowledge in the Asia-Pacific Region: Proceedings (2012)
10. Prioritization of Demand-driven Agricultural Research for Development in South-Asia (2012)
11. Regional Consultation on Improving Wheat Productivity in Asia: Proceedings and Recommendations (2012)
12. Workshop on Climate-Smart Agriculture in Asia: Research and Development Priorities: Proceedings and Recommendations (2012)
13. First Global Conference on Women in Agriculture (GCWA): Proceedings (2012)
14. Regional Workshop on Implementation of Suwon Agrobiodiversity Framework: Proceedings (2012)
15. Regional Dialogue on Conservation Agriculture in South Asia: Proceedings and Recommendations (2012)
16. Expert Consultation on Agricultural Biotechnology, Biosafety and Biosecurity: Proceedings and Recommendations (2012)
17. Workshop on Moving Beyond Strategy to Improve Information and Knowledge Management for Agricultural Development in the Pacific Islands Countries and Territories: Proceedings (2012)
18. Stakeholders' Interface on GM Food Crops : Proceedings and Recommendations (2011)

19. Expert Consultation Meeting on Postharvest and Value Addition of Horticultural Produce – Strengthening Technologies for Linking Farmers to Market : Proceedings and Recommendations (2011)
20. International Symposium on Sustainable Agricultural Development and Use of Agrobiodiversity in the Asia-Pacific Region (2010)
21. APAARI-ADB Asia-Pacific Consultation on Agricultural Research for Development (AR4D) in Asia and the Pacific-The Way Ahead (2009)
22. Expert Consultation on Biopesticides and Biofertilizers for Sustainable Agriculture (2009)
23. Symposium on Global Climate Change : Imperatives for Agricultural Research in Asia-Pacific (2008)
24. Expert Consultation on Agricultural Biotechnology for Promoting Food Security in Developing Countries (2008)
25. Workshop on Development and Management of ARD Information Resources (2008)
26. Asia-Pacific Regional Workshop on Agricultural Research for Development (2008) (for establishment of NGO Consortium-NAARAP)
27. Expert Consultation to Review Progress of Agricultural Research Networks and Consortia in Asia-Pacific (2007)
28. ICT/ICM Sensitization and Awareness Building Workshop for NARS Leaders and Senior Managers (2007)

Success Stories

29. ITC e-Chaupal : Innovation for Large Scale Rural Transformation – A Success Story, Jyoti Chaliha and Shoma Bhattacharya (2014)
30. Wax Apple Industry in Taiwan: A Success Story, Chi Cho Huang *et al.* (2014)
31. Agricultural Information and Knowledge for All : Success Stories on ICT/ICM in AR4D in Asia and the Pacific Region (2013)
32. Linking Farmers to Market: A Success Story of Lettuce Export from Chinese Taipei (2012), Min-Chi Hsu *et al.*
33. Biofuel Growers Market Network (2012), K. Narayan Gowda
34. Success Stories on ICT/ICM in AR4D in Asia and the Pacific Region, Malcolm Hazelman and S. Attaluri
35. Short Duration Mungbean: A New Success in South Asia (2010), M.L. Chadha
36. Taro Improvement and Development in Papua New Guinea (2009), Abner Yalu *et al.*
37. Cotton-Wheat Production Systems in South Asia: A Success Story (2008), C.D. Mayee *et al.*
38. Linking Farmers to Market: Some Success Stories from Asia-Pacific Region (2008), Rosendo S. Rapusas *et al.*

39. Rainbow Trout (Oncorhynchus mykiss) Culture in the Himalayan Kingdom of Nepal (2005/1), A.K. Rai *et al.*
40. Sustaining the Green Revolution in India (2004/3), S. Nagarajan
41. Lentil Improvement in Bangladesh (2004/1), Ashutosh Sarker *et al.*
42. Success Story on the Control of Newcastle Disease in Village Chickens (2003/1), Robyn Alders
43. Hybrid Rice in China - A Success Story (1994), Lou Xizhi and C.X. Mao
44. Tilapia Farming in the Philippines - A Success Story (1994), Rafael D. Gurrero III
45. Dairying in India - A Success Story (1994), R.P. Aneja

Status Reports

46. Jackfruit Improvement in the Asia-Pacific Region: A Status Report (2012)
47. Information and Communication Technologies/Management in Agricultural Research for Development in the Asia-Pacific Region : A Status Report (2011)
48. Strengthening of Plant Genetic Resources for Food and Agriculture: Conservation and Utilization in the Pacific (2011)
49. Bt-Cotton in India – A Status Report (2nd Edition) (2009)
50. Production and cultivation of Virus-Free Citrus Saplings for Citrus Rehabilitation in Taiwan (2008)
51. Biosafety Regulation of Asia-Pacific Countries (2008)
52. Micropropagation for Quality Seed Production in Sugarcane in Asia and the Pacific (2008)
53. Commercialization of Bt-Corn in the Philippines (2005)
54. Information and Communication Technologies in Agricultural Research for Development in the Asia-Pacific-Region (2004)

Other Publications

55. Twenty Two Years of APAARI - A Retrospective
56. Benchmarking Agricultural Research Indicators Across Asia-Pacific : ASTI Regional Synthesis Report
57. Training Workshop on Open Access Publishing Using Open Journal Systems
58. APAARI on CD
59. Priorities for Agricultural Research for Development in South-Asia
60. Improving Wheat Productivity in Asia
61. Fifteen Years of APAARI - A Retrospective
62. APAARI Vision - 2025
63. APAARI Newsletter (half yearly)

B. TAAS

1. Brainstorming Workshop on Soybean for Household Food and Nutrition Security - Proceedings and Recommendations, March 21-22, 2014.
2. National Workshop on Outscaling Farm Innovation - Proceedings and Recommendations, September 3-5, 2013.
3. The Indian Oilseed Scenario: Challenges and Opportunities - Strategy Paper by Dr. R.S. Paroda, August 24, 2013.
4. Brainstorming on Achieving Inclusive Growth by Linking Farmers to Markets - Proceedings and Recommendations, June 24, 2013.
5. A Brief Report on Seventh Dr. M.S. Swaminathan Award presented to Dr. William D. Dar. DG, ICRISAT, Hyderabad. June 24, 2013.
6. Managing Our Water Resources for Increased Efficiency - Strategy Paper, by Dr. R.S. Paroda. May 28, 2013.
7. Foresight and Future Pathways of Agricultural Research Through Youth - Proceedings & Recommendations, March 1-2, 2013.
8. Special Lecture Delivered at Indian Seed Congress 2013 on "Indian Seed Sector: The Way Forward" by Dr. R.S. Paroda. 8 January, 2013.
9. The Seventh Foundation Day Lecture on "Ensuring Food and Nutrition Security in Asia: the Role of Agricultural Innovation" by Dr. Shenggen Fan, DG, IFPRI. January 11, 2013.
10. Global Conference on Women in Agriculture - Proceedings and Recommendations. March 13-15, 2012.
11. The Sixth Dr. M.S. Swaminathan Award Lecture on "Challenges and Opportunities for Food Legume Research and Development" by Dr. M.C. Saxena, January 25, 2012.
12. Implementing the International Treaty to Address Current Concerns about Managing our Plant Genetics Resources - Strategy Paper by Dr. R.S. Paroda. January 23, 2012.
13. Sixth Dr. M.S. Swaminathan Award Lecture for Challenges and Opportunities for Food Legume Research and Development, January 25, 2012.
14. TAAS Foundation Day Lecture on "Harnessing Knowledge for India's Agricultural Development" by Dr. Uma Lele, August 12, 2011.'
15. National Dialogue on Building Leadership in Agricultural Research Management, Hyderabad, August 27 - 28, 2010 - Proceedings & Recommendations.
16. Stakeholder Interface on GM Food Crops, May 19, 2011 - Recommendations.
17. TAAS Flyer - Hindi
18. TAAS Flyer - English
19. Brainstorming Session on Prospects of Producing 100 million tons of Wheat by 2015 and presentation of Fifth Dr. M.S. Swaminathan Award for leadership in Agriculture - Proceedings & Highlights, December 18, 2010.

20. NSAI Foundation Day Lecture on "Revitalizing Indian Seed Sector for Accelerated Agricultural Growth" by Dr. R.S. Paroda, October 30, 2010.
21. TAAS Foundation Day Lecture on "Climate Change and Food Security : From Science to Sustainable Agriculture" by Dr. Mahendra M. Shah, May 7, 2010.
22. National Seminar on "Quality Seed for Food Security through Public-Private Partnership" April 13-14, 2010 - Proceedings & Recommendations.
23. Millions Fed: Proven Successes in Agricultural Development, January 19, 2010 (Translation in Hindi jointly published by IFPRI, APAARI and TAAS) Hindi/English.
24. Fourth Dr. M.S. Swaminathan Award for Leadership in Agriculture - A brief Report, August 11, 2009.
25. Brainstorming Workshop on "Climate Change, Soil Quality and Food Security" August 11, 2009 - Proceedings & Recommendations (Hindi/ English).
26. Brainstorming Workshop on 'Strategy for Conservation of Farm Animal Genetic Resources' April 10 - 12, 2009 - Proceedings.
27. Brainstorming Workshop on 'Strategy for Conservation of Farm Animal Genetic Resources' April 10 - 12, 2009 - Ranchi Declaration.
28. Brainstorming Workshop on "Emerging Challenges before Indian Agriculture - The Way Forward", March 6, 2009 - Proceedings & Recommendations (Hindi/English).
29. Overcoming the World Food and Agriculture Crisis through Policy Change, Institutional Innovation and Science - Fourth Foundation Day Lecture, delivered by Dr. Joachim von Braun, Director General, International Food Policy Research Institute, Washington, March 6, 2009.
30. National Symposium on Quality Protein Maize for Human Nutritional Security and Development of Poultry Sector in India and Presentation of the Third Dr. M.S. Swaminathan Award for Leadership in Agriculture, May 3, 2008 - Proceedings and Highlights.
31. Symposium on "Farmer-Led Innovations for Sustainable Agriculture" December 14-15, 2007 - Proceedings.
32. Brainstorming Session on "Models of Public-Private Partnership in Agricultural Biotechnology", April 7, 2007 - Highlights and Recommendations.
33. Farmer-Led Innovations Towards Plant Variety Improvement, Conservation and Protecting Farmers' Rights, November 12 - 13, 2006, National Dialogue Highlights and Recommendations.
34. The Second Dr. M.S. Swaminathan Award for Leadership in Agriculture - October 9, 2006 - A brief report.
35. Strategy for Increasing Productivity Growth Rate in Agriculture - Strategy Paper by Dr. R.S. Paroda, August 2006.

36. Farmer-Led Innovations for Increased Productivity, Value Addition and Income Generation - Brainstorming Session, October 17, 2005 - Highlights & Recommendations.
37. Public-Private Partnership in Agricultural Biotechnology - Second Foundation Day Lecture, delivered by Dr. Gurdev S. Khush, Adjust Professor, University of California, Davis, USA, October 17, 2005.
38. First Dr. M.S. Swaminathan Award for Leadership in Agriculture, March 15, 2005, Highlights.
39. Role of Information Communication Technology in Taking Scientific Knowledge/Technologies to the End Users - National Workshop, Recommendations, January 10 - 11, 2005 , Recommendations.
40. Role of Science and Society Towards Plant Genetic Resources Management - Emerging Issues - Brainstorming Session, January 7 - 8, 2005, Highlights and Recommendations.
41. Challenges in Developing Nutritionally Enhanced Stress Tolerant Germplasm - Special Lecture, delivered by Dr. S.K. Vasal, Distinguished Scientist, CIMMYT, Maxico, January 15, 2004.
42. Enabling Regulatory Mechanisms for Release of Transgenic Crops - Brainstorming Session, October 18, 2003.
43. Regulatory Measures for Utilizing Biotechnological Developments in Different Countries - First Foundation Day Lecture, delivered by Dr. Manju Sharma, Secretary, Department of Biotechnology, Government of India, October 17, 2003.

DR. R.S. PARODA

Dr. Rajendra S. Paroda is an accomplished plant breeder and geneticist by profession and an able research administrator. He has made significant contributions in the field of crop science research. He is known for modernization and strengthening the national agricultural research system (NARS) in India as well as in Central Asia and the Caucasus. He was instrumental in establishing the Asia-Pacific Association of Agricultural Research Institutions (APAARI) and the Asia-Pacific Seed Association (APSA), while serving with FAO in early ninties. Since, 1992, he is continuing as Executive Secretary of APAARI. He was elected as the first Chairman of the Global Forum on Agricultural Research (GFAR) and served from 1998-2001. Dr. Paroda was also the Director General, Indian Council of Agricultural Research (ICAR) & Secretary, Department of Agricultural Research and Education (DARE), Government of India during 1994-2001. He has the unique distinction of being the main architect of one of the world's largest and most modern National Gene Bank at NBPGR, New Delhi. He is Fellow of almost all the prestigious Science Academies in India and the Agricultural Academies of Russia, Georgia, Armenia and Tajikistan, besides that of Third World Academy of Sciences (TWAS), Italy. He had been the President of the National Academy of Agricultural Sciences (India) from 1996-2001 and was elected as General President of the prestigious Indian Science Congress Association for the year 2000-2001. In addition, he served as President of more than a dozen agricultural scientific societies in India. In recognition of his meritorious contributions to agricultural research, the President of India conferred on him the prestigious PADMA BHUSHAN in 1998. He also received several prestigious awards, namely, ICAR Team Research Award (1983-84), Rafi Ahmed Kidwai Memorial Prize (1982-83), Federation of Indian Chamber of Commerce and Industry (FICCI) Award (1988), Om Prakash Bhasin Award (1992), Asia-Pacific Seed Association Special Award (1995), Dr. Harbhajan Singh Memorial Award (2001), Dr. B.P. Pal Memorial Award (2003), Borlaug Award (2006) and Agriculture Leadership Award (2008), 1st Dr. A.B. Joshi Memorial Award (2012), Prof. Kannaiyan Memorial Award (2012), Medal from Govt. of Vietnam (2012), Krishi Siromani Samman by Mahindra (2013) and Vaigyanik Drishlikon Society (VDS) Samman (2013). In all, 15 Universities including Ohio State University, Indian Agricultural Research Institute, Scientific Council of Agricultural Academy, Agricultural Universities of Pantnagar, Kanpur, Jorhat, Coimbatore, Hyderabad, Udaipur, Varanasi, Srinagar, Meerut, Bhubneshwar, Punjab and Dharwad have conferred honory D.Sc. (Honoris Causa) degrees on him. Dr. Paroda has also served as a member of many international organizations such as Australian Center for International Agricultural Research (ACIAR), Commonwealth Agriculture Bureau International (CABI), Finance Committee of the Consultative Group on International Agricultural Research (CGIAR), Global Biotech Advisory Council of Monsanto, Board of Trustees of IRRI, Chairman of ICRISAT Board of Trustees and Chairman, Program Committee of GFAR. In view of his outstanding achievements, both American Society of Agronomy and the Crop Science Society of America had awarded Dr. Paroda with their prestigious Honorary Membership in 2001. ICRISAT and Kazakhstan have named their Gene Banks after him. He also served as a member of the World Meteorological Organization (WMO) High Level Taskforce for preparing a Global Framework for Climate Services. As Chairman of the Organizing Committee of Global Forum on Agricultural Research for Development (GCARD), he provided leadership at global level to organize successfully GCARD2 in October, 2012 in Uruguay. His passion, as Chairman, Trust for Advancement of Agricultural Sciences (TAAS), is to link science to society through needed policy reorientation and to work for the overall progress of the resource poor farmers. Since 2010, he has been serving as Chairman of the Farmers' Commission of Haryana State and as member of the Rajasthan State Planning Board. Currently, he is a member of the ICAR Society as well as its Governing Body.

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