ASTI Country Brief | December 2019

PAPUA NEW GUINEA

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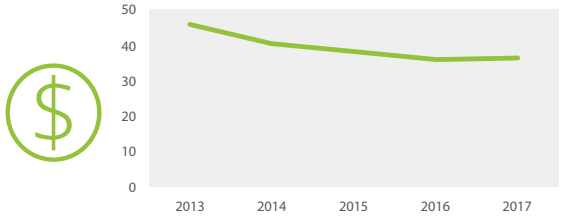
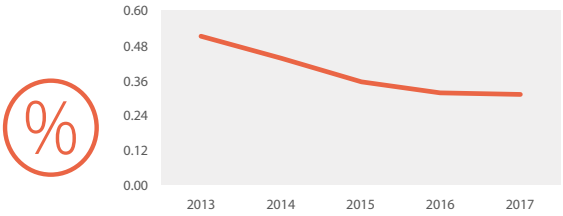
AGRICULTURAL RESEARCH SPENDING



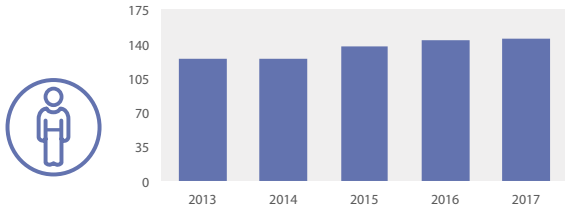
	PAPUA NEW GUINEA	CAMBODIA	LAOS	MYANMAR
Million kina (2011 constant prices)	36.4			
Million PPP dollars (2011 constant prices)	19.6	30.2	19.3	46.6

SPENDING INTENSITY



	PAPUA NEW GUINEA	CAMBODIA	LAOS	MYANMAR
Agricultural research spending as a share of AgGDP	0.31%	0.22%	0.26%	0.06%

AGRICULTURAL RESEARCHERS

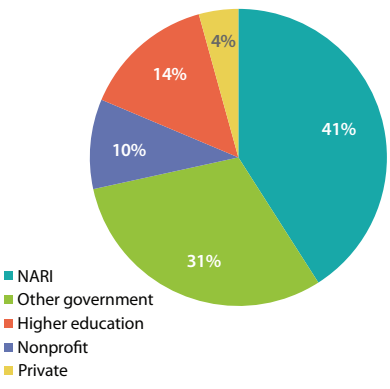


	PAPUA NEW GUINEA	CAMBODIA	LAOS	MYANMAR
Full-time equivalents	146.3	319.0	203.2	657.1
Share of researchers with MSc and PhD degrees	39%	45%	47%	37%

Notes: Data in the table above are for 2017. All tables and figures in this brief exclude the private for-profit sector, with the exception of the institutional profile figure below. Information on access to further resources, data procedures and methodologies, and acronyms is provided on page 8. See **www.asti.cgiar.org/papua-new-guinea/directory** for an overview of PNG's agricultural R&D agencies.

- PNG's agricultural research expenditure declined steadily during 2013–2017 as the combined result of reductions in both donor and government funding. In 2017, PNG invested just 0.31 percent of its AgGDP in agricultural research.
- In contrast to spending, agricultural researcher numbers rose progressively during 2013–2017 to reach 146 FTEs in total.
- The country's research agencies lack the critical mass of highly qualified researchers and accompanying infrastructure needed to address the multidisciplinary challenges facing the agricultural sector. Many critical research areas remain overlooked.

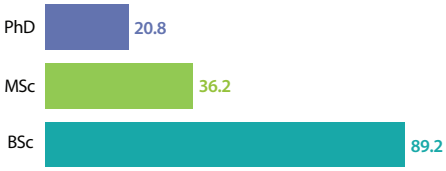
INSTITUTIONAL PROFILE, 2017



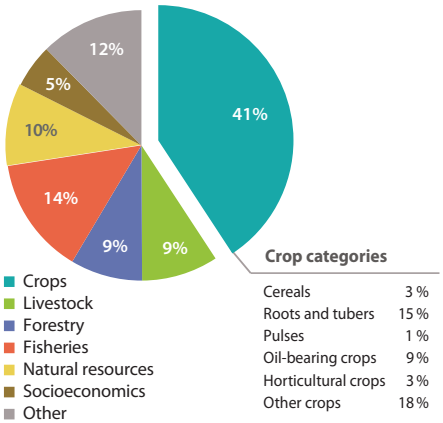
RESEARCHER PROFILE, 2017

By gender (%)

By qualification level (FTEs)



RESEARCH FOCUS, 2017



Crop categories

Cereals	3 %
Roots and tubers	15 %
Pulses	1 %
Oil-bearing crops	9 %
Horticultural crops	3 %
Other crops	18 %

KEY CHALLENGE

- PNG lacks a critical mass of highly qualified agricultural researchers. The vast majority of those currently employed only hold BSc degrees. Local universities offer few training opportunities in agricultural sciences beyond the BSc level, so scientists generally have to travel overseas to pursue postgraduate degrees, and funding opportunities to do so are also limited.

POLICY IMPLICATIONS

- Accelerated training of young researchers to the MSc and PhD level is a critical first step in ensuring PNG has an appropriate pool of qualified scientists at the national level. Local university programs in agricultural sciences need to be strengthened so that more scientists have the opportunity to pursue higher level degrees locally. Foreign donors (particularly Australia) fund a large share of postgraduate training for PNG scientists overseas. The government must ensure that sufficient (financial and other) incentives are in place to motivate and retain staff members returning to PNG once they graduate.

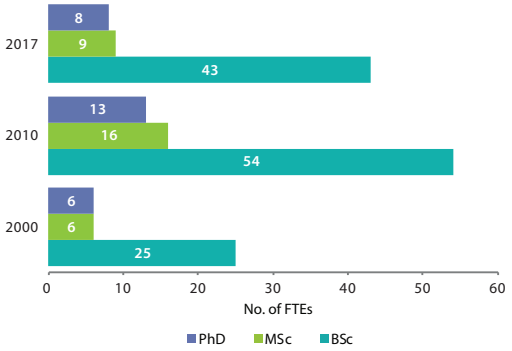
Agricultural researchers by degree level, 2017

SECTOR/AGENCY	PhD	MSc	BSc	TOTAL
Government		(FTEs)		
NARI	8.0	9.0	43.0	60.0
PNGFRI	1.4	4.2	15.6	21.2
FPDA	–	5.0	5.5	10.5
NFA	–	3.5	13.0	16.5
Subtotal	9.4	21.8	77.0	108.2
Higher education				
UNITECH-Department of Agriculture	4.2	0.9	0.3	5.4
UNITECH-Department of Forestry	0.9	1.2	0.0	2.1
UNRE	*0.3*	*4.1*	*0.5*	*4.9*
UOG-Department of Agriculture and Rural Development	0.6	1.8	0.6	3.0
Subtotal	6.0	8.0	1.4	15.4
Nonprofit				
Cocoa Board	1.5	3.0	4.5	9.0
CIC	0.9	1.2	1.8	3.9
OPRA	3.0	2.3	4.5	9.8
Subtotal	5.4	6.5	10.8	22.7
TOTAL	**20.8**	**36.2**	**89.2**	**146.3**

Note: Data in italics were estimated.

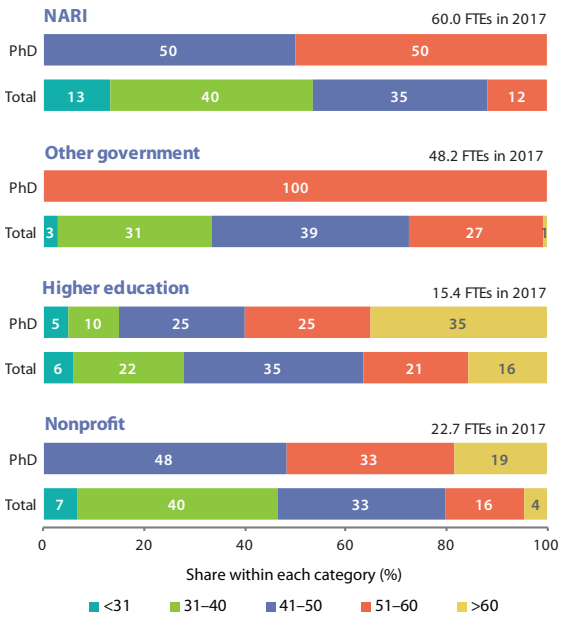
- Of the 146 FTE researchers involved in agricultural research in PNG in 2017, only 21 were PhD-qualified, and only 36 were MSc-qualified. Average degree levels were higher at the universities and nonprofit agencies than at the government agencies. In 2017, NARI employed just 8 scientists with PhD degrees and 9 with MSc degrees; these numbers are extremely low compared with many similarly sized national agricultural research institutes across the Asia–Pacific region. Moreover, it is important to note that 6 of the 8 PhD-qualified staff at NARI were in management positions and hence conducted very limited research.

NARI researchers by degree level, 2000, 2010, and 2017



- The total number of researchers employed by NARI has risen over time—largely driven by an increase in the number researchers qualified to the BSc degree level—but numbers have fallen considerably in recent years. Some researchers with BSc degrees were not offered longer term contracts based on the assessment of their performance as trainees. Other BSc- and MSc-qualified staff left NARI for more lucrative positions or educational opportunities elsewhere. In 2010, most PhD-qualified researchers employed at NARI were expatriates recruited either to fill gaps in a number of key disciplines (including crop breeding, postharvest research, and soil management) or to manage a series of donor-funded projects. Most expatriates left NARI upon the completion of these projects due to lack of funding, which has left large gaps in many research areas.

Agricultural researchers by age bracket, 2017



- Close to 60 percent of PNG's agricultural researchers with PhD degrees are in their fifties or sixties, and, hence, are approaching retirement. Although the official retirement age for government employees is 60 years, many opt to retire early (at 55 years). Consequently, large-scale losses of senior scientists will occur in the coming years, highlighting the urgent need to train young MSc-qualified scientists to the PhD level.

CAPACITY STRENGTHENING OPPORTUNITIES

Currently, PNG's universities offer very few training opportunities in agricultural sciences beyond the BSc level, so researchers who want to further their qualifications have little choice but to travel abroad. UNITECH, UNRE, and UOG all offer BSc-level training in agricultural sciences, but they are severely challenged in terms of funding, the quality of their teaching and research facilities, and the capacity of their teaching staff in certain disciplines. Only UNITECH offers limited MSc and PhD training in agricultural sciences. In 2017, just 14 MSc students and 1 PhD student were enrolled in UNITECH's Department of Agriculture.

These postgraduate training limitations have prompted donors, especially Australia (both ACIAR and DFAT), but also the European Union, New Zealand, China, Japan, and Taiwan to provide much-needed support for capacity strengthening. Grants are mainly available to researchers under the age of 40 years. Those who are older must either provide their own funding or seek funding from their employers or other sources. Donors also fund various short-term training programs for researchers. ACIAR and DFAT are by far the largest supporters for this type of training.

Training of NARI's researchers by qualification, gender, and location, 2013–2017

	BY DEGREE		BY GENDER		BY LOCATION		
DISCIPLINE	MSc	PhD	Male	Female	PNG	Australia	New Zealand
Plant breeding/genetics	2	–	2	–	1	–	1
Agronomy	1	–	–	1	–	1	–
Animal nutrition	1	2	2	1	1	2	–
Food sciences/postharvest issues	–	1	1	–	–	1	–
Economics	1	–	1	–	–	1	–
Science communication	1	–	1	–	–	1	–
Total	**6**	**3**	**7**	**2**	**2**	**6**	**1**

During 2013–2017, 9 NARI researchers completed postgraduate training, mostly in Australia. Postgraduate training is entirely funded through scholarships by donor agencies, although NARI continues to pay scientists their base salaries while they undertake their training. Each year, NARI nominates eligible staff members for training based on their performance, the number of contract terms they have served, and the institution's skills gaps. The final decision on who receives training usually lies with the donor agency. Staff who receive training commit to remaining with NARI for at least two years after receiving their degree.

NARI's researcher capacity by discipline and qualification, 2017

	FTEs	
DISCIPLINE	PhD	MSc
Plant breeding/genetics (including biotechnology)	–	1.0
Plant pathology	1.0	1.0
Plant Agronomy	2.0	2.0
Animal breeding/genetics	–	1.0
Animal husbandry and nutrition	1.0	–
Poultry	–	1.0
Entomology	1.0	–
Forestry and agroforestry	–	1.0
Soil sciences	–	–
Natural resource management	1.0	1.0
Water and irrigation management	–	–
Food sciences and nutrition	1.0	1.0
Socioeconomics (including agricultural economics)	1.0	–
Total	**8.0**	**9.0**

NARI lacks a critical mass of qualified researchers in a large number of key areas. For instance, it does not employ any breeders or soil scientists with PhD degrees. Two livestock researchers have completed PhD training overseas since data were collected for 2017 under the ASTI survey.

DIFFICULTIES ATTRACTING AND RETAINING EXPERIENCED SCIENTISTS

Agricultural research agencies in PNG experience comparatively high staff turnover. The key factors causing researchers to move on from government agencies are lack of advancement opportunities, limited training opportunities, lack of senior scientists to provide in-house training and mentoring, and low remuneration levels compared with other sectors nationally and internationally.

Filling vacancies is difficult because the country has a critical shortage of local expertise and insufficient funding to attract experts from overseas. Agricultural research agencies in PNG cannot operate effectively under such conditions, nor contribute meaningfully the country's agricultural and development challenges. Government assistance is needed to establish a conducive working environment with sufficient incentives to attract, retain, and motivate staff.

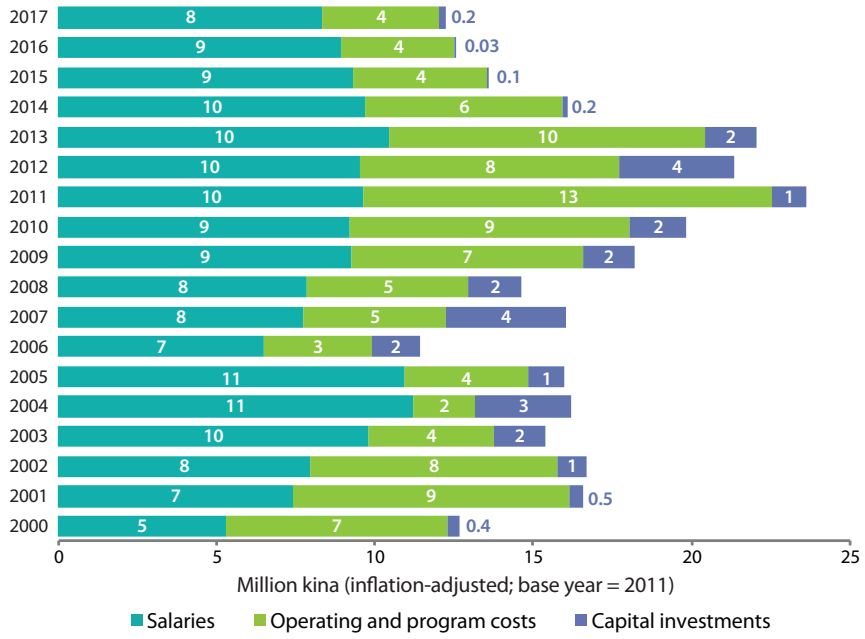
KEY CHALLENGE

- Agricultural research funding in PNG has been highly volatile over time, driven by significant yearly fluctuations in government and donor support. Total funding has declined substantially in recent years, particularly at NARI. In 2017, the country invested only 0.31 percent of its AgGDP in agricultural research, down from 0.51 percent in 2013. This investment level is very low in light of the country's persistent challenges, including low productivity, malnutrition, and the adverse effects of climate change on food production.

POLICY IMPLICATION

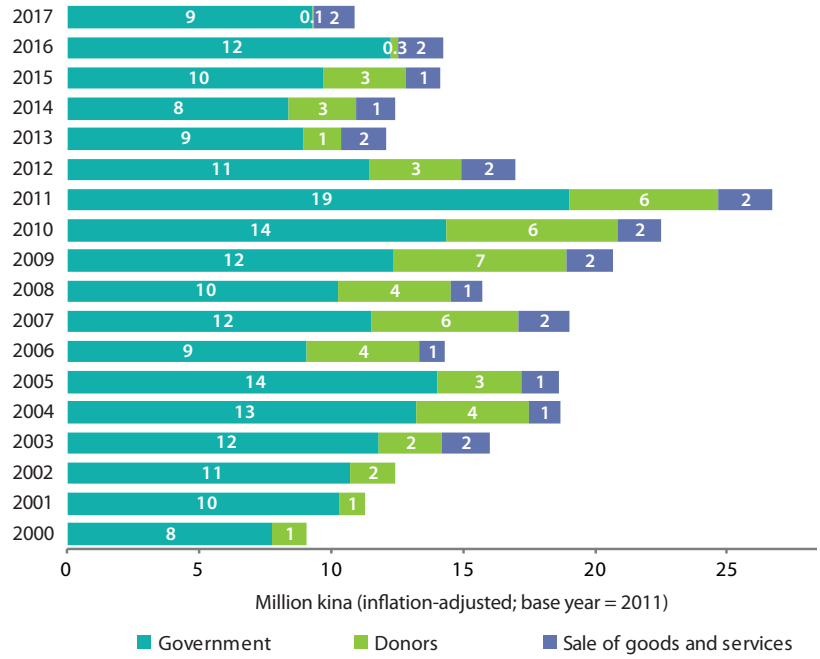
- Stable and sustainable levels of government funding are key. Rather than relying on donors to fund critical research areas, the government needs to more clearly define its own long-term priorities, ensure the alignment of donor funding with these priorities, and the design of coherent agricultural R&D programs to address them. Mitigating the effects of any single donor's abrupt change in support is crucial, highlighting the need for greater funding diversification through the sale of goods and services or by attracting complementary investment from the private sector.

NARI's expenditures by cost category, 2000–2017



On average, salaries accounted for 54 percent of NARI's expenditures during 2000–2017. Operating and capital investments were high in years when donor funding was high, but once large donor-funded projects (notably from ACIAR and the European Union) ended, NARI was forced to scale down its activities. In addition, capital investments were mainly allocated to the construction of offices and staff accommodation, rather than to the much-needed upgrades of laboratories.

NARI's funding sources, 2000–2017



Yearly funding to NARI was highly volatile during 2013–2017. Government funding contracted by almost half during 2011–2012 based on the government's decision to cut certain research projects and halt the construction of a new biotechnology building. During 2007–2011, NARI was highly dependent on Australian funding through the ARDSF project, but its completion in 2012 prompted a considerable cut in funding. A large European Union–funded capacity strengthening project also ended in 2012. By 2017, donor funding was virtually nonexistent, and the few donor projects that have been initiated since then have very small budgets.

DONOR FUNDING

- ACIAR is by far the most important donor of agricultural research in PNG. The Centre funds research activities on a broad range of commodity and value chain issues, including production, postharvest, value-addition, and marketing systems. In addition to extensive crop research, ACIAR also supports research on livestock feeding systems, forestry, fisheries, and natural resource management. During 2015–2018, ACIAR's average yearly investment in PNG projects totaled US$7.2 million (in current prices). The principal recipients were NARI, FPDA, CIC, CCIL, FRI, and OPRA.
- ARDSF, funded by Australia's DFAT, assisted select R&D agencies in delivering improved services to their rural stakeholders. It also included a competitive grant scheme to support innovations for agricultural development. During the five years ARDSF operated (2007–2012), NARI received AU$1 million.
- The European Union funded a number of large research projects in PNG focused on enhancing food security by preserving and improving the genetic diversity of sweet potatoes and aibika, enhancing land and labor productivity through small-scale mechanization, and generating and adapting improved agricultural technologies to mitigate climate change. During 2011–2015, NARI received US$4.3 million (in current prices) through European Union-funded projects.

COMMODITY LEVIES

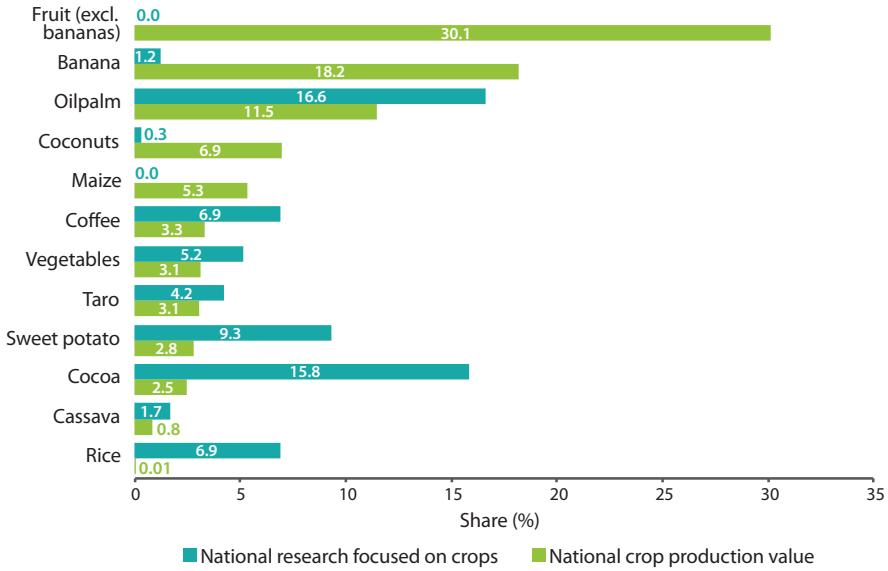
- Given the importance of agricultural exports to the national economy combined with price volatility in global markets, price stabilization schemes were established in the 1970s for coffee, cocoa, copra, and oil palm. Producer levies (taxes) are charged when commodity prices rise above or below formula-driven trigger prices. Levies are paid by the industry or producers based on marketable tonnage of the crop produced, so actual yearly levels vary due to fluctuations in production and prices. A portion of these levies is channeled to research institutions. In 2017, CIC received 6 million kina, OPRA 5.7 million kina, and CCIL 0.5 million kina in levies for research activities (all in current prices).

Number of peer-reviewed publications by scientists employed at NARI and UNITECH, 2013–2017

TYPE OF PUBLICATION	2013	2014	2015	2016	2017
International journals	7	5	10	15	40
South Pacific journals	1	1	2	1	2
National journal (Niugini Agrisaiens)	2	5	1	6	2
Total	**10**	**11**	**13**	**22**	**44**
Peer-reviewed publications per FTE researcher per year	0.2	0.2	0.2	0.3	0.7

- The number of journal articles published by agricultural researchers employed at NARI and UNITECH rose steadily during 2013–2017, as did the average number of publications per researcher. Nevertheless, the publication record of PNG's agricultural researchers remains very low by international standards.

Congruence between agricultural research and production value for selected commodities 2016/2017



- Major incongruencies exist between the amount of time crop researchers focus on specific crops compared with the crops that generate the highest production values. Fruit (other than bananas), for instance, accounted for 30 percent of PNG's total crop production value in 2016, yet PNG's researchers do not conduct any research on fruit. Bananas, coconuts, and maize also appear to be underresearched based on their crop values alone, whereas sweet potatoes, cocoa, and rice appear to be overresearched based solely on their crop values.

Sources: Research focus data are from ASTI; production values are from FAOSTAT.
Note: Research focus data are for 2017; production value data are for 2016.

KEY CHALLENGE

- Despite the release of a number of improved varieties over time, the long-term impact of agricultural research on agricultural productivity has been very low in PNG. Underinvestment in research programs is a major reason for this, but inadequate research infrastructure, a weak agricultural extension system, and ineffective institutions, are other factors that have restricted the impact of R&D on productivity.

POLICY OPTION

- PNG needs a strong national agricultural research and innovation policy agenda, and the necessary expertise to support this agenda long term. Also critical is an enabling policy environment that will stimulate cooperation among the country's agricultural R&D agencies in order to maximize the efficient use of scare resources and the impact of innovations on agriculture, rural and economic development, and ultimately malnutrition and poverty.

New varieties released by NARI and Cocoa Board, 2013–2017

CROP	NARI	COCOA BOARD
Cocoa	–	4
Potatoes	2	–
Pyrethrum (flowers)	2	–
Sweet potatoes	2	–
Taro	4	–
TOTAL	**10**	**4**

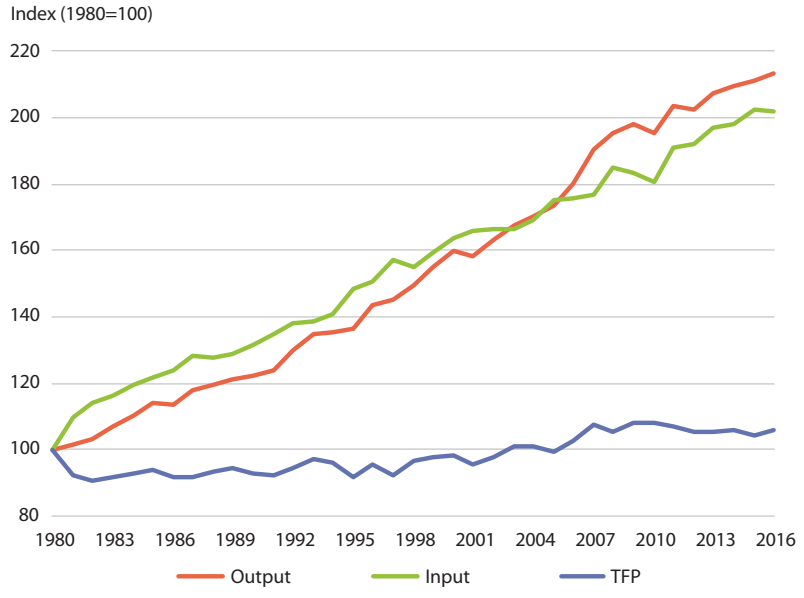
During 2013–2017, NARI released ten new crop varieties and the Cocoa Board released four new cocoa varieties. NARI is the official tester of new varieties, which must be developed or adapted for at least two years prior to being released to farmers. Of the varieties that NARI has released, none have been formally registered. PNG has no formal intellectual property rights regime in place for the protection of new varieties, technologies, or other research outputs.

LIMITED AGRICULTURAL PRODUCTIVITY GROWTH

- Increasing the efficiency of agricultural production—that is, getting more output from the same amount of resources—is critical for improving food security. TFP is an indicator of how efficiently agricultural land, labor, capital, and other inputs (seed, fertilizer, and so on) are used to produce a country's agricultural outputs (crops and livestock). TFP is calculated as the ratio of total agricultural outputs to total production inputs, so when more output is produced from a constant amount of resources, TFP increases. R&D activities producing new technologies and innovations are a crucial factor driving TFP, but technological spillovers from abroad, higher numbers of skilled workers, investments that favor the development of input and output markets (such as roads and communications), and government policies and institutions that promote market development and competition are major drivers as well.

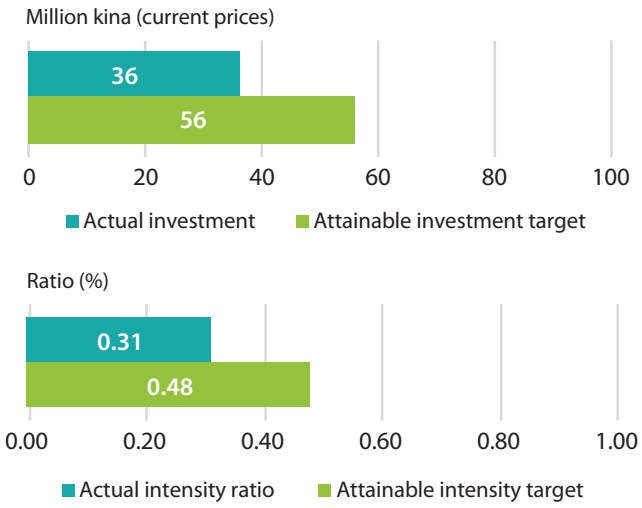
Agricultural output in PNG more than doubled during 1980–2016, driven almost entirely by growth in the use of inputs. TFP growth was extremely low during this period, at just 0.15 percent per year. In fact, TFP growth was negative during 1980–1995, but large advances in the country's commodity industries (palm oil, cocoa, coconut, and coffee) improved the performance of PNG's agricultural sector in the subsequent decade. During 1996–2005, yearly TFP growth exceeded 1 percent per year. Although this represents a considerable improvement over previous decades, it is still extremely low compared with most low- and middle-income countries, especially in Southeast Asia. Between 2005 and 2016, PNG's agricultural productivity growth slowed—to 0.4 percent per year—due to disease-related and other issues in the commodity industries (coffee rust, cocoa pod borer, aging coconut palms) and in the potato subsector (potato blight disease). Future acceleration of agricultural growth will be highly dependent on technical change.

Long-term growth in agricultural input, output, and productivity, 1980–2016



Source: Calculated by authors based on USDA-ERS (2019).

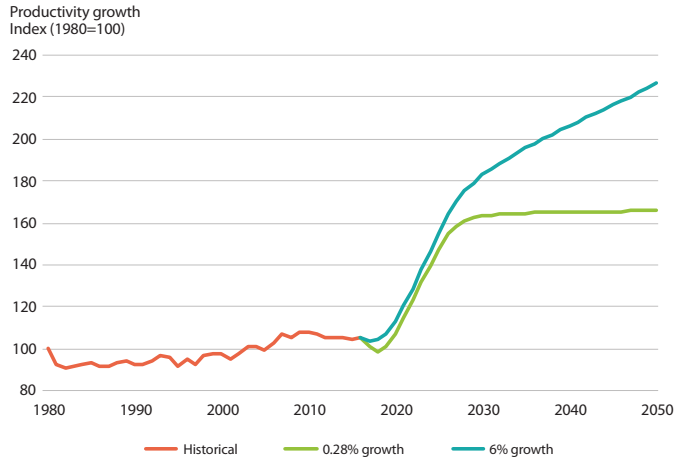
Actual research spending and attainable targets, 2017



Sources: Calculated by authors based on ASTI (2019) and Nin-Pratt (2016)

Notes: Traditionally, agricultural research intensity ratios compare investment and AgGDP levels to determine whether countries may be underinvesting. ASTI's Intensity Index incorporates additional factors that account for the size and nature of a nation's economy and hence facilitate more accurate cross-country comparisons. For more information, see https://astinews.ifpri.info/2017/07/01/anew-look-at-research-investment-goals-for-ssa/.

Agricultural productivity projections based on low- and high-investment scenarios, 1980–2050



Sources: Calculated by authors based on ASTI (2019), USDA-ERS (2018), Nin-Pratt (2016), FAO (2018), and World Bank (2018).

Note: For more information on the methodology behind these projections, see https://www.asti.cgiar.org/knowledge-stocks and https://www.asti.cgiar.org/tfp-projections.

THE IMPACT OF INCREASED R&D INVESTMENT ON FUTURE PRODUCTIVITY GROWTH

Conventional recommendations of agricultural research intensity levels, such as the 1 percent target set by the United Nations, assume that national investments should be proportional to the size of the agricultural sector. In reality, a country's capacity to invest in agricultural research depends on a range of variables, including the size of the economy, a country's income level, its level of diversification of agricultural production, and the availability of relevant technology spillovers from other countries. In efforts to address these nuances, ASTI developed a multi-factor indicator of research intensity that comprises a range of weighted criteria (for further details, see Nin-Pratt 2016). Under this approach, countries with the same mix of inputs are deemed to require similar minimum levels of research investment, and investment below that level is interpreted as an indicator that the country is potentially underinvesting based on its particular input mix.

ASTI's weighted indicator of research intensity demonstrates that PNG is indeed underinvesting in agricultural research. Even though the 1 percent investment target is out of reach, based on the structural characteristics of PNG's economy and agricultural sector, an investment target of 0.48 percent of AgGDP is thought to be realistic and attainable. To have met this lower target in 2017, PNG would need to have invested 56 million kinas, instead of the 36 million it actually invested (both in current prices). In other words, the gap between actual investment in agricultural research and estimated attainable agricultural research investment was 20 million kinas in 2017 alone. The 2017 investment gap is higher than in the 2000–2010 period because of PNG's irregular pattern of R&D investment since 2000. Between 2000 and 2017, average yearly growth in R&D spending was only 0.28 percent, but this long-term average masks considerable yearly variations. During 2000–2006 and 2014–2017, PNG's yearly rates of R&D investment growth were –4.8 and –5.8 percent, respectively, whereas during 2006–2013, growth averaged +5.9 percent per year.

What would it take for PNG to close the R&D investment gap, and how would increased agricultural R&D investment affect future productivity growth? In an effort to answer these questions, ASTI ran both low- and high-investment scenarios for the 2017–2050 period. The low-investment scenario was based on 0.28 percent growth in R&D investment per year (that is, the actual average rate that occurred during 2000–2017). The high-investment scenario was based on 6.0 percent growth in R&D investment per year (that is, close to the actual average rate that occurred during 2006–2013). Under the high-investment scenario—which is entirely feasible—PNG would close its agricultural R&D investment gap by as early as 2025. But what impact would these two scenarios have on productivity?

The two investment scenarios are projected to yield only very small differences in productivity growth to 2025, first, because such investments involve an inherent time lag before they deliver results, and second, because the fast productivity growth under both scenarios during 2017–2025 stems from the high (actual) rate of investment growth during 2006–2013. Once the effect of this past investment peak fades after 2025, TFP growth in the low-investment scenario stagnates, and the effect of the higher investments under the second scenario accelerates. Under the high-investment scenario, TFP levels could as much as double between 2017 and 2050, yielding a projected rate of TFP growth of 2.3 percent per year on average for the period.

WEAK AGRICULTURAL RESEARCH AND EXTENSION SYSTEM

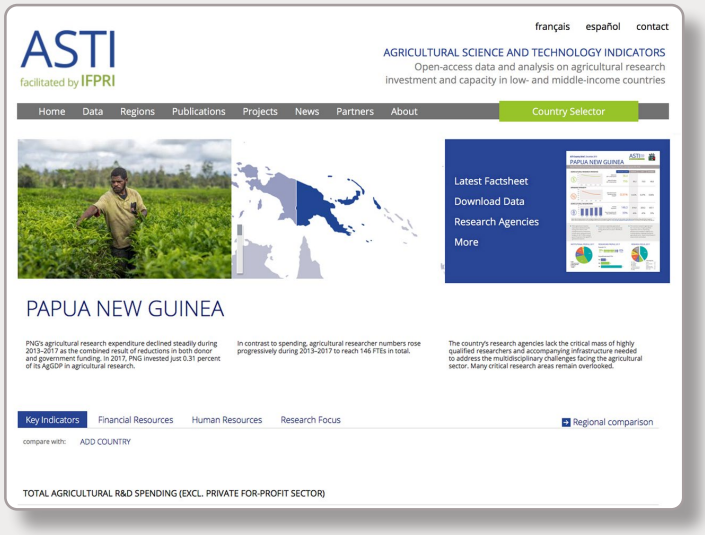
An important factor limiting the impact of agricultural research investment in PNG is the relative ineffectiveness of the country's agricultural extension system. Government extension/advisory services are severely underfunded and, hence, restricted in their ability to provide adequate support. Research agencies endeavor to fill this gap by partnering with local government extension services and a range of other stakeholders—including, agro-industry, local and international nongovernment organizations operating in target areas, civil society organizations, schools, and so on—to encourage the adoption of new technologies. Linkages among these stakeholders are generally weak because activities tend to operate on an ad hoc basis. A more holistic approach to agricultural innovation, comprising research, extension, education, and policy is vital. Also key in stimulating interactions among the relevant actors are an effective institutional framework, relevant governing mechanisms, and a conducive political environment.

OVERVIEW OF PNG'S AGRICULTURAL RESEARCH AGENCIES

Thirteen agencies conduct agricultural R&D in PNG. NARI (60 FTE researchers in 2017) is the largest by far, accounting for about 40 percent of PNG's total agricultural research capacity in 2017. In addition to assisting the sectoral and national government bodies in formulating agricultural policies, NARI conducts research related to food crops, livestock, aquaculture, natural resources, postharvest and value chain issues, and agricultural economics. NARI is headquartered in Lae and operates 6 agricultural research centers, 1 chemistry analytical laboratory, 1 biotechnology laboratory, and 1 insectary laboratory. PNGFRI (21 FTEs), FPDA (11 FTEs), and NFA (17 FTEs) focus on forestry, vegetable crops, and fisheries research, respectively. The higher education sector accounted for just 10 percent of the country's agricultural research capacity in 2017. Crop, livestock, forestry, and natural resources research is conducted by UNITECH's Department of Agriculture (5 FTEs) and Department of Forestry (2 FTEs), by UNRE (5 FTEs) and by UOG's Department of Agriculture and Rural Development (3 FTEs). PNG's nonprofit sector plays a comparatively important role in the country's agricultural research system. CIC (4 FTEs) focuses on coffee research, OPRA (10 FTEs) carries out oil palm research, and the Cocoa Board (9 FTEs) focuses on coca research. Finally, two private for-profit companies—New Britain Palm Oil Limited (6 FTEs) and Trukai Industries (0.2 FTE)—conduct research on oil palm, and on sugar and rice, respectively.

For a complete list of the agencies included in ASTI's dataset for PNG, visit **www.asti.cgiar.org/papua-new-guinea**.

For more information on ASTI's **data procedures and methodology**, *visit* **www.asti.cgiar.org/methodology**; *for more information on agricultural R&D in PNG, visit* **www.asti.cgiar.org/papua-new-guinea**.



ACRONYMS USED IN THIS COUNTRY BRIEF

ACIAR	Australian Centre for International Agricultural Research
ARSDF	Australia Agricultural Research Development Support Facility
CCIL	Cocoa and Coconut Industry Limited
CIC	Coffee Industry Corporation
DFAT	Department of Foreign Affairs and Trade
FPDA	Fresh Produce Development Agency
FTE(s)	full-time equivalent(s)
NARI	National Agricultural Research Institution
NFA	National Fisheries Authority
OPRA	Oil Palm Research Association
PNG	Papua New Guinea
PNGFRI	Papua New Guinea Forest Research Institute
PPP	purchasing power parity (exchange rates)
R&D	research and experimental development
TFP	total factor productivity
UNITECH	University of Technology
UNRE	University of Natural Resources and Environment
UOG	University of Goroka

ABOUT ASTI, IFPRI, APAARI, AND NARI

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