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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, 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, 5 countries were classified as high income, 7 as medium income and 10 as low income.

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.

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It is recommended that in 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.

Key words : agricultural research, objectives and strategies, investment, sustainable development, Asia-Pacific, APAARI

1 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% 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 5 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%. 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 the 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% in 2010.

Meeting the food demand 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 detailed comprehensive information and systematic assessment about the past achievement 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.

2 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 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 have been received. This high response rate indicated seriousness of the countries invited at 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 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 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 US\$20,000 was considered high income, between US\$2,500 and 20,000 as medium income and below US\$2,500 was considered low income. These definitions are not exactly the same as 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, 5 are classified as high income, 7 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% 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.

¹ As of 1 July 2015, low-income economies are defined as those with a GNI per capita, calculated using the [World Bank Atlas method](#) of \$1,045 or less in 2014; middle-income economies are those with a GNI per capita of more than \$1,045 but less than \$12,736; high-income economies are those with a GNI per capita of \$12,736 or more. Lower-middle-income and upper-middle-income economies are separated at a GNI per capita of \$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, US\$	PPP GNI/capita at current Int. \$	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

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

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. We will see whether and how these characteristics are reflected in the country reports on policies for agricultural research and innovation for development.

3 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 differences in form, content and quality of information provided in the country reports. A combination 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 county or for the region.

3.1 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.

Table 2 Reported main agricultural policies and/or agricultural research policies 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 NRM (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 response by each country, column totals will not be equal to n or N in this and subsequent tables)

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 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 7 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 8 countries, 5 belonging to high income group, mentioned rural development, rural economic growth, promotion of agricultural industry and rural industry for economic development as 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.

3.2 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 solve 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 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.

Table 3 Reported 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

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 5 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, 2 of them in low income group, mentioned linking urban and rural development, and promotion of land management as adopted strategies.

3.3 Main specific focus areas covering commodities, enterprises, systems, and research approaches

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.

Table 4 Main 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

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 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 & information industries” and make 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.

3.4 Major priority areas for 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.

Table 5 Major priority areas for 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

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. Under each of the above broad categories individual responding countries mentioned a few to a large number of specific areas reflecting local situation, 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.

3.5 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, bio-safety 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 have been 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.

Table 6 Reported 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

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 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% by 2020 to 45% 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.

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. 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% in 2015 to 50% in 2020; contribution of high technology products in agriculture rising from 15% in 2015 to 35% 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 7% growth rate in national GDP, though the demand for food grains will only grow by about 50%, 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 numbers 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. 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 numbers to indicate target.

3.6 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.

Table 7 Reported 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

Only 8 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 few and they have not matured enough to undertake or sponsor significant research and innovation activities. 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.

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 – 2 high income, 1 medium income and 3 low income - 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 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 HQs of AVRDC- an associate centre. Among the medium and low income countries, Philippines, Malaysia, India and Sri Lanka hosts the HQs of IRRI, World Fish, ICRISAT and 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 Table A6).

3.7 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 cursory information that are summarized in Appendix A7, a few observations can be made.

First, source of funding. With the expectation of Australia, government seems to be the primary source of funding for agricultural research and innovation in all the countries. 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% of research expenditure comes from the government – both central and provincial governments. Remaining 10% 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% 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. 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, level of investment. Only China, Bangladesh and Papua New Guinea mentioned that their agricultural research expenditure is equivalent to 0.5-0.6%, 0.67% and 0.60% of agricultural GDP, respectively against 2% of AgGDP recommended for developing countries. Out of China's agricultural research budget, 50% is allocated to crops, and 6% to livestock. Nepal reported that spending on research as a share of the agriculture sector budget has declined from 10-12% in the past to about 8% at present. Generally speaking, agriculture research and innovation is underinvested in the low and medium income countries.

Third, research personnel. Several countries have reported the number of scientists engaged in agricultural research and innovation (Appendix A7). 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, a few remarks can be made about the quality of the research staff in some of the reporting countries. In Korea, Taiwan and Japan, 72, > 40% and 38% of research staff, respectively, have PhD degrees compared to less than 10% in most low income countries. In Pakistan, only 18% of staff in government research institutions have PhDs compared to over 45% in universities. Nepal reported that PhD 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 PhD holders as they usually leave to join better paid NGOs/development agencies. China reported that about 50% 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% of research personnel are woman. No other country has provided this information.

Thus the cursory 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.

3.8 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 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.

Table 8 Reported 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 A8

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.

3.9 Looking ahead: roadmap for 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 interaction within regional bodies such as 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.

Table 9 Looking ahead – short and medium term in view

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, Rep.	Several specific plan 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
Iran, Islamic Rep.	The national research system will be reformed to adopt a more holistic approach to research for development during 6th plan 2016-20
Fiji	Fiji 2020 Agriculture Sector Policy Agenda Modernising Agriculture prepared in 2014
Sri Lanka	No formal roadmap, R & D guided by 2016-18 production plan with national policy goals stated earlier.
Philippines	Will continue to implement industry specific S and 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

4 Summary and Recommendations

4.1 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 are 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 area.

Among the main priority research areas, sustainability/natural resources management/climate change and new technology/improved productivity are most frequently mentioned 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 cursory 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.

4.2 Some issues deserve 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

4.2.1 Alignment with the sustainable development goals (SDG) agenda

The SDGs have been adopted at the United Nations General Assembly only recently and all the countries in the world are signatories, hence committed to the agenda (United Nations 2015). Among the 8 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, increasingly, the potential role of

agriculture in addressing MDG goals 1, 7 as well as 3 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 are missing and then see how missing elements can be filled. If all individual countries adopt the same approach, a coherent bigger picture will automatically emerge.

4.2.2 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 remain in terms of genetics, feed, disease management and market development.

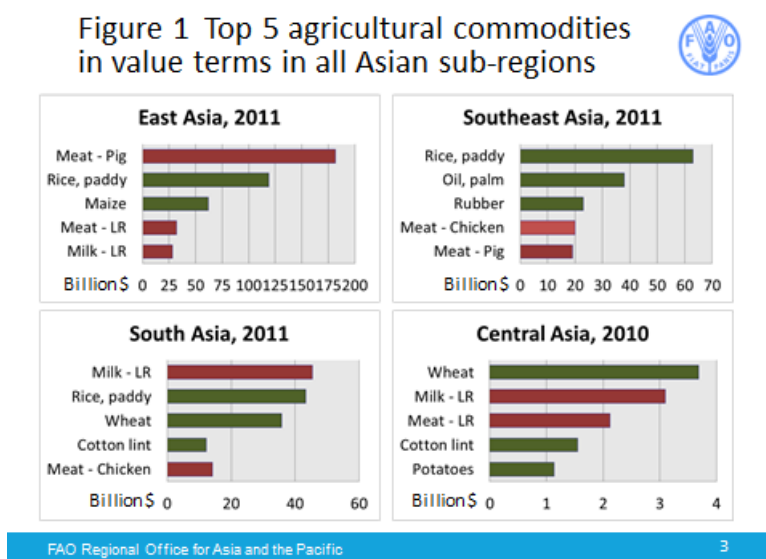
Globally, out of top ten agricultural commodities in value terms, half are livestock commodities like milk, chicken, pork, beef. Among the top ten commodities, maize and soybean are important crops and a significant portion of these are used as animal feed – hence connected to livestock. In various sub-regions 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; 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 or focus areas, 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 given to the livestock sub-sector within broad agriculture sector to address SDGs.

4.2.3 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 enhance 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 in 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).



Source: Vinod Ahuja, personal communication

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)

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 importunities of need and use’.³ 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 not apply. Many low income countries may have to prioritize where and how their limited

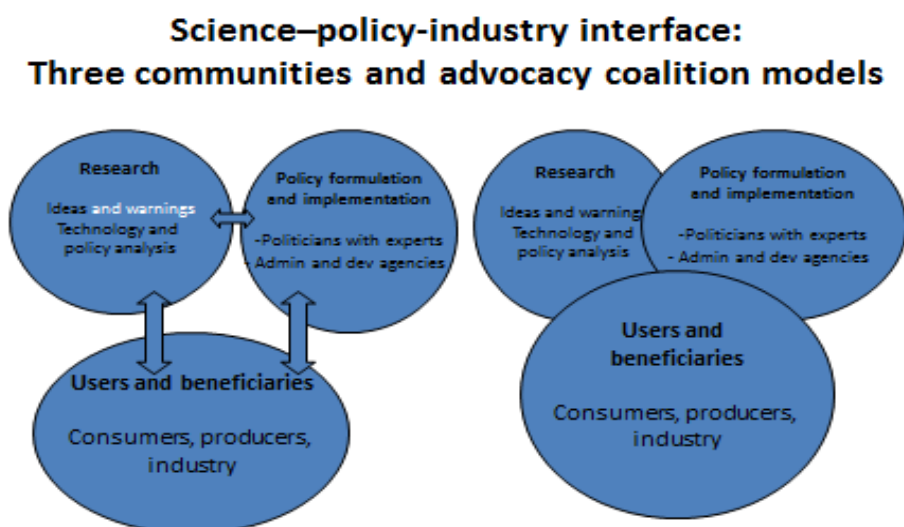
³ See the following two statements quoted in Perry (2015) : “Science can flourish only in an atmosphere of complete freedom, protected from the nagging importunities of need and use, because the scientist must travel where his imagination leads him”. Peter Medawar, Nobel Prize in Physiology or Medicine, 1960. “We do science best when we don’t have an application in mind”. Thomas Südhof, Nobel Prize for Medicine, 2013.

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.⁴

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.

Figure 2. Science-policy-industry interface



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

⁴ Based 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, 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.

4.2.4 Collaboration within regional bodies

The ASEAN and the 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 AEC goals, the second one is "to promote cooperation, joint approaches and technology transfer among ASEAN Member Countries and international, regional organisations 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 few, if any, intercountry collaboration in agricultural research that has been initiated and funded by the ASEAN. Only in donor funded multi-country projects, there is collaboration. Among the ASEAN Members 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 is going on.

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 policy objectives of the countries in Asia and the Pacific having implications for agricultural research and innovation

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

Source: Country reports for APAARI dialogue

Appendix A2. Main strategies for implementation of adopted policies

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 dev.
High income										
Australia		√	√			√	√	√		
Japan	√	√	√		√	√				
Korea, Rep.	√		√			√		√		
Taiwan			√			√	√	√	√	
New Caledonia			√					√	√	√
Medium income										
Malaysia		√	√			√			√	
China		√	√					√		√
Thailand			√	√	√					
Iran, Islamic Rep.		√	√	√		√				
Fiji			√	√					√	
Sri Lanka	√	√			√					
Philippines		√	√		√	√				
Low income										
Bhutan			√			√			√	
Papua New Guinea		√	√			√			√	
Vietnam								√	√	√
Lao PDR		√						√		
India		√		√	√			√		
Pakistan		√	√	√		√				
Bangladesh		√						√		√
Cambodia		√							√	
Nepal	√			√			√	√		
Afghanistan		√	√					√	√	

Source: Country reports for APAARI dialogue

Appendix A3. Main specific focus area

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	√					
Korea, Rep.			√	√		√	
Taiwan			√	√			√
New Caledonia	√	√			√		
Medium income							
Malaysia			√	√		√	√
China		√				√	
Thailand	√	√	√	√			
Iran, Islamic Rep.	√			√		√	
Fiji		√				√	√
Sri Lanka	√	√			√		
Philippines	√			√	√		√
Low income							
Bhutan			√			√	√
Papua New Guinea				√	√	√	
Vietnam	√	√	√				√
Lao PDR		√	√			√	
India		√	√	√	√		√
Pakistan		√				√	
Bangladesh		√		√			
Cambodia			√	√			√
Nepal	√	√	√	√			
Afghanistan		√				√	

Source: Country reports for APAARI dialogue

Appendix A4. Major priorities in agricultural research and innovation for development

Level of income and country	Food supply/ food safety	Cost cutting innovations/ competitiveness	Technology for rural industries/ Rural R&D/ 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	√	√	√	√				√	√
Korea, Rep.	√	√						√	√
Taiwan				√			√	√	
New Caledonia			√					√	
Medium income									
Malaysia				√			√		
China	√			√	√		√	√	
Thailand		√			√			√	
Iran, Islamic Rep.				√				√	
Fiji				√				√	
Sri Lanka				√		√		√	
Philippines				√	√			√	
Low income									
Bhutan			√	√	√			√	
PNG					√			√	
Vietnam				√	√				
Lao PDR				√				√	
India				√				√	
Pakistan				√				√	
Bangladesh				√		√		√	
Cambodia				√	√	√		√	
Nepal				√		√		√	
Afghanistan	√			√					

Source: Country reports for APAARI dialogue

Appendix A5. Major targets set to be addressed through agricultural development

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 dev	Sustainable dev/NRM	Monitor aid effectiveness
High income							
Australia		√					√
Japan	√			√			
Korea, Rep.	√			√	√	√	
Taiwan	√	√			√	√	
New Caledonia	√	√				√	
Medium income							
Malaysia	√						
China				√	√	√	
Thailand	√		√	√		√	
Iran, Islamic Rep.	√			√		√	
Fiji			√	√		√	
Sri Lanka	√		√			√	
Philippines	√		√			√	
Low income							
Bhutan	√			√			
Papua New Guinea	√		√			√	
Vietnam	√		√		√	√	
Lao PDR	√				√	√	
India	√			√			
Pakistan	√			√		√	
Bangladesh	√		√	√		√	
Cambodia	√		√			√	
Nepal	√		√	√		√	
Afghanistan				√		√	

Source: Country reports for APAARI dialogue

Appendix A6. Roles and responsibilities of institutions and nature of partnership

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
Korea, Rep.	√					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
Iran, Islamic Rep.	√	√	√	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 dialogue. For CGIAR donor information <http://www.cgiar.org/who-we-are/cgiar-fund/fund-donors-2/>

Appendix A7. 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
Korea, Rep.	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	?			
Iran, Islamic Rep.	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 dialogue

*at the Taiwan Agricultural Research Institute only

Appendix A8. Major challenges and opportunities

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	√						√				√	√	
Korea, Rep.				√			√						√
Taiwan	√		√	√			√				√		
New Caledonia										√			
Medium income													
Malaysia	√	√	√	√									√
China	√						√						
Thailand	√										√	√	
Iran, Islamic Rep.	√							√	√				
Fiji									√	√			
Sri Lanka	√	√	√			√							
Philippines	√				√	√		√		√		√	
Low income													
Bhutan								√	√				
PNG					√			√				√	
Vietnam		√						√				√	
Lao PDR	√								√	√			
India	√				√							√	
Pakistan	√	√									√		
Bangladesh	√	√			√					√			
Cambodia								√	√	√			
Nepal								√		√			
Afghanistan	√								√	√		√	

Source: Country reports for APAARI dialogue