Conference Paper

Solutions for agricultural transformation : insights on knowledge-intensive agriculture

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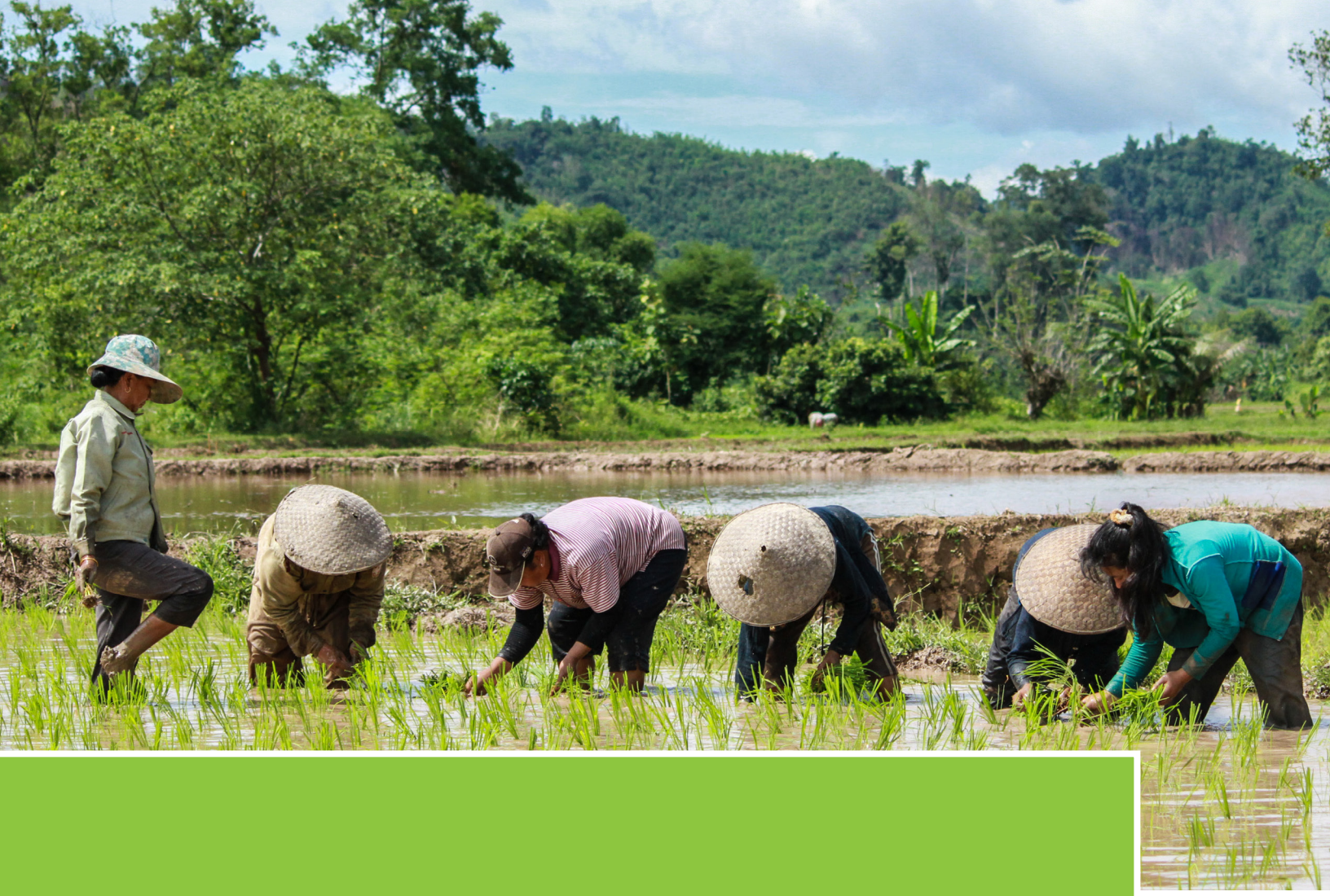

SOLUTIONS FOR AGRICULTURAL TRANSFORMATION

INSIGHTS ON KNOWLEDGE-INTENSIVE AGRICULTURE

APRIL 2018

ASIAN DEVELOPMENT BANK

ADB

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Photo on the front cover: No farmer should be left behind in the journey toward knowledge-intensive agriculture. (Photo by Xaykhame Manilasit)
Photo on inside pages: Al Benavente

Contents

Abbreviations

ADB	Asian Development Bank
ANR	agriculture and natural resources
AWD	Alternate Wetting and Drying
CGIAR	Consultative Group for International Agricultural Research
FAO	Food and Agriculture Organization of the United Nations
HLT	high-level technology
ICT	information and communication technology
IRRI	International Rice Research Institute
MDG	Millennium Development Goal
PPP	public–private partnership
PRC	People's Republic of China
RDTA	research and development technical assistance
ROK	Republic of Korea
SDG	Sustainable Development Goal
UN	United Nations

Executive Summary

The Asian Development Bank (ADB) organized a 2-day workshop on Knowledge-Intensive Agriculture for government officials, development practitioners, partner institutions, experts, private sector, and policymakers from different countries on 15-16 June 2017. The workshop provided a platform to exchange experiences and ideas on how to design and implement appropriate measures to deliver knowledge and technology to farmers to build a knowledge-intensive agriculture. This report summarizes the following key points and messages from the workshop sessions on various aspects of knowledge-intensive agriculture.

Agriculture is now at a crossroad. The agricultural resource base is shrinking, the productivity of its resource base is declining, and its adverse environmental impacts are worsening. Existing agricultural production systems, which require many inputs, have become increasingly untenable. Agriculture needs to take a new path for it to address the challenge of environmental degradation and climate change while meeting the global commitment to end hunger and malnutrition.

The current regime of resource-intensive agriculture can be transformed into knowledge-intensive agriculture. Science and technology can potentially revolutionize food production. Scientific and technological advancements have made it possible to increase food production notwithstanding its shrinking resource base. However, several factors may deter the realization of such opportunities. Farmers' lack of knowledge and their access to technology are some of the possible roadblocks. The appropriate approach, mechanism, and institutions to deliver the knowledge and technology to farmers are yet to be developed.

Existing and/or emerging knowledge should suit the needs of the agriculture sector. The transition from traditional to knowledge-intensive agriculture depends on the country's level of development. The farmers' attitude and culture are crucial considerations as well. There is also a need to invest in effective agricultural extension services to ensure that appropriate knowledge and technologies are disseminated.

Public-private-farmer partnership is key to the success of knowledge-intensive agriculture. Informed action is the main enabler of knowledge-intensive agriculture. Private companies collect massive data relevant to the food and agriculture sector. However, these data are not readily available and accessible to smallholders which spells the need to build the appropriate, accessible, and affordable provider-user network. Governments need to provide policy and infrastructural support for farmers to access the information collected and processed by the private sector.

No farmer should be left behind in the journey toward knowledge-intensive agriculture. Given the differences in knowledge and land endowment, not all farmers will be able to take advantage of relevant knowledge and technology. This could widen the gap between small and large farmers. One way to help farmers access new technology is by organizing them in groups. Governments should facilitate the producers' cooperatives so that smallholders can collectively access the key requirements of knowledge-intensive agriculture. Another option is to make the technology divisible to the extent possible for small farmers so they can use them independently since group-based access is often affected by the rural power structure.

Knowledge-intensive agriculture should be holistic. Aside from production at farms, investment is also required at mid-end (processing and storage) and front-end (distribution and retail) stages of the food chain to reduce post-harvest loss. Benefits of knowledge-intensive agriculture cannot be fully realized without improving and developing large market and distribution facilities widely known as wholesale markets.

Agricultural finance needs to scale up. The main thrust of knowledge-intensive agriculture involves collecting data, turning data into information, turning information into knowledge, and finally applying and reusing this knowledge in the field. Assisting the farmers with credit has been cumbersome and therefore sub-optimal. To promote knowledge-intensive agriculture, there is a need to promote innovative financing mechanisms to support the farmers regardless of their scale and location.

Introduction

The worldwide struggle to abate the incidence of hunger and malnutrition continues. The target set at the 1996 World Food Summit was to reduce the number of undernourished people to half their present level no later than 2015[1]—from 1,011 million in 1990–1992 to just 505.5 million by 2015. As of 2015, however, the number of hungry people still reached 777 million (Food and Agriculture Organization of the United Nations (FAO) 2016). Similarly, the Millennium Development Goals (MDGs) aimed to halve the proportion of hungry people, from 23.2% in 1990-1992 to 11.6% by 2015. However, the proportion of hungry people in 2014–2016 was 12.9%, again falling short of the target (FAO 2015). The number of hungry people in Asia and the Pacific remained at around 512 million at the end of the MDG period (FAO 2016).

Lessons learned from the previous unmet targets spurred the global community to renew its pledge in 2015 to build a hunger-free world by 2030 as one of its Sustainable Development Goals (SDGs). Doing more of the same, such as increasing agricultural production by expanding the use of inputs and other resources, will not suffice in meeting the challenge of the SDGs.

Agriculture is now at a crossroad: its resource base is shrinking, the productivity of its resource base is declining, and its adverse environmental impacts are worsening. Increasing food production, which is critical in achieving the SDG for hunger and malnutrition, can no longer solely be done through resource intensification.

Fortunately, technological innovations and improvements create opportunities for a paradigm shift from labor- and resource-intensive, to knowledge-intensive agriculture. This shift, however, would mean facing formidable challenges. Farmers' lack of knowledge and their access to technology are some of the possible roadblocks. The appropriate approach, mechanism, and institutions to deliver the knowledge and technology to farmers are yet to be developed.

The Asian Development Bank (ADB) organized a 2-day workshop on Knowledge-Intensive Agriculture for government officials, development practitioners, partner institutions, experts, private sector, and policymakers from different countries on 15-16 June 2017. The workshop provided a platform to exchange experiences and ideas on how to design and implement appropriate measures to deliver knowledge and technology to farmers to build a knowledge-intensive agriculture.

[1] FAO. World Food Summit. http://www.fao.org/WFS/.

Sharing of smart solutions. The 2-day workshop on Knowledge-Intensive Agriculture gathered around 60 participants to discuss ongoing initiatives, current and emerging trends, policy imperatives, and future directions (photo by Al Benavente).

This report consolidates the key points and messages from the workshop sessions on various aspects of knowledge-intensive agriculture (see Appendix 1 for the workshop program). At the panel discussions, experts, policymakers, and private sector leaders discussed key issues, including the restructuring and transformation of labor-intensive agriculture to knowledge-intensive agriculture; integration of information and communication technology (ICT) into agricultural supply chains; use of high-level technologies in upstream and downstream agricultural activities; addressing infrastructure gaps, the digital divide, and lack of knowledge, skill, and education of the farming communities; and the importance of partnerships and mainstreaming of the use of knowledge in the agricultural sector. This report distills and sums up these discussions to share with a broader audience.

The report is structured based on the flow of the workshop sessions:

- Agricultural Transformation: Evolution of Knowledge-Intensive Agriculture
- ADB Initiatives to Promote Knowledge and High-Level Technologies in Agriculture
- E-Agriculture: Use of Information and Communication Technologies for Agricultural Transformation
- Role of Partnerships in Knowledge-Intensive Agriculture
- Leveraging Project Knowledge and Experiences
- Summary and Recommendations

Welcome Remarks

Speaker

Bambang Susantono
Vice-President, Knowledge Management and Sustainable Development
Asian Development Bank

A very good morning to all the distinguished experts gathered here to discuss and facilitate the paradigm shift from labor to knowledge-intensive agriculture. I welcome you all on behalf of ADB.

Today we are guided and bound by the Sustainable Development Goal (SDG) 2, pledged globally in September 2015, to build a world free of hunger and malnutrition by 2030. Despite our past efforts, 490 million people went to bed unfed or half-fed in Asia and the Pacific in the same year that SDG 2 was adopted. In parallel, challenges that farmers face are still evolving with regional changes and global transformations. Providing food to everyone will therefore continue to be demanding requiring new thinking and stronger policy implementation measures.

This workshop serves as a platform for identifying measures to enable food producers and providers to achieve their goals of feeding the growing population of the world. It is true that agricultural growth during the last 5 decades or so has been driven by technology aiming to augment labor use and intensify agricultural inputs to extract more rent from the land. However, it is time to focus on maximizing output per unit of resources, with attention to the environment and climate change. These are the key pillars of a new normal, with the severity and frequency of extreme weather events increasing all over the world, more so in Asia and the Pacific.

Once it was believed that land has "some original and indestructible powers" as said by the famous economist David Ricardo in 1817. But things have changed. We know now, that the power of land is not "indestructible." Soil fertility is declining. Agricultural resources, including land, are shrinking and being claimed increasingly by other sectors. Farm workforce is decreasing as the young population are less interested in agriculture, making it a sector reliant on an aging population. For example, the average age of farmers in the

"We need new knowledge not only to make agriculture profitable, competitive with other branches of the economy and retain a young workforce, but also to address the environmental impacts of agricultural activities."

Philippines is over 57, and more than 58 in Thailand.[2] In India, about 2,000 farmers leave the agricultural sector every day.[3] The average age of farmers in the People's Republic of China is more than 56.[4] There was a 3.6 percentage point increase in the proportion of the farm population over the age of 55 in Viet Nam during 2006–2011.[5] We need new knowledge to make agriculture profitable so that it can compete with other branches of the economy and retain a young workforce, and address the environmental impacts of agricultural activities.

The projections by a 2009 ADB study suggested huge production losses, with the combined effects of flood, drought, salinity, water shortage, and temperature changes. Yields of primary commodities like irrigated rice, wheat, and soybeans could fall by 9%–44%, thereby lifting commodity prices by up to 50%. A lower micronutrient intake could see child malnutrition rates climb to 20% by 2050.

There is a need for a collective effort to promote the use of knowledge and improve technologies in agriculture, which can make agriculture profitable and attract a younger workforce. At the same time, it is even more important that we impart that knowledge among the farmers, disseminate the benefits of new technologies, and institute the right policy to deal with these new challenges.

I reiterate ADB's firm commitment to invest in the modernization of the agricultural sector.

In 2016 we organized a forum on safe, nutritious, and affordable food for all. This included a partnership dialogue and technology show on high-level technologies. There was active participation by more than 20 organizations, and a number of technical sessions with interactive discussions and a farmers' roundtable to hear the voices from the field. The main recommendations of the forum were (i) to promote the use of information and communication technologies (ICT), and other high-level technologies in agriculture (ii) prioritize investments in agricultural value chain development and (iii) develop innovative modalities for inclusive agribusiness financing.

This workshop is a continuation of our efforts to generate and share our knowledge to modernize agriculture to meet tomorrow's demand for food. As part of our continuing efforts, another forum is being planned that will focus on the restructuring and transformation of the agriculture sector.

2 M. B. Villar. 2017. Of aging farmers and food security. Business Mirror. 6 March. http://www.businessmirror.com.ph/of-aging-farmers-and-food-security/; Somporn Isvilanonda Knowledge Network Institute of Thailand. 2010. Thailand Agriculture: The Country's Profiles and Current Status. Presentation during the Agri Benchmark Cash Crop Conference 2010. May. Perth, Australia. http://www.agribenchmark.org/fileadmin/Dateiablage/B-Cash-Crop/Conferences/2010/Presentations/Thailand_Isvilanonda.pdf.

3 P. Sainath. 2013. Over 2,000 fewer farmers every day. The Hindu. 2 May. http://www.thehindu.com/opinion/columns/sainath/over-2000-fewer-farmers-every-day/article4674190.ece.

4 Y. Zang, X. Li, and W. Song. Determinants of Cropland Abandonment at the Parcel, Household, and Village Levels in Mountain Areas of China: A Multilevel Analysis. Land Use Policy. November. 41. pp. 186–192. http://www.sciencedirect.com/science/article/pii/S0264837714001185.

5 S. Heide-Ottosen. 2014. The Ageing of Rural Populations: Evidence on Older Farmers in Low and Middle-Income Countries. London: Help Age International. http://www.helpage.org/silo/files/the-ageing-of-rural-populations-evidence-on-older-farmers-in-low-and-middleincome-countries.pdf.

Our collective commitment to ending hunger and malnutrition will leave little doubt to ensure that we will move toward achieving SDG 2. This workshop is an enabling platform and contributes strongly in that direction. ADB looks forward to working with you more closely to achieve this end goal. Let me welcome you all once again, and wish you all constructive discussions and a successful workshop.

Thank you.

Agricultural Transformation: The Evolution of Knowledge-Intensive Agriculture

This session highlighted the evolution of the transformation and development of agriculture in the post-green revolution era, and tackled the mechanization and immersion of different technologies, the extent to which current extractive technologies can support agricultural growth, the integration of information and communication technologies (ICT) into agricultural supply chains, and the importance of innovative financing. The application of ICT to optimize the developments in the agriculture sector was discussed as well.

Moderator

Amy S.P. Leung
Deputy Director General
Sustainable Development and Climate Change Department
Asian Development Bank

The Evolution of Knowledge-Intensive Agriculture

Keynote Speaker

AKM Mahfuzuddin Ahmed
Technical Advisor
Rural Development and Food Security (Agriculture) Thematic Group
Asian Development Bank

The keynote presentation delivered by AKM Mahfuzuddin Ahmed offered a historical overview of agricultural transformation and its evolution. The invention of agriculture itself represents a great technological breakthrough that radically changed human society and led to the rise of the earliest civilizations. Throughout prehistory and antiquity, agriculture was based on cultivation of inexpensive and seemingly unlimited area of land.

The Industrial Revolution led to the application, within agriculture, of new scientific knowledge and industrial innovations, such as harnessing energy from fossil fuels. The Industrial Revolution made possible the era of modern economic growth alongside an exponential increase of population.

Since the 1960s, global population has grown at a fairly stable rate of 1.6% per year. Malthus, in *An Essay on the Principle of Population* (1798), predicted that population would outpace food supply. For instance, cereal production rate increased at 2.2% per year. Hence, the per capita supply of cereals in 2014 was 40% higher than in 1961 (FAO 2017). The growth in production was accomplished primarily by growth in cereal yields, averaging 2% per year. Growth must continue to meet the food requirements of a growing population. The United Nations (UN) projected that global population will rise to 9.7 billion by 2050 (UN 2015). The Food and Agriculture Organization of the UN (FAO) projected that the growth in cereals must be 40% higher in 2050 compared to its baseline (2006–2008).[6]

The economy underwent massive structural changes in recent decades. The output and employment share of agriculture fell over time throughout the course of development. Great demographic shifts involve rising populations, urbanization, rising female labor force participation, and an aging rural population. As a result of rising living standards and demographic shifts, consumer preferences have evolved from staples and traditional food, to diets based on animal proteins, packaged and processed foods, and more exacting standards of quality and food safety.

Even as agriculture expands and transforms, its sustainability is in doubt as it presses against fundamental resource limits. Past history of agricultural expansion, urban development, and land degradation has exhausted the potential for area expansion for agriculture. Natural habitats have diminished, while extractive practices have depleted water resources and wild fish stocks. Today's agriculture is operating in a different climate now than in the past. Agriculture itself is a significant source of greenhouse gas emissions, and conventional production systems are no longer sustainable under these conditions.

The alternative to conventional production systems is emerging as a knowledge revolution in agriculture unfolds. Knowledge-intensive agriculture involves the application of advanced knowledge and information to raise productivity and profitability throughout the agrifood system, while managing and mitigating risks at the same time. This contrasts with conventional agriculture, in which production depends on the availability of land and inputs, and is subjected to the uncertainties of nature.

[6] FAO. 2009. How to Feed the World in 2050. http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf.

Knowledge-intensive agriculture involves the application of ICT to optimize the development and application of new varieties, farm production inputs, farm operations, as well as downstream processing, storage, logistics, and marketing, including standards, quality, and traceability.

In the future, there would likely be a greater application of ICT in promoting food safety, particularly through the use of electronic identification systems, geo-informatics, and quality and safety measurement technology (e.g., determination of firmness, detection of contaminants, and chemical analysis).

The spread of knowledge-intensive agriculture, however, may worsen inequalities among agricultural producers. By 2040, many Asian countries will have an economic structure of output similar to many developed economies today (Briones and Felipe 2013). However, a relatively large share of their workers will continue to stay in agriculture, even as job generation weakens, as agricultural technology becomes more labor-saving.

A key role for public policy is to ensure the harness of knowledge innovations to promote sustainability and inclusiveness. Sustainable agriculture can draw on Big Data from environmental sensors, remote sensing, and smart farming, to detect contaminants: alteration of key ecologies (e.g., microbial populations in soil) and the spread of pests and diseases. A key to inclusive knowledge-intensive agriculture is farmer education, which must increasingly rely on e-extension to widen its reach. Penetration of financial services to serve the capital requirements of knowledge-intensive agriculture can be enabled by mobile systems for credit scoring, payments, and savings. With such innovations, knowledge-intensive agriculture may yet evolve on a trajectory that brings in rather than excludes small farmers and micro, small, and medium-sized enterprises.

“A key to inclusive knowledge-intensive agriculture is farmer education.”

Highlights of the Panel Discussion and Open Forum

Discussants

Jikun Huang
Professor and Director
China Center for Agricultural Policy
Peking University

Akmal Siddiq
Director
Environment, Natural Resources, and Agriculture Division
Central and West Asia Department
Asian Development Bank

Roehlano M. Briones
Senior Research Fellow
Philippine Institute for Development Studies

The panelists, who are from the academic, policy research, and development operations, agreed with the points raised in the keynote presentation, though with qualifications about the concept, feasibility, and potential impact of knowledge-intensive agriculture.

Whose knowledge? The panel discussion raised an important question about the inclusiveness of knowledge-intensive agriculture as one panelist asked the important question, "Knowledge-intensive agriculture for whom?" In some technologies, the knowledge is already bound up in an input, rather than the farmer; for instance, biotechnology is embodied in the seed. The farmers' lack of knowledge is a critical constraint in the spread of benefits from knowledge-intensive agriculture.

Moreover, just because an application involves high technology does not mean it is worthwhile to adopt. The overriding consideration for adoption should be efficiency, productivity, and distribution of benefits between farmers and other stakeholders compared to the current practices and technology. These three factors should also determine the role of markets and governments in promoting knowledge-intensive agriculture.

Knowledge for what? Although the panel discussion reiterated that science and technology have indeed played a critical role in history, the problem with agriculture today is not necessarily only technical. Rather, serious structural problems and the mismanagement of resources are the causes of distortion in the agricultural production system. Food security is threatened not by scarcity of land, but also by scarcity of water. Along with better technology we need better management and efficient institution to resolve these resource problems.

Knowledge to create or destroy agricultural jobs? The difference between innovations that are labor-saving (e.g., use of drones) and those that boost labor demand (e.g., seeds) is highlighted in the panel discussion. As rural wages continue to be stagnant, rural laborers may find attractive employment opportunities in the industry and services sectors in urban areas. This transition, however, depends on the matching of skills currently possessed by agricultural laborers with skills demanded in the industry and services sectors. Some would inevitably face difficulty in finding their niche. Technological advancement in agriculture and elsewhere implies greater creation of wealth, but distribution may still remain disproportionate. Perhaps what is needed is the massive reorganization of the welfare state to address employment prospects of low skilled workers.

Open forum. A question on the link between knowledge-intensive agriculture and integrated rural development was raised during the open forum. The discussion agreed that transition from traditional to knowledge-intensive agriculture depends on the level of a country's overall as well as rural development. For instance, in Australia, farmers have been spending a lot on tractors, whereas in Asia and the Pacific, farmers rely on manual labor. Farmers may likewise differ in their attitudes toward new technology adoption. Therefore, we should not pursue 'one size fits all' policy, rather emphasize on the customization of actions and strategies to promote knowledge-intensive agriculture.

Concerns were raised on the possible concentration production control by only a few large companies with the growing use of ICT; whether knowledge-intensive agriculture will end up bypassing smallholders, unfairly favoring big companies (e.g., pesticide producers), excluding indigenous knowledge systems, and achieving scale neutrality.

Knowledge-intensive agriculture need not follow the same pathway as traditional agriculture. The path of knowledge-intensive agriculture includes greater reliance on outsourcing, thereby mitigating some of the expertise demands on smallholders and the possibility that various ICT innovations (such as online platforms) can actually broaden the spread of benefits from knowledge intensification. The session was wrapped up by noting the importance of socioeconomic implications of knowledge-based solutions, as well as the need for a diversity of solutions to some of the concerns raised.

A venue for knowledge sharing. Participants and speakers exchange ideas and insights during the open forum (photo by Al Benavente).

ADB Initiatives to Promote Knowledge and High-Level Technologies in Agriculture

This session presented the technical assistance project of the Asian Development Bank (ADB) that promotes the use of high-level technologies (HLT) in both upstream and downstream agriculture. The importance of investments in education as a prerequisite for knowledge-intensive agriculture was highlighted as well.

Moderator

Akmal Siddiq
Director
Environment, Natural Resources, and Agriculture Division
Central and West Asia Department
Asian Development Bank

Education for High-Tech Agriculture

Keynote Speaker

Sungsup Ra
Director
Human and Social Development Division
South Asia Department
Asian Development Bank

The keynote presentation in this session focused on the production, dissemination, and management of knowledge required for the agricultural sector. Although other branches of science have been providing generic knowledge for all sectors, agriculture needs customized knowledge to meet the growing demand for food. Therefore, to facilitate the shift from resource-intensive to knowledge-intensive agriculture, high-technology universities with human resources and physical facilities need to be developed.

The majority of farmers are smallholders and lack the resources and knowledge to practice knowledge-intensive agriculture. Current agricultural extension services are designed mainly to deliver the agricultural inputs to the farmers. Whether or not this purpose has been adequately served is a different question but the current extension service needs to be refurbished to deliver the knowledge and technology to the farmers. Extension service workers have to be educated and trained as well. The rising demand for tertiary education offers an opportunity to revamp the agricultural education system.

Simultaneous to these, there is a need for a knowledgeable farming community. To transmit knowledge from the laboratory to the field, it is necessary to invest in piloting, demonstration, and dissemination. Government policy has to support transmission of knowledge. Small farmers belonging to the lowest income group and producing the bare minimum for their families need all kinds of support to practice knowledge-intensive agriculture.

The importance of support for high-technology agricultural universities to prepare future leaders in high technology agriculture in developing member countries was discussed in the keynote presentation. These universities will focus on harnessing the best scientific knowledge and technical breakthroughs, diffusing technologies and best practices, and strengthening academia–industry partnership across the entire agricultural value chain. Financial support will be needed for the development of curriculum, laboratories, faculty, entering into partnerships with world class universities, and strengthening academe-industry linkages. The proposed amount of investment is $400 million, spread out across South, Southeast, East, as well as Central and West Asia ($100 million each).

HLT for precision agriculture do not only include high-level technologies (e.g., remote sensing, geographical information system or global positioning system drones, robotics), but also knowledge and skills in the areas of logistics, management, and finance and many others. For example, in the People's Republic of China (PRC), spraying operations are done using drones. Aquaponics, a combination of aquaculture and hydroponics is prevalent in the Republic of Korea. Vertical farming is practiced in Japan and the United States.

The keynote presentation raised the following questions for further exploration to promote knowledge-intensive agriculture:

- How can we facilitate deep collaboration across disciplines, universities, and between sectors?
- Which high-level technologies should we target for developing countries?
- Do we have teachers available for high-technology agriculture in developing countries?
- How should ADB approach development of education for high-technology agriculture?

ADB Knowledge Sharing Technical Assistance: Investment Assessment and Application of High-Level Technology for Food Security in Asia and the Pacific

The ADB Food Security Forum was held in October 2016 to discuss the use of HLT in agriculture. Following the said forum, ADB approved the project Investment Assessment and Application of High-Level Technology for Food Security in Asia and the Pacific. This project has three main outputs: (i) assessment of investment for priority setting to promote HLT, (ii) promotion of HLT in upstream activity, and (iii) improvement of knowledge on wholesale market.

Improving Knowledge on Wholesale Markets

Speaker

Md Abul Basher
Natural Resource and Agriculture Specialist
Rural Development and Food Security (Agriculture) Thematic Group
Asian Development Bank

The wholesale market has three phases of development: first generation, second generation, and third generation markets. In first generation markets, which are the most basic and common phase of development in developing Asia, food in its raw form is traded. Some problems occur in first generation markets, such as asymmetric information about prices; poor arbitrage across space; absence of value addition; unreliability of supply, especially perishables; and risks of food contamination.

Second generation markets represent an upgraded version of the wholesale markets, with the introduction of sorting, refrigeration, cleaning, packaging, as well as a safe, secured, and clean environment.

Third generation markets is characterized by storage and quality infrastructure, product segmentation, and environmental excellence.

The ongoing ADB knowledge sharing and technical assistance (KSTA) seeks to contribute to the goal of upgrading first generation markets to second and even third generation markets. The main rationale for the effort is to meet the growing demand for fresh and quality food due to a rising middle class in urbanizing centers throughout Asia and the Pacific. The wholesale market can help meet this demand by reducing difficulties and cost of monitoring, detecting, and preventing, food contamination. It can also help by creating and maximizing leverage effects.

Wholesale markets functions as follows:

(i) collect products, through a supply network of producers, intermediaries, and logistics service providers, to ensure a smooth and undisrupted supply;
(ii) provide value addition, by certifying safety and quality; sorting and grading of agricultural products; and maintaining inventory under safe and nutrition-preserving storage; and
(iii) promote sales and marketing to consumers, identify and even anticipate changing preferences, and incentivize requisite adjustments in the supply chain.

Most wholesale markets in developing Asia and the Pacific are not performing these functions adequately to meet the food demands of middle-income economies. The KSTA seeks to lay the groundwork for solutions to the underdevelopment of wholesale markets.

To accomplish this, the KSTA will first undertake detailed profiling of agricultural supply chains and infrastructure in Asia and the Pacific. A custom-tailored model for selecting developing member countries will then be developed. Customization is needed owing to differences in country context and level of development. Government officials and policymakers on wholesale market development and management will be trained. These officials will be exposed to possible models in wholesale markets in developed countries, together with capacity building and training activities.

Assessment of Investment for Priority Setting to Promote High-Level Technologies

Speaker

Jikun Huang
Professor and Director
China Center for Agricultural Policy
Peking University

ADB's Operational Plan for Agriculture and Natural Resources (ANR) 2015–2020 focused on ANR as a key driver of inclusive growth and promotion of food security in Asia and the Pacific. Thus, there is a need to assess investments required in ANR to achieve economic growth and food security. The presentation provided an overview of this component of the KSTA. This component aims to:

(i) to estimate the total investments required in the ANR sector by considering the changing climate and ongoing economic and demographic transitions to produce adequate food to meet the demand in the region by 2030;
(ii) to prioritize areas for investment in the PRC and Indonesia; and
(iii) to suggest actions to be taken by governments and other stakeholders to mobilize new investments in the prioritized areas.

The regional analysis will span Central Asia, East Asia, South Asia, Southeast Asia, and the Pacific. Two countries are chosen for the country case studies: the PRC and Indonesia.

For the regional study, the methodology involves the utilization of a global quantitative modeling system to provide insights on baseline developments in global agricultural production systems, focusing on the potential impact of climate change; exploring the costs and implications of investments for reducing hunger in Asia and the Pacific; and examining the investment gaps by comparing the investment needed and the current levels of investment. The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) modeling framework includes macroeconomic feedback from a global computable general equilibrium model.

This IMPACT model is also used in the case study in Indonesia, which is linked with the Indonesia Computable General Equilibrium model. A comprehensive evaluation of investment obstacles and policy in agriculture are also included in the study.

This project will help ADB and national governments prioritize their agriculture investments and by extending technical support, help foster collaborative partnerships and contribute to the plans of national economic development.

Climate-Smart Practices and Varieties for Intensive Rice-Based Systems in Bangladesh and Cambodia

Speaker

Arvind Kumar
Senior Scientist
International Rice Research Institute

"Alternate wet-dry (AWD) irrigation has been demonstrated to reduce water use by 30% compared with flooded irrigation. Conventional irrigation has been criticized as a major source of greenhouse gas: with AWD, methane emissions fall by 40%."

One of the objectives of the KSTA is to promote climate-smart practices and varieties in selected countries. Activities under this component are as follows:

(i) identification of constraints for the adoption of climate-smart water saving mechanized technologies;
(ii) identification of policy, institutional support, and logistics needed to scale up high-level climate-smart water saving mechanized technologies;
(iii) conduct of six field demonstrations for 1-year crop cycles at two sites in Bangladesh (alternate wetting and drying [AWD]) and four field demonstrations at two sites in Cambodia (mechanized direct-seeded rice) and delivery of training by progressive farmers, government officials, and representatives from nongovernment organizations and the private sector;
(iv) multiplication of 13.5 tons of quality seeds of rice and other crops and distribution to 8,500 farmers; and
(v) demonstration of the benefits of water–labor–energy savings; reduction in greenhouse gas emissions; and increase in yield, farmers' income, and system productivity in Bangladesh and Cambodia.

The KSTA will build on lessons learned from earlier ADB- and International Rice Research Institute (IRRI)-supported projects. The current project is pilot testing an AWD system with water-saving varieties and management practices in Cambodia and Bangladesh. The main activities in both countries include identification of constraints, policy, institutional support and logistics, conduct of field demonstration; training; and farm visits. Based on completed activities, some challenges have been identified. Among the challenges in the adoption of AWD are reliance on field-to-field irrigation, the role of formal and informal leadership in water management decisions, and the staggered demand within small hydrological unit. AWD itself is laborious and time-consuming, as well as knowledge-intensive in terms of water management.

IRRI, meanwhile, has pioneered the development of a decision tool for water management. The decision tool collects real-time water-level data from the plot. The data enter a gateway or a cloud infrastructure (e.g., iGovPhil). Different government

agencies, such as the irrigation department, agriculture department, and irrigation association operators can access the information in the cloud.

Potential climate-smart water-saving technologies include: improved rice varieties, diversification of rice-based cropping system, conservation of agriculture, and mechanized crop planting to smart irrigation systems. There are numerous constraints in adopting these various options, broadly classified as biophysical (landscape, soil, water, and climate risk); production system (limited access to technology, skills, and knowledge); economic (high investment costs, limited capital); sociocultural (reliance on traditional practices, aversion to risk, low participation of women); and gaps in enabling environment (limited access to credit, markets; weak institutions, and poor governance).

Support mechanisms are needed to develop climate-smart agriculture, including policies to attract investments and improve farmer's access to credit. Extension activities for farmers are also necessary.

Highlights of the Panel Discussion and Open Forum

Discussants

Krishna Pada Halder
Chief Scientific Officer
Bangladesh Rice Research Institute

Takeshi Ueda
Principle Natural Resource and Agriculture Economist
Environment, Natural Resources, and Agriculture Division
Southeast Asia Department
Asian Development Bank

Ouk Makara
Director
Cambodian Agricultural Research and Development Institute

While appreciating the appropriateness of the methodology proposed for investment assessment, one panelist inquired if the assessment spans the agri-based industries and services; and whether the model encompasses food and feed interactions and household level impacts. All panelists also resonated the emphasis on agri-education for the promotion of knowledge-intensive agriculture.

During the open forum, participants commented on the need for education and investments in HLT. Education is essential to knowledge-intensive agriculture but tends to receive low priority in resource allocation, compared to infrastructure. This accounts for the lack of sustainability in some technology-related initiatives. Investments in high-level technologies are needed but often the incentives are absent, e.g., for entrepreneurial start-ups in agribusiness.

There were related queries regarding the distinction between HLT and knowledge-intensive agriculture; and what was being done to raise the knowledge of farmers to be able to use new technologies. It was reiterated that training of farmers was certainly an emphasis of the KSTA. It was also clarified that the proposed universities are also intended to address human resource requirements of agricultural research, development, and extension.

The session was concluded noting that today's HLT represents, an unprecedented advance over past capabilities. For instance, mobile phones offer a method for delivering information to farmers in the most remote areas of a country at a very low cost. ADB is keen on promoting HLT to demonstrate profitability, and thereby engage the private sector, who will eventually drive the development and adoption of these technologies.

E-Agriculture: Use of Information and Communication Technologies for Agricultural Transformation

This session examined actual cases of applying ICT for agricultural transformation, covering public sector experience in the Republic of Korea (ROK); private sector experience in Europe, Africa, and Asia; and ADB experience in the PRC.

Moderator

David Shearer
Director
International Partnerships
WorldFish Center

The Republic of Korea's Information and Communication Technology-Related Agricultural Projects and Lessons Learned

Keynote Speaker

Sanghun Lee
Director
International Trade and Cooperation Department
Korea Agency of Education, Promotion, and Information Services in Food Agriculture, Forestry, and Fisheries

The ROK has invested heavily in the development of ICT infrastructure and now has the fastest internet speed and the highest ICT index in the world. Different farms in the area of dairy, livestock, horticulture, and aquaculture are using ICT in the ROK. Farmers get real-time data about the status of their farms and trigger automated actions in response by using agri-ICT tools.

One such system is AGRIX, which is an integrated agriculture projects information system that serves as a one-stop agricultural financing service. It offers online service for farmers and subsidies management. Another example is the Korean Soil Information System, which produces detailed information on soil condition, climate mapping, and biological mapping. The Okdab Agricultural Information System is also an online service that provides various information on production (e.g., agriculture weather and farming calendar), and marketing (e.g., real-time auction price, market price survey, and agricultural outlook). Consumers may also access a traceability system that tracks information from farm-to-table (e.g., beef). These services are developed and provided by the Government of the ROK.

Using its own Official Development Assistance resources, the Government of the ROK is also assisting other countries in Asia and the Pacific in realizing the benefits of ICT innovation. One of the ROK's agri-ICT is the National Agrifood Information system which collects and disseminate agriculture data by using different gadgets. With the Official Development Assistance support, the ROK has already started piloting the system in Indonesia to establish an online national sugar data system that can be accessed by the farmers.

Data-Driven Agriculture: Empowering Smallholders via Technology

Keynote Speaker

Vishnu Nair
Regional Director (Asia and the Pacific)
Pessl Instruments GmbH

This presentation discussed the private sector perspective on experiences and prospects for a data-driven agriculture and how smallholders are empowered through the use of ICT. Data-driven agriculture enables integrated farm management system encompassing irrigation, farm equipment, weather data, and others. There are innovative data acquisition tools that are used to collect field or weather information, such as drones, field sensors, and satellites. However, some further steps are needed to make them available to the farmers at an affordable cost.

The proprietary network of field devices for generating high-resolution environmental data is called an Agro-Meteo Network. These devices are useful in weather monitoring, nutrition management, crop health management, and other services. Collected data are stored in the data center, which funnels the data to a specific client as per their need.

A private company specializes in the use of field sensors to collect agricultural data and then sharing them with the farmers as per their need. The company has ongoing operations in Niger and the Philippines from which the smallholders regularly receive various information that have resulted in yield improvements.

The company installed solar powered on site sensors, which are maintained by local distributors to collect a wide range of location-specific granular information for sharing. Farmers registered with these distributors specify the location of their farms, the types of the crop they produced, and the range of the services they required. The real-time information are automatically transmitted to farmers in their handheld gadgets such as mobile phones. Depending on the contract of the services, farmers sometimes receive simple instructions on what to do, instead of raw data that are very difficult for them to analyze, so they can decide on their course of action.

The company has a similar project in the Philippines, where monitoring systems are installed in the municipality area of Buguias to share the data with farmers with mobile phones and web interface.

Gansu Internet-Plus Socialized Agricultural Service System Development Project

Keynote Speaker

Jan Hinrichs
Natural Resources Economist
Environment, Natural Resources, and Agriculture Division
East Asia Department
Asian Development Bank

The Gansu Internet-Plus Agriculture Project aims to develop inclusive agricultural service systems together with farmer cooperatives. An agricultural service industry chain encompasses agricultural production and operation, cold chain logistics of agricultural products, and marketing service system of special agricultural products.

The project entails the application of network connected sensors and tracing technology along the value chain, from production to marketing, and the enhancement of market access through a two-way information exchange system between producers and consumers. In particular, consumers will be provided with product origin and process information, while producers are provided with market information and production support services.

The project, which costs $240 million, aims to deliver three outputs:

(i) **Output 1** is a comprehensive information system and management platform, which will eventually develop data and training centers with information platforms to process data generated at production and processing for e-commerce marketing. Three regional farmer-training centers in Jiuquan, Lanzhou, and Tianshui are chosen based on six major featured agricultural industries of Gansu.

(ii) **Output 2** is a modernized agricultural processing, storage, and marketing system built from a logistic and distribution system (e.g., intelligent cold chain), and design of an integrated information exchange network for enhanced market access.

(iii) **Output 3** is a modernized agricultural production which involves the establishment of agricultural production bases. High-value production systems will be equipped with "internet of things (IoI)" applications for increased production efficiency and coordination.

Highlights of the Open Discussion

Based on the case studies presented, workshop participants were divided into groups to discuss three questions, followed by a presentation of discussion outputs:

1. What are the key lessons from the case studies?
2. What are the key opportunities for impact?
3. What is the role for public and private investment?

There was a convergence among the groups that the private sector must play a significant role in promoting data-driven knowledge-intensive agriculture and governments should play the auxiliary role. Governments must provide the necessary infrastructure but should avoid actions that can potentially drive away or crowd out the private investment to provide ICT-related services to the farmers.

However, it was also recognized that depending on the country context, governments can play a major role, especially in the beginning, to provide open access to information to small farmers to demonstrate the benefits of knowledge-intensive agriculture. Governments should also ensure the supportive governance and regulatory environments in which the inclusive knowledge-intensive agriculture can thrive with the participation of the private sector and farmers.

Concern was also raised whether or not the dependence of the farmers on the private sector creates the possibility of their exploitation later. It was advised that governments remain vigilant to ensure that farmers get their fair share in the agricultural surplus generated from knowledge-intensive agriculture.

Role of Partnerships in Knowledge-Intensive Agriculture

Public–private farmer partnership is crucial in promoting knowledge-intensive agriculture. However, a clear and conducive interphase between the private and public sector to promote knowledge-led agricultural growth is yet to emerge. This session focused on the synergy between public and private sectors and their complementary roles.

Moderator

AKM Mahfuzuddin Ahmed
Technical Advisor
Rural Development and Food Security (Agriculture) Thematic Group
Asian Development Bank

The Role of Public–Private Partnerships in Knowledge-Intensive Agriculture

Keynote Speaker

Paul P. S. Teng
Principal Officer
National Institute of Education, Singapore

This presentation discussed the importance of partnerships among different stakeholders in the back-end, mid-end, and front-end stages of agricultural activities. Examples of back-end activities are research and development to develop inputs, technology transfer, and husbandry (production). Mid-chain involves processing and storage. Front-end activities are more concerned on delivery to consumers (such as distribution and retail).

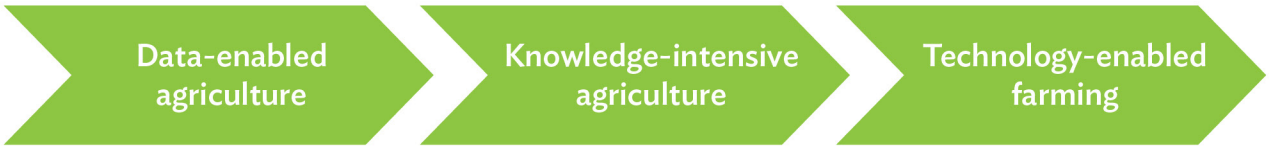
Knowledge is used to link these stages. The complexity of back-ends and front-ends of these supply chains require partnerships of different modalities.

One modality of partnership is public–private partnership (PPP). PPP is "...any (research) collaboration between public and private sector entities in which partners jointly plan and execute activities with a view to accomplishing agreed-upon objectives while sharing the costs, risks, and benefits incurred in the process."[7] PPP has a broad definition. At each stage of the agrifood supply chain, the nature and modality of the PPP needs to be clearly stipulated and agreed upon, especially the contribution of each partner. There are enablers to ensure success of PPPs for each stage and its modality.

Various types of PPPs may be grouped based on their purpose or on their modality. Examples of PPPs based on purpose are resourcing partnerships, contracting partnerships, and collaborative or joint venture partnerships. On the other hand, examples based on modality are research partnerships, commercialization (product development), sector or value chain development partnerships, technology transfer or exchange partnerships, and upscaling and stewardship partnerships.

The identified enablers of success for PPPs are shared common goals, universalization in applying knowledge, supportive macro-policies, regulations and institutions, an enabling regulatory and intellectual property environment for supply-chaining, supportive internal systems and governance in each partner, and mindset and culture for engagement.

Partnerships should not only include the government and the private sector, but other stakeholders like multistakeholder partnership and public–private–producer partnerships (PPP-Ps). An emerging "ecosystem" for PPP-Ps could be described as follows:



Source: Teng, P. 2017. *The Role of PPPs in Knowledge-intensive Agriculture.* Presentation material prepared for the Knowledge-intensive Agriculture Workshop. Manila, Philippines. 15-16 June.

Among all the sectors, agriculture is the least digitized sector. However, there is great potential if we are able to turn data into useful knowledge for wise decision making.

[7] D. Spielman, F. Hartwich, and K. von Grebmer. 2010. Public–Private Partnerships and Developing-Country Agriculture: Evidence from the International Agricultural Research System. Public Administration and Development. 30 (4). pp. 261–276.

Financing for Agriculture: The Role of Public–Private Partnerships

Keynote Speaker

Arup Kumar Chatterjee
Principal Financial Sector Specialist
Finance Sector Group
Sustainable Development and Climate Change Department
Asian Development Bank

This presentation explained the role of PPPs in financing for agriculture. Just like in other sectors, access to finance is crucial for growth of the agriculture sector. However, the risks prevalent in the sector inhibit financial institutions from lending. The situation is worsened by the lack of records and statistics, and by the higher transaction costs in rural areas compared to urban areas. Thus, governments carry out initiatives to attract investments for the sector.

Who needs finance? All actors along the value chain need finance. However, special attention is given to smallholder farmers and even small agricultural entrepreneurs because of their inability to access financial support. Other areas that need financial investments are rural infrastructure and research and development.

Who finances agriculture? Despite their limited investments, farmers and small entrepreneurs are among the financiers of the agriculture sector. Cooperatives and credit unions are also sources of financing for the sector. More formal institutions such as local commercial banks, branches of foreign banks, and insurance companies provide financial instruments. National and local governments, development banks, and donors invest in agriculture, especially in the aspects of infrastructure and of research and development. Financial instruments given by these financiers vary. Some provide direct finance, while others give value-chain finance.

Why do we need PPPs in agriculture? While the government is expected to provide financial support needed by the agriculture sector, budgetary constraints exist that could hamper developments in the sector. Developing competitive agriculture is often costly. Through the partnership, by increasing private sector interest, social objectives would be better met and the base of the pyramid would be reached. The PPP modality provides an option to modernize agriculture and revitalize rural economies.

The session cautioned that PPP in agriculture should not be thought of as a panacea. Experience suggests PPP has some niche areas where it works well. These include value chains, farm-to-market connectivity, construction of wholesale markets, irrigation infrastructure, agri-insurance, and agriculture research and innovation.

"While the government is expected to provide financial support needed by the agriculture sector, budgetary constraints exist that could hamper development in the sector... The PPP modality provides an option to modernize agriculture and revitalize rural economies."

Highlights of the Panel Discussion

Discussants

Qiaoqiao Zhang
Director
Centre for Agriculture and Biosciences International

Leocadio S. Sebastian
Regional Program Leader for Southeast Asia
Consultative Group for International Agricultural Research (CGIAR)
Climate Change, Agriculture and Food Security Research Program

Ram C. Sharma
Regional Coordinator for Central Asia and the Caucasus
International Center for Agricultural Research in the Dry Areas

Martin Lemoine
Principal Investment Specialist
Private Sector Operations Department
Asian Development Bank

Michiko Katagami
Principal Natural Resources and Agriculture Specialist
Rural Development, and Food Security (Agriculture) Thematic Group
Asian Development Bank

The panel offered complementary perspectives on PPPs for knowledge-intensive agriculture. It was highlighted that we should be aware of the differences in culture and business models. The kind of leadership also matters in the promotion of PPPs. Every institution should try to develop and align their strategic goals with the Sustainable Development Goals (SDGs).

The perspective of research also emerged in the panel discussion, and it was agreed that PPP should be used to bridge the information gap and facilitate knowledge transfer. In terms of promoting knowledge-intensive agriculture, governments must take the initiative to build trust and confidence among the private sector.

The private sector invests in highly commercial crops like livestock and high-value horticulture. They need space and control to respond to the demands of the market. In a fully integrative model, the private sector takes part in the whole process of the agricultural value chain. Admittedly, the private sector tends to emphasize control and consolidation over the supply chain to meet market demands. In some cases though, it will benefit investors to collaborate with farmers by equipping them with knowledge to ensure the quality of the produce. Based on ADB experience, the traditional, public extension system is ill-equipped to scale up technology dissemination to smallholders throughout developing Asia. ADB tries to adopt innovative extension solutions through the use of ICT in partnership with the private sector.

Based on the insights on ADB's past projects on food security and what it currently does to respond to the needs of the agriculture sector, one view was that traditional research and development failed, and this was partly because they were too costly. Now, the ADB tries to adopt innovative solutions through the use of ICT in collaboration with the private sector. For example, in Pakistan, farmers receive short messaging service-based extension support. The use of mobile communication has significantly minimized the costs incurred by the project.

Highlights of the Open Forum

Participants in the open discussion emphasized on the design and rule of the game to be followed in pursuing PPPs. Citing the seed as an example, one participant mentioned that governments should focus on the foundation and breeder seed, while private producers can take care of registered and certified seeds. Appropriate mechanisms to share the benefits of private investment have also been highlighted. For infrastructure (e.g., internet backbone), the private sector can be induced to invest—even commit very large outlays—if they are not crowded out by the public sector, and if they are convinced that they can capture some of the benefits accruing to rural producers.

At the same time, the importance of humanizing the private sector engagement has also been flagged by more than one participant. For instance, the private sector may seek to promote agrichemicals in its farmer extensions, whereas environmental goals may be high priority in government-led extensions.

Collaboration is key. Participants raise questions and issues on the PPP modality, particularly how it can help modernize the agriculture sector (photo by Al Benavente).

Leveraging Project Knowledge and Experiences

This session presented the approaches and experiences of various stakeholders from different countries in promoting knowledge-intensive agriculture. The operational experiences of ADB in the agriculture and natural resources sector were also tackled.

Moderator

Jiangfeng Zhang
Director
Environment, Natural Resources, and Agriculture Division
Southeast Asia Department
Asian Development Bank

Highlights of the Panel Discussion

Panelists offered various experiences and perspectives from different countries as shared by government officials, donor agencies, and ADB.

Panelists: Government Officials from ADB Developing Member Countries

M A Matin
Director General In-Charge
Rural Development & Cooperative Division, Bangladesh

Ngin Chhay
Director
Department of Rice Crop, Cambodia

Ifan Martino
Development Planner
National Development Planning Board, Indonesia

Banshi Sharma
Joint Secretary
Ministry of Livestock Development, Nepal

Vu Ngoc Chau
Director
Ministry of Agriculture and Rural Development, Viet Nam

Panelists: Asian Development Bank Staff

Randall E. Jones
Senior Natural Resource and Agriculture Economist
Environment, Natural Resources, and Agriculture Division
South Asia Department
Asian Development Bank

Sanath Ranawana
Senior Natural Resources Economist
Environment, Natural Resources, and Agriculture Division
Southeast Asia Department
Asian Development Bank

Samjhana Shrestha
Senior Economist
Environment, Natural Resources, and Agriculture Division
Central and West Asia Department
Asian Development Bank

Srinivasan Ancha
Principal Climate Change Specialist
Environment, Natural Resources, and Agriculture Division
Southeast Asia Department
Asian Development Bank

The experience of an ADB-supported value chain project, Achieving Food Security through Climate Resilience Dairy Value Chain Development in Tajikistan was shared in this session. Although the dairy sector is a key source of livelihood in Tajikistan, the productivity of the sector is low. This project introduced a modern and highly productive breed of cows, and improved the supply chain by linking milk suppliers to the market. The project seeks to boost on-farm productivity and environmental sustainability through resource management (rotational grazing, limits on the number of heads per household), and other measures to ensure safe and quality milk and dairy products through the value chain.

One panelist highlighted the importance of custom-tailoring the technology to suit the local context and enhance sustainability. He cautioned about too much drive for profit by the private sector that defies the other social and environmental considerations. Nonetheless, he agreed with the important role to be played by the private sector to promote climate-smart knowledge-intensive agriculture.

Lessons learned from the ADB-supported transport corridors initiative in the Greater Mekong Subregion (GMS), GMS East-West Economic Corridor Agriculture Infrastructure Sector Project, with a strong emphasis on agricultural competitiveness, was also discussed in this session. Aside from infrastructure (e.g., roads and highways), the project seeks transformation of these transport corridors into economic corridors. The importance of institutions (e.g., making safety and quality testing available within the country), policies (e.g., mainstreaming climate change); technology (e.g., use of geographical information systems in land-use planning); behavior (both of farming communities and private sector); and markets and financial instruments for this transformation was emphasized.

Learning from others. Panelists share their respective experiences in promoting knowledge-intensive agriculture (photo by Al Benavente).

The slow implementation pace coupled with the lack of ability to disburse funds in a timely manner was identified as a major challenge in many developing countries like Nepal. At the same time, it was argued that high subsidy is not required to promote financially viable agriculture based on knowledge and technology.

While sharing experiences from Bangladesh, it was pointed out that agriculture failed to mobilize private investments. Very little of the remittances is invested in agriculture, although the rural area is the main recipient of these remittances.

One panelist emphasized the role of inter-ministerial collaboration and consistency to promote food safety and security, and reiterated that not a single government agency is responsible for the whole value chain. Although consumers are willing to pay a premium for safe and nutritious food, such signals do not reach the farmers. The role of both public and private sector is to bridge the connection between producers and consumers. He also emphasized the sustainability of the gains of infrastructural projects. A key bottleneck is the developing member government implementers' failure to account for the needs of their clients. For instance, a value chain project may identify assembly points that may not be the best locations from the viewpoint of farmers. The marketing arrangements would then unravel in the absence of external support.

In some countries, Indonesia for example, the government worked with the private sector and introduced different interventions. As a seasonal product, the technology for off-season mango production addressed the problem on supply risk. The private sector was the one who provided technologies and inputs to farmers. Other sectors are also interested in applying the same business model. ICT in the form of mobile applications was used in disseminating information to farmers.

Following the severe drought in 2014-2016, Viet Nam started modernizing its irrigation by adopting water-saving technologies, such as on-demand irrigation. Also, various information on soil quality such as moisture content are being communicated with the farmers. This has guided the farmers in planning the schedule and amount of irrigation water. Water delivery systems and resilience to extreme weather events

both improved. In the near future, Viet Nam will start charging irrigation service fees to support the maintenance of irrigation facilities.

Another perspective on Viet Nam's experience was also shared by another panelist. He emphasized the need for spending on the soft components of new technologies: state-of-the-art expertise and domestic capacity building. Some governments (such as Viet Nam) now rule out the use of loan proceeds to support such components. This causes problems both in design and sustainability. In the case of the Viet Nam irrigation project, Productive Rural Infrastructure Sector Project in the Central Highlands, Australian experts engaged by the project provided key advice to improve the existing design and deliver better irrigation services to farmers. Other modalities of procurement may be explored to facilitate spending on capacity building and experts, for instance, shifting to results-based or outcome-based contracts (as opposed to activity- or input-based contracts).

"The role of both public and private sector is to bridge the connection between producers and consumers."

Highlights of the Open Forum

In response to a query, it was mentioned that a change in law will be required to allow pricing in irrigation systems in Viet Nam. In the case of privately-provided irrigation, service providers are already charging farmers for water. Volumetric pricing reflects existing practice and an imminent change in law. Such pricing mechanism is necessary to attract private investments under public–private partnerships.

The session concluded that promotion of high-level technologies or new technologies must be accompanied by human resource and management investments. Knowledge-intensive agriculture will require new farmers, institutions, extension systems, even business models and development agency staff. All stakeholders have to work together to meet these requirements.

Summary and Next Steps

The final session of the workshop focused on wrapping up insights from the previous discussions and identifying the next steps.

Moderator

Fiona Lynn
Agriculture and Food Security – Private Sector
Department of Foreign Affairs and Trade, Australia

Panelists

Geloria Karolina
Head of Sub-Directorate Land Extension Management
Directorate-General of Infrastructure and Facilities
Ministry of Agriculture, Indonesia

Biresh Goswami
Director
Bangladesh Agricultural Research Institute

Paul Teng
Principal Officer
National Institute of Education, Singapore

David Shearer
Director
International Partnerships, WorldFish Center

Several issues emerged from this session:

- **Consider local knowledge and practices.** While promoting knowledge-intensive agriculture, localized knowledge and practices should not be disregarded. Instead, it should build on what had worked well for farmers so far in increasing food production. The conventional wisdom of the farmers should be valued and applied.
- **Maximize complementary roles of the government and the private sector.** Rather than competing with each other, the private and public sectors should work together based on the comparative strength of each sector. Governments should provide the policy support and build infrastructure required for knowledge-intensive agriculture. The private sector should collect the data and information by installing equipment in the field.
- **Explore collective access to technologies.** It was duly recognized that the key to spreading benefits to farmers is scale neutrality of new technology, which is very rare. Hence, the impact pathways of new technologies, including along the lines of knowledge-intensive agriculture, are nonlinear, implying that different stakeholders—government, private sector, farmers—are not benefited similarly. As a result, inclusiveness and sustainability may become significant issues in knowledge-intensive agriculture. One way to enable affordable access of farmers to new technology is to organize them in groups. Governments should facilitate the producers' cooperatives so that the smallholders can collectively access the key requirements of knowledge-intensive agriculture.
- **Make access and use of technology divisible.** A suggestion was also made to make the technology divisible to the extent possible so that small farmers can use them independently. This is because group-based access to technology, in many cases, is affected by a rural power structure, which, in extreme cases, leads to disintegration of the group.

- **Balance "technology-push" and "demand-pull" approaches.** The session acknowledged that there is a difference between "technology-push" and "demand-pull" approaches to promote knowledge-intensive agriculture. The technology-push approach requires government to establish research and development programs, while the private sector, by nature of incentives, tends to pursue the demand-pull approach. The monopolization of agricultural knowledge, technology, and inputs may emerge as a big concern and farmers may become hostage of this cartelization of the private companies. This is why government investment is important to ensure that knowledge-intensive agriculture is based on affordable technologies that are crop-specific, location-specific, and also user friendly for farmers.

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Annex 1: Program

15 June 2017	
9 a.m.–9:30 a.m.	**REGISTRATION AND NETWORKING**
9:30 a.m.–9:45 a.m.	**OPENING** **Introduction:** ***Mahfuz Ahmed,*** *technical advisor, Rural Development and Food Security, Asian Development Bank (ADB)* **Welcome Remarks:** ***Bambang Susantono****, vice-president (Knowledge Management and Sustainable Development), ADB* **Introduction of Participants, Speakers, and Organizers**
9:45 a.m.–11:15 a.m.	**SESSION 1: Agricultural Transformation: The Evolution of Knowledge-Intensive Agriculture** **Session Chair:** ***Amy S.P. Leung****, deputy director general concurrently chief thematic officer, Sustainable Development and Climate Change Department, ADB* **Keynote Presentation:** ***Mahfuz Ahmed****, technical advisor, Rural Development and Food Security, ADB* **Discussants** ***Jikun Huang****, professor and director, China Center for Agricultural Policy, Peking University* ***Akmal Siddiq****, director, Environment, Natural Resources & Agriculture Division, Central and West Asia Department, ADB* ***Roehlano M. Briones****, senior research fellow, Philippine Institute of Development Studies* **Open Discussion**
11:15 a.m.–11:30 a.m.	**NETWORKING BREAK**

continued on next page

15 June 2017	
11:30 a.m.–1:30 p.m.	**SESSION 2: Investment Assessment and Application of High-Level Technology (HLT) for Food Security in Asia and the Pacific** **Session Chair:** ***Akmal Siddiq,*** *director, Environment, Natural Resources and Agriculture Division, Central and West Asia Department, ADB* **Keynote Presentation:** ***Sungsup Ra,*** *director, Human and Social Development Division, South Asia Department, ADB* **Presentations** • ***Md Abul Basher,*** *natural resources and agriculture specialist, Rural Development and Food Security, ADB* • ***Jikun Kuang,*** *consultant, International Food Price Research Institute* • ***Arvind Kumar,*** *senior scientist, International Rice Research Institute* **Discussants** • ***Krishna Pada Halder,*** *chief scientific officer, Bangladesh Rice Research Institute* • ***Takeshi Ueda,*** *principal natural resource and agriculture economist, Environment, Natural Resources and Agriculture Division, Southeast Asia Department, ADB* • ***Ouk Makara,*** *director, Cambodian Agricultural Research and Development Institute* **Open Discussion**
1:30 p.m.–3 p.m.	**NETWORKING LUNCH**
3 p.m.–5 p.m.	**SESSION 3: Using ICT for Agricultural Transformation** **Session Chair:** ***David Shearer,*** *director, International Partnerships and Program Delivery, WorldFish* **Keynote Presentations** • The Republic of Korea's Information and Communication Technology - Related Agricultural Projects and Lesson Learned • ***Sanghun Lee,*** *director, International Trade and Cooperation Department, Korea Agency of Education, Promotion, and Information Services* • Data-Driven Agriculture: Empowering Smallholders via Technology • ***Vishnu Nair,*** *regional director (Asia and the Pacific) for Pessl Instruments GmbH* • Gansu Agriculture Internet Service System Development Project • ***Jan Hinrichs,*** *natural resources economist, Environment, Natural Resources & Agriculture Division, East Asia Department, ADB* **Open Discussion**

16 June 2017	
8:45 a.m.–10:45 a.m.	**SESSION 4: Revisiting the Role of Public-Private Partnership** **Session Chair:** ***Mahfuz Ahmed****, technical advisor, Rural Development and Food Security, ADB* **Keynote Presentations:** • The Role of PPPs in Knowledge-Intensive Agriculture ***Paul P.S. Teng,*** *principal officer, National Institute of Education, Singapore* • Financing for Agriculture: The Role of Public-Private Partnerships ***Arup Kumar Chatterjee,*** *principal financial sector specialist, Finance Sector Group, Sustainable Development and Climate Change Department, ADB* **Discussants** • ***Qiaoqiao Zhang****, director of memberships, Centre for Agriculture and Biosciences International* • ***Leocadio S. Sebastian****, regional program leader for Southeast Asia, CGIAR Research Program for Climate Change, Agriculture and Food Security* • ***Ram C. Sharma****, regional coordinator for Central Asia and the Caucasus, International Center for Agricultural Research in the Dry Areas* • ***Martin Lemoine,*** *head of agribusiness investment team, Private Sector Operations Department, ADB* • ***Michiko Katagami,*** *principal natural resources and agriculture specialist, Rural Development and Food Security, ADB* **Open Discussion**
10:45 a.m.–11 a.m.	**NETWORKING BREAK**
11 a.m.–1 p.m.	**SESSION 5: Leveraging Project Knowledge and Experiences** **Session Chair:** ***Jiangfeng Zhang,*** *director, Environment, Natural Resources & Agriculture Division, Southeast Asia Department, ADB* **Panelists: Government Officials** • ***M.A. Martin, director general, Rural Development and Cooperative Division, Bangladesh*** • ***Ngin Chhay,*** *director, Department of Rice Crop, Cambodia* • ***Ifan Martino****, planner, National Development Planning Board, Indonesia* • ***Banshi Sharma,*** *joint secretary, Ministry of Livestock Development, Nepal* • ***Vu Ngoc Chau,*** *director, Water Efficiency Improvement in Drought Affected Provinces (WEIDAP) Project, Ministry of Agriculture and Rural Development, Viet Nam* **Panelists: Asian Development Bank Staff** • ***Randall E. Jones****, senior natural resource and agriculture economist, Environment, Natural Resources and Agriculture Division, South Asia Department, ADB (Rural Infrastructure Project in Bangladesh)* • ***Sanath Ranawana****, senior natural resources economist, WEIDAP* • ***Samjhana Shrestha,*** *senior economist, Environment, Natural Resources and Agriculture Division, Central and West Asia Department, ADB (Achieving Food Security through Climate Resilience Dairy Value Chain Development)* • ***Ancha Srinivasan****, principal climate change specialist, Environment, Natural Resources and Agriculture Division, Southeast Asia Department, ADB (Climate-Friendly Agribusiness Value Chains Sector Project)* **Open Discussion**

16 June 2017	
1 p.m.–2:30 p.m.	**NETWORKING BREAK**
2:30 p.m.–4 p.m.	**SESSION 6: Determining Next Steps and Future Directions** **Session Chair/Moderator:** ***Fiona Lynn****, director, Agriculture and Food Security Section, Private Sector, Development Finance and Agricultural Development Branch, Department of Foreign Affairs and Trade, Australia* **Panel Discussion** • ***Geloria Merry Karolina****, head of Sub Directorate Land Extension and Management, Directorate General of Infrastructure and Facilities, Ministry of Agriculture, Indonesia* • ***Biresh Kumar Goswami****, director, Bangladesh Agricultural Research Institute, Bangladesh* • ***Paul P.S. Teng****, principal officer, National Institute of Education, Singapore* • ***David Shearer****, director, International Partnerships and Program Delivery, WorldFish* **Open Discussion**
4 p.m.–4:30 p.m.	**CLOSING** **Wrap-Up** ***Mahfuz Ahmed,*** *technical advisor, Rural Development and Food Security, ADB*

Annex 2: List of Participants

	Organization	Delegation
A.	**Developing Member Countries**	
	Bangladesh	
		1. A.F.M. Alamgir Kabir Assistant Secretary Ministry of Agriculture
		2. M A Matin Director General In-charge Rural Development and Cooperative Division Rural Development Academy, Bogra 5842 Government of the People's Republic of Bangladesh
	Cambodia	
		3. Ngin Chhay Director Rice Crop Department Ministry of Agriculture, Forestry and Fisheries
		4. Ung Sopheap Deputy Director Industrial Crop Department Ministry of Agriculture, Forestry and Fisheries
	Indonesia	
		5. Ifan Martino Planner Ministry of National Development Planning of Indonesia (BAPPENAS)
		6. Yanti Ermawati Head of Recommendation Service, Sub Division Evaluation and Recommendation Service Secretary of Infrastructure and Facilities, Director General of Infrastructure & Facilities Ministry of Agriculture
		7. Gloria Merry Karolina Head of Sub Directorate Land and Extension Directorate of Land Extension and Management Directorate General of Infrastructure and Facilities Ministry of Agriculture
	Nepal	
		8. Banshi Sharma Joint Secretary Animal Production and Market Promotion Division Ministry of Livestock Development
		9. Basu Dev Kaphie Senior Agriculture Economist Ministry of Agricultural Development

continued on next page

	Organization	Delegation
	Uzbekistan	
	10.	Azizbek Abdumukhtorov Chief Specialist Department of Attraction of Investments and Processing of Investment Projects Ministry of Agriculture and Water Resources
	Viet Nam	
	11.	Pham Thi Thu Ha Researcher Institute of Policy and Strategy of Agriculture and Rural Development Ministry of Agriculture and Rural Development
	12.	Vu Ngoc Chau Director for Water Efficiency Improvement in Drought Affected Provinces Ministry of Agriculture and Rural Development
B.	**Consultative Group for International Agricultural Research**	
	13.	Qiaoqiao Zhang Director, Memberships Centre for Agriculture and Biosciences International
	14.	Sivapragasam (Siva) Annamalai Regional Director Centre for Agriculture and Biosciences International Southeast Asia (based in Malaysia)
	15.	Ram Chandra Sharma Regional Coordinator for Central Asia and the Caucasus International Center for Agricultural Research in the Dry Areas
	16.	Rodel D. Lasco Senior Scientist Southeast Asia World Agroforestry Centre
	17.	Leocadio S. Sebastian Regional Program Leader for Southeast Asia CGIAR Research Program on Climate Change Agriculture and Food Security
	18.	Arma R. Bestuso Senior Research Associate Food Security Through Root and Tuber Crops in Upland and Coastal Communities of Asia-Pacific (CIP-FoodSTART+) International Potato Center
	19.	Arvind Kumar International Rice Research Institute Philippines
	20.	Nitika Sandhu International Rice Research Institute Philippines
	21.	Hummath Bhandari International Rice Research Institute Bangladesh
	22.	Alic Laborte International Rice Research Institute Philippines
	23.	Georgina Verger International Rice Research Institute Cambodia
	24.	Corinta Guerta International Rice Research Institute Philippines

	Organization	Delegation
	25.	David Shear Director International Partnerships and Program Delivery, WorldFish Malaysia
	26.	Paul Joseph Ramirez Research Fellow, WorldFish Malaysia
	27.	Mag Catindig KM/M&E Manager AsiaDHRRA
	28.	Cezar Belengel Program Manager (Farmers' Fighting Poverty) AsiaDHRRA
C.	**Development Partners (Bilateral/Multilateral)**	
	29.	Fiona Lynn Director Agriculture and Food Security Department of Foreign Affairs and Trade Australia
	30.	Jaime Montesur Agronomist/Coordination Specialist Food and Agriculture Organization of the United Nations Philippines
	31.	Sanghun Lee Director, International Trade and Cooperation Department Korea Agency of Education, Promotion, and Information Services in Food Agriculture, Forestry and Fisheries
D.	**University**	
	32.	Antonio (Kills) Jesus A. Quilloy Assistant Professor Farm Management, Production Economics, Resource Economics College of Economics and Management University of the Philippines Los Baños
	33.	Biresh Kumar Goswami Director Bangladesh Agricultural Research Institute
	34.	K.P. Halder Chief Scientific Officer Bangladesh Rice Research Institute
	35.	Paul Teng Principal Officer National Institute of Education Nanyang Technological University Singapore
	36.	Ouk Makara Director Cambodian Agriculture Research and Development Institute Cambodia
	37.	Vishnu Nair Regional Director (Asia and the Pacific) Pell Instruments GmbH
	38.	Jikun Huang Professor and Director China Center for Agricultural Policy Peking University PRC

Organization	Delegation
	39. Roehlano M. Briones Senior Research Fellow Philippine Institute of Development Studies (PIDS)
E. Asian Development Bank	
	40. Bambang Susantono Vice-President Knowledge Management and Sustainable Development
	41. Amy S.P. Leung Deputy Director General concurrently Chief Thematic Officer Sustainable Development and Climate Change Department
	42. Akmal Siddiq Director Environment, Natural Resources, and Agriculture Division Central and West Asia Department
	43. Sungsup Ra Director Human and Social Development Division South Asia Department
	44. Jiangfeng Zhang Director Environment, Natural Resources, and Agriculture Division Southeast Asia Department
	45. Takeshi Ueda Principal Natural Resources and Agriculture Economist Environment, Natural Resources, and Agriculture Division Southeast Asia Department
	46. Jan Hinrichs Natural Resources Economist Environment, Natural Resources, and Agriculture Division East Asia Department
	47. Arup Kumar Chatterjee Principal Financial Sector Specialist Finance Sector Group Sustainable Development and Climate Change Department
	48. Martin Lemoine Head of Agribusiness Private Sector Operations Department
	49. Ancha Srinivasan Principal Climate Change Specialist Environment, Natural Resources, and Agriculture Division Southeast Asia Department
	50. Randall E. Jones Senior Natural Resources and Agriculture Economist Environment, Natural Resources, and Agriculture Division South Asia Department
	51. Samjhana Shrestha Senior Economist Environment, Natural Resources, and Agriculture Division Central and West Asia Department
	52. Md. Golam Mortaza Senior Economics Officer Bangladesh Resident Mission
	53. Md. Shahidul Alam Senior Project Officer Bangladesh Resident Mission

Organization	Delegation
54.	Piseth Long Senior Project Officer Cambodia Resident Mission
55.	Emma Allen Country Economist Indonesia Resident Mission
56.	Rajan Acharya Programs Analyst Nepal Resident Mission
57.	Arun S. Rana Senior Programs Officer Nepal Resident Mission
58.	Sanath Ranawana Senior Natural Resources Economist Viet Nam Resident Mission
59.	Mahfuz Ahmed Advisor, SDCC-AR concurrently Technical Advisor Rural Development and Food Security (Agriculture) Thematic Group Sustainable Development and Climate Change Department
60.	Michiko Katagami Principal Natural Resources and Agriculture Specialist Rural Development and Food Security (Agriculture) Thematic Group Sustainable Development and Climate Change Department
61.	Abul Basher Natural Resources and Agriculture Specialist Rural Development and Food Security (Agriculture) Thematic Group Sustainable Development and Climate Change Department
62.	Leah Arboleda Natural Resources and Agriculture Officer Rural Development and Food Security (Agriculture) Thematic Group Sustainable Development and Climate Change Department
63.	Maria Angela Pilar Banaria Senior Operations Assistant Rural Development and Food Security (Agriculture) Thematic Group Sustainable Development and Climate Change Department
64.	Jennifer Baui Consultant Rural Development and Food Security (Agriculture) Thematic Group Sustainable Development and Climate Change Department

Solutions for Agricultural Transformation

Insights on Knowledge-Intensive Agriculture

As of 2015, the number of hungry people still reached 777 million. Similarly, the Millennium Development Goals aimed to halve the proportion of hungry people, from 23.2% in 1990–1992 to 11.6% by 2015. Agriculture is now at a crossroad. Its resource base is shrinking, and the productivity of the resource is declining. Existing agricultural production systems with heavy dependence on different inputs have become increasingly untenable. Fortunately, technological innovations and improvements create opportunities for a paradigm shift from labor and resource-intensive to knowledge-intensive agriculture. In a workshop organized by the Asian Development Bank, stakeholders exchanged experiences and ideas on how to design and implement measures to build a knowledge-intensive agriculture. This report summarizes the key messages from the workshop.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to a large share of the world's poor. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

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