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(Item 4 of the provisional agenda)

INFORMATION AND COMMUNICATIONS TECHNOLOGY FOR FOOD SECURITY AND SUSTAINABLE AGRICULTURE IN THE KNOWLEDGE ECONOMY

Background information note

SUMMARY

The World Summit on the Information Society set forth a vision of the future information society and recognized the contribution that information and communications technology (ICT), including space-based technology, can make to the promotion of food security and sustainable agriculture. Indeed, with modern agriculture rapidly moving away from artisanal, labour-intensive traditional practices and towards information-intensive models, access to information and modern communications technologies has become a necessity for farmers, especially in the developing countries of the Asia-Pacific region.

In the present document, the potential benefits and opportunities of such technologies are discussed in the context of food security and sustainable agriculture in Asia and the Pacific. ICT can be applied in the areas of agricultural policy, resource management, marketing, extension and disaster risk reduction to help countries increase production and reduce threats. It has already been instrumental in the development of many cutting-edge applications, such as farm automation, precision farming and bioinformatics. In short, ICT has a central role to play in modern agriculture and the maintenance of agricultural sustainability and food security.

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Introduction

A. Background

1. The Asia-Pacific region faces various challenges in meeting target 1 of the first Millennium Development Goal: to halve, between 1990 and 2015, the number of people suffering from hunger. Agricultural sustainability and food security could be threatened by low yields, poor management of land and water resources, and under-educated labour. They are also easily disrupted by major disasters, such as droughts, floods, earthquakes and landslides. Information and communications technology (ICT)[1] can be applied in the areas of resource management, marketing, extension and disaster risk reduction to help countries increase food production and reduce threats.

2. In recognition of the importance of these issues, the World Summit on the Information Society in 2003 highlighted the application of ICT in agricultural development as a priority. In action line C7 in the Geneva Plan of Action,[2] the Summit addressed e-agriculture, and noted that "public-private partnerships should seek to maximize the use of ICTs as an instrument to improve production (quantity and quality)," as part of an overall objective to support sustainable development in a number of fields.

3. It is clear that ICT applications are of vital importance for sustainable agricultural development in the ESCAP region, where agriculture represents a high proportion of the gross domestic product in most countries and percentages of agricultural populations are high. The Asia-Pacific region is growing rapidly in terms of both economic development and population, creating enormous pressures on land and water resources; the per capita ownership ratio of land and water resources has been dropping. The region's population stood at 3.2 billion in 1990, and reached about 4 billion in 2006.[3] Meanwhile, industrial development has steadily encroached on arable land. ICT applications that facilitate the rational use of natural resources could have a major impact on agricultural sustainability.

4. Countries in the ESCAP region have proven willing to adapt to new farming technologies. They have participated in global programmes, such as rice genome mapping and sequencing, that promote a bioinformatics approach to agricultural development. Many countries have also introduced precision farming and farm automation, practices that may revolutionize agriculture. In order to ensure the broadest impact on agricultural sustainability, there must be follow-up on and adoption of technological advances, with corresponding efforts to bring such knowledge to farmers.

5. The ESCAP region is one of the most disaster-prone regions in the world, and agriculture is perhaps the most vulnerable of all sectors. For example, Cyclone Nargis caused huge losses in

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[1] The term "information and communications technology", as used in the present document, should be understood to include space-based technology, as appropriate.

[2] See A/C.2/59/3, annex, section B, para. 21.

[3] *Statistical Yearbook for Asia and the Pacific 2007* (United Nations publication, Sales No. B.08.II.F.1).

Myanmar—an estimated 2.4 million people were affected, with 130,000 people reported dead or missing and over 600,000 hectares of agricultural land flooded.[4] In view of the special importance of the role ICT can play in disaster risk reduction, particularly in regard to protecting agriculture, this issue will be dealt with under item 5 of the provisional agenda[5] (see E/ESCAP/CICT/2).

6. In short, ICT has a central role to play in modern agriculture and the maintenance of agricultural sustainability and food security. However, for the developing countries of the region, there are several obstacles. The most common challenge is that access to telephone and electricity networks in rural and remote areas is limited; telecentres that offer broader ICT services are still scarce because of the disproportionately high investment and operating costs required. Shortcomings at local levels are where the digital divide becomes most obvious. Innovative ways of combining modern technologies, such as agricultural information systems, with traditional technologies, such as radio broadcasting, should be considered when evaluating ICT development options. Furthermore, funding from donors, Governments and rural communities could be used to connect users who are otherwise overlooked by service providers on the basis of profitability.

7. In preparing the present document, the secretariat has taken into account the theme topic for the sixty-fifth session of the Commission: sustainable agriculture and food security.

B. Structure of the report

8. The present document contains three sections in addition to the introduction. In section I, opportunities for ICT in promoting food security are identified. Topics discussed include: (a) ICT as a main driver in modern agriculture, within the contexts of agricultural production, nutrition, the marketing and distribution of agriculture produce, and food security mapping and profiling; (b) the role of ICT-enabled technology, including biotechnology, in increasing farm yields and improving the nutrient content of food; and (c) the monitoring and forecasting of climate, weather and crops. Section II contains a description of the benefits of public-private partnerships as well as partnerships among United Nations agencies on e-agriculture initiatives. Finally, themes highlighted in section III include: (a) the identification of emerging priorities in terms of Government and other stakeholder actions on various fronts, and (b) the catalytic role envisaged for ESCAP in applying ICT to promote food security and sustainable agriculture in the Asia-Pacific region.

9. Mention of firm names, commercial products and specific technologies does not imply the endorsement of the United Nations.

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[4] United Nations, "Myanmar Cyclone Nargis", OCHA Situation Report No. 35, Office for the Coordination of Humanitarian Affairs, 26 June 2008. Accessed from www.reliefweb.int/rw/RWFiles2008.nsf/FilesByRWDocUnidFilename/EDIS-7FYSXY-full_report.pdf/$File/full_report.pdf on 2 July 2008.

[5] E/ESCAP/CICT/L.1.

I. OPPORTUNITIES FOR USING ICT TO PROMOTE FOOD SECURITY

A. ICT and modern agricultural technologies

10. ICT is a major driver of technological advancement in agriculture, as evidenced in such fields as bioinformatics, farm automation and precision farming. Other advanced studies, including explorations of genetic engineering and space seed processing, rely heavily on ICT. In the ESCAP region, developed countries, such as Australia, Japan, New Zealand and the Republic of Korea, as well as developing countries, such as China, India, Malaysia and some of the Central Asian countries, have been experimenting with these new technologies.

11. Bioinformatics is the field of science that combines information technology and computer science with biology. The initial focus of bioinformatics was the creation and maintenance of a database to store biological information. The field has since evolved to encompass other key areas, such as the analysis and interpretation of various types of biological data, including genome sequencing.[6] In 2005, a rice cultivar became the first commercially important plant to have its genome fully mapped. This is particularly important because rice is a staple food for much of the world's population. The rice sequence can be used to locate genes, with a view to improving yields and making rice more nutritious.[7]

12. Precision farming, or precision agriculture, is a technique that uses technology to collect and analyse data for the assessment of variations in soil or climate conditions, in order to guide the application of the right agricultural practices, in the right place, in the right way, at the right time. It relies greatly on new technologies, including the Global Positioning System, sensors, satellite or aerial images, and information management tools, to collect information on such variables as optimum sowing density, fertilizers and other input needs. This information is then used to apply flexible practices to a crop.

13. Farm automation involves the use of control systems, such as computers, to derive higher yields with more predictable results through farming processes that are more efficient, less labour-intensive and less time-consuming.

14. In addition to the above applications, the agricultural community has embarked on experimental studies, which include genetic engineering and a space seed programme.

15. In space seed programmes, now mainly in the test phase, the agricultural community works with satellite companies to send plant seeds into space; the seeds are then returned to Earth. Chinese researchers have reported sowing over 600,000 hectares of land with space-exposed seeds. Reportedly, trees grown from such seeds produce more fruit, which is also reported to taste sweeter,

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[6] The genome is all the hereditary information encoded in the DNA of an organism. Genome sequencing is a process that identifies the order of the structural units of the DNA (adenine, guanine, cytosine and thymine).

[7] International Rice Genome Sequencing Project, "The map-based sequence of the rice genome", *Nature*, vol. 436, No. 7052, pp. 793-800.

have more vitamins, be more resistant to disease and have a longer shelf life. Rice, cotton, oil seeds and vegetables have also been sent into space. However, the scientific community has not reached a conclusion on the benefits of the space seeds. Some who have experimented on seeds in space say the benefits do not justify the cost.[8]

16. Biotechnology offers considerable potential as an instrument for achieving food security and sustainable agriculture. It uses advanced plant breeding techniques, including genetic modification and manipulation, to directly modify the structure and characteristics of genes, with a view to introducing beneficial traits to crops grown for food and fibre.

17. Biotechnology has been used to improve crop technology. Several commercially important species of plants have been modified to incorporate transgenic traits that provide tolerance to herbicide, viruses or fungi; insect resistance; or quality improvements. Important crops that have been modified genetically include maize, soybean, cotton, tomato, potato, alfalfa, petunia, rapeseed, mustard, rice, wheat, beet, barley, chickpea, cabbage and tobacco. There is considerable potential for genetic engineering to contribute to improved yields and reduced risks in developing countries, provided that it focuses on the needs of poor farmers and consumers in those countries.[9]

18. The application of biotechnology in developing countries of the Asia-Pacific region could reduce the need for inputs and increase efficiency of input use. This could lead to the development of crops that use water more efficiently, fix nitrogen from the air, extract phosphate from the soil more effectively, and resist pests without the use of synthetic pesticides.

19. Biotechnology, nonetheless, must be viewed as just one element in a comprehensive sustainable agriculture and food security strategy focused on broad-based agricultural growth, not a technological quick fix for region-wide hunger. Furthermore, many Governments have restricted the field applications of gene-altering technologies. The ongoing debate on biotechnology calls for national, regional and international management measures. Such measures may include laws and institutions that deal with ways of maximizing the impacts of biotechnology, while reducing its risks. This would entail capacity-building in research, international partnerships, enterprise development, and community participation in technology development. It would also include the formation of institutions and laws that ensure that biotechnology research and commercialization are undertaken according to specific safety protocols, and take into account intellectual property rights and the preservation of biodiversity. These measures would require close cooperation between a wide range of actors and cannot be reduced to simplistic public-private partnerships. Many of these institutional arrangements would depend on the nature of the technology and local ecological conditions, as well as the political cultures at the national level.

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[8] Kelly Young, “Space seed idea falls on stony ground”, *New Scientist Space,* 6 June 2005 (available at http://space.newscientist.com/article/dn7472).

[9] Centre for Alleviation of Poverty through Secondary Crops Development in Asia and the Pacific, “Biotechnology and Farm Yields”, CAPSA Flash, vol. 6, No. 2.

B. Conventional applications of ICT in agriculture

20. In most countries of the ESCAP region, due to various limitations, ICT applications in agriculture are confined to the more conventional uses. However, with agriculture rapidly moving away from artisanal, labour-intensive, traditional practices and towards information-intensive models, access to ICT and other technologies has become a necessity for farmers, including those in developing countries of the Asia-Pacific region. ICT can play a key role in achieving much-needed improvements in regional agriculture productivity, agriculture planning and practices and food distribution, as well as in the area of information on weather impacts and disasters.

21. Empirical evidence suggests that, in the area of agricultural production, prices of inputs such as seeds, fertilizers and pesticides are the most frequently telecommunicated information. The telephone (mobile or fixed-line) is the communications technology most commonly used by farmers in the Asia-Pacific region. The use of other ICTs could also contribute significantly to agricultural productivity.

1. Nutrition

22. The most important ICT applications for addressing malnutrition relate to educating personnel and enabling efficient networking. The Food and Agriculture Organization of the United Nations (FAO), for instance, provides online training materials on many nutrition-related topics. Monitoring nutrition status—and reacting to large-scale threats—is an area of assessment and analysis that relies heavily on ICTs. Food insecurity and vulnerability information and mapping systems are increasingly being implemented to assemble, analyse and disseminate profiles of food insecure and malnourished groups: who they are, where they are located, and why they are at risk.

2. Marketing and distribution of agricultural produce

23. The link between food security, markets and ICT are obvious when it comes to integrating farmers into national, regional and international trade systems. ICT improves the ability to search for information and increase the quantity and quality of information available, ultimately reducing uncertainty and enhancing market participation (box 1). Answers to questions such as: “How do buyers and sellers find each other, and what prices can be achieved?” and “Is it better to store the produce or sell it immediately?” open opportunities, support the functioning of markets, and hence the availability of food, and increase income. Positive externalities affect all aspects of development, ranging from better education opportunities and lower fertility rates to increased productivity, which eventually feed back to food security.

24. On that basis, it is not surprising that most efforts to make ICT available to farmers have sought to improve the availability and quality of information either indirectly through producer associations, extension workers, among others, or directly through broadcast radio information, mobile phone messaging and community e-centres (box 2). For the most part, small farmers do not

use ICT to market products beyond local and regional markets. Instead, there are nationally and globally active organizations that aim at mobilizing small-holders to join a programme and market their produce. Such programmes use ICT to provide overall coordination, transfer knowledge, arrange transportation and exchange market information.

Box 1

Agmarknet: an agricultural marketing information system

In India, almost all the states and union territories provide producers, traders, consumers and other market users with some form of market information. However, the information is collected and disseminated through conventional methods which can cause inordinate communications delays, thus adversely affecting the economic interests of affected target groups. In order to provide an effective information exchange on market price, the Directorate of Marketing and Inspection, Department of Agriculture & Cooperation, Ministry of Agriculture, and the Agricultural Informatics Division, National Informatics Centre, Ministry of Communications & Information Technology, collaborated to create the Agricultural Marketing Information Network. The project aims at establishing an efficient nationwide system for the collection and dissemination of market information, and computerizing data on market fees, market charges, storage and modes of transportation.

Source: The Agricultural Marketing Information Network website (www.agmarknet.nic.in).

Box 2

Community e-centres to improve agricultural productivity

Rural access to ICT through community e-centres can be used to improve agricultural productivity by connecting the rural poor to direct markets, and by giving them ready access to information on the prices of inputs and products. Better information would also give farmers a sense of market demand and seasonal variations in produce and prices, which would enable them to adjust their production.

A wide variety of information is available on the Web, which can be accessed through telecentres. This includes information that enables farmers and farmers' cooperatives to determine current and forecast prices for agricultural produce, and to market directly to a broader choice of wholesalers or retailers. Information also includes global-to-local monitoring and analyses of crop conditions and yield forecasts, so that farmers (and farmers' cooperatives) can strategize steps to optimize the quantity, quality, and security of their crops, both prior to and after planting.

In villages around Pondicherry, villagers operate local "knowledge centres", which are part of a network of telecentres established by the Swaminathan Foundation. These operators adapt data and information from public sources for their own weather bulletins, which they post on notice boards for the local fishermen. The telecentre also broadcasts appropriate information over loudspeakers, to benefit those who are illiterate, and publishes a local newsletter.

Another example is the e-Choupal model, established by a private Indian tobacco company. These telecentres are operated by ITC-trained local farmers, and provide the agricultural community with access to good practices in agriculture and market prices for commodities. Better market information helps farmers to decide when and where to sell. By purchasing directly from the farmers, the tobacco company made the channel more efficient and created value for both itself and the farmers, who benefit from more accurate weighing, faster processing and prompt payment. By 2007, more than 6,400 e-Choupals were operating in about 31,000 villages.[a]

[a] Sachin Sahay, "Mission e-Choupal", presentation to the ESCAP Consultative Meeting for the Establishment of Regional Knowledge Network of Telecentres in Asia and the Pacific, Bangkok, 27 and 28 September 2007 (available at http://telecentresap.org/meeting/cmap2007/India_Presentation_eChoupal.pdf).

25. ICT also benefits transport systems at various levels, from a one-vehicle trucking business using a telephone to locate a destination or secure a return load, to larger businesses with sophisticated radio systems to locate and identify vehicles automatically and transmit posting instructions from a central control location. Overall cost reductions and efficiency increases will eventually have an impact on the emergence of food markets and the distribution of food. ICT can even compensate, in part, for deteriorating transport infrastructure.

26. Where agricultural products are distributed unequally, shortages occur; and where transportation systems are inadequate to bring sufficient food into the deficit region, or where people are unable to access food or afford the costs of the food provided or imported for their needs, critical food shortages and even famines occur. It is widely agreed that the availability of appropriate information is an effective means of averting such situations. Information on the variability of food production, for example, is needed to plan accumulations of food stocks. Further, the difficulties of moving food into isolated regions can be reduced if the limited transportation facilities are used more efficiently, and the costs of food imports will be lower if there is sufficient time to purchase food on regional or world markets and to arrange for inexpensive shipment to the affected areas. Finally, government action can be better coordinated to respond to shortages. Again, ICT-based systems such as the Famine Early Warning Systems Network[10] and the Global Information and Early Warning System[11] for food and agriculture are means of leveraging action to avoid food shortages or disasters, such as famines.

[10] See www.fews.net/Pages/default.aspx.
[11] See www.fao.org/giews/ENGLISH/index.htm.

3. Stronger e-government for improved intragovernmental coordination

27. Poor policy decisions are one major factor contributing to food insecurity. Food insecurity sometimes happens because the food is not where it is needed, not because the global supply of food is insufficient. Food security depends on the availability of food, physical and economic access to it, and the physiological utilization of nutrients. Ensuring food security is a complex task involving agricultural, nutritional, gender and technological issues. Thus it requires the intervention of various ministries within a country and a streamlined and well-coordinated flow of information between them. In addition, timely and accurate information regarding food supply and demand needs to be delivered to the right decision maker.

28. It is well recognized that e-government practices facilitate communication and improve the coordination of authorities at different tiers of government, within organizations and at the departmental and city levels. It is therefore expected that e-government uptake will enhance policymaker capabilities to promote food security. Furthermore, because e-government can enhance the speed and efficiency of operations, it can also facilitate the logistics of food relief, which is characterized by urgency: distribution networks must be established quickly, with minimal organizational support. Essential to the success of such operations are real-time communications and transportation assets, and the overall agility of the government response.

4. Monitoring and forecasting of climate, weather and crops

29. Since the green revolution, arguably the greatest contributor to increased farm yields has been information technology, delivered to decision makers via innovative communication technology. This includes (a) monitoring and forecasting of climate, weather and crops, (b) the integration of forecasts with strategic preparation and response, from the ministerial to the farm level, (c) international social and corporate responses, and (d) precision farming which was described previously. The successful integration of such processes should lead to improved agriculture and to food security, as all stakeholders would be better able to forecast supplies and prices of agricultural products, as well as improve the reliability of results through better management of resources.

30. Forecasts have come a long way since the first weather satellites were launched in the 1960s. The process initially relied on a series of images of clouds from space, which enabled scientists to follow meteorological patterns via their visible cloud tracks. Meteorological satellites now help identify weather developments, and also help to map water levels in reservoirs (information that is essential for good regional management of water supplies, including for power generation and irrigation). Weather forecasts are now available almost globally from the World Meteorological Organization,[12] as well as from national and other sources.

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[12] See http://worldweather.wmo.int/.

31. As early as the 1980s, weather satellite data were used to infer and monitor the health of crops, supporting specialists' interpretations of drought or other problems. The Famine Early Warning System, based in the United States of America, tracked the progress of crops in Africa at the time of the Sahelian drought and famine crises, to determine possible needs for international food assistance. The Food and Agriculture Organization of the United Nations subsequently developed the Global Information and Early Warning System to carry out similar functions at the global level. More recently, vegetation health data have been adapted so that non-specialists can directly interpret the data, which are being updated weekly and posted on the Web.[13]

32. Initially available only to weather specialists, information products and services are now more widely available. Commercial value-added services, based on satellite data provided by Governments, are sold on subscription to interested users, such as some commodity wholesale corporations. These corporations use the information to forecast supplies, areas of shortage and potential demand, ultimately to better forecast (and possibly influence) purchase and sales prices. Complementing these sources are public services provided by some Governments, most often in the Organisation for Economic Co-operation and Development countries with large agricultural components.

33. A potentially integrated system for agricultural monitoring and planning can be described as a three-stage process: planning for a cropping season, monitoring and responding to a cropping season in progress, and managing the harvest.

34. *Planning for a cropping season*. It is now possible to forecast cropping conditions in many parts of the world. Local agricultural officials can pass on such information to farmers, who can then prepare for a growing season by selecting appropriate crop varieties and growing practices for an anticipated wet or dry growing season.

35. *Monitoring and responding to a cropping season in progress*. Using services to monitor vegetation health as noted above,[14] plus meteorological station data, one can determine the general regional health patterns of crops (and other vegetation). This can help agricultural officials and farmers to determine possible interventions (fertilization, application of pesticides, irrigation or other practices). With weekly to 10-day weather forecasts becoming increasingly reliable and accessible, farmers can also optimize interventions such as irrigation and the possible application of chemicals (especially in the context of climate forecasts facilitated by El Niño/Southern Oscillation monitoring). As farmers and agricultural officials use such information to anticipate global production and prices, they can better forecast their farm-level and national food and financial situations.

36. *Managing the harvest*. The success of many types of crops depends significantly on the weather and crop conditions in the times just before and during harvest. For example, if wheat or corn

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[13] See the Center for Satellite Applications and Research for vegetation health index images and comparisons (available at www.star.nesdis.noaa.gov/smcd/emb/vci/VH/vh_currentImage.php).

[14] See http://dms.iwmi.org/ for a prototype for South-West Asia by the International Water Management Institute.

crops are harvested in the rain, or when waterlogged, they may rot, unless dried out quickly before storage. Current weather observations and multiple-day forecasts can help maximize harvesting-to-storage or shipment conditions, for maximum retention of available crop yield.

37. The three stages described above rely heavily on data from space- and ground-based observations. The data are fed into computer models, then interpreted by specialists. Increasingly, such data have been made available on the Web, gratis, for decision makers ranging from international organizations and Government ministries to farmers.

38. The process outlined above exists in pieces, mostly in countries that are relatively advanced in such information management. Developing countries consume, and in some cases produce, information for different parts of this process. There is an opportunity for Asia-Pacific institutions to cooperatively integrate and use such information to the benefit of their agricultural producers and consumers.

39. There could be considerable benefit from a regional approach to integrating such components into an environment supportive of good decision-making by ministry officials and others, including farmers, at the local level (and ultimately in local languages). The secretariat has a long history of working with the World Meteorological Organization, and continues its work as a joint creator and sponsor of the Typhoon Committee and the Panel on Tropical Cyclones. The formation of a regional cooperation body supporting hazard and resource management (including a focus on agriculture and food security) may bring useful results. Additional partnership with FAO, the International Telecommunication Union or other stakeholders could also be helpful.

II. PARTNERSHIPS

A. Public-private partnerships in e-agriculture: stakeholder roles and incentives

40. A public-private partnership is an initiative formed and operated jointly by a Government or a public sector entity and one or more private sector companies, non-governmental organizations or civil society organizations. Fundamental to this partnership is an understanding of why the partnership is required, the respective mandates, and the incentives and roles of the partners in the initiative. Some examples of public-private partnerships in Asia include the e-Choupal centres, LifeLines-India, Krishi Vigyan Kendra, and the Kisan Call Centres in India; the Commonwealth of Learning—supported Lifelong Learning for Farmers Project in various countries; the Grameenphone Community Information Centers in Bangladesh; and the e-Haat Bazaar in Nepal, among others. The e-Choupal model shows how cooperation between a private company, rural entrepreneurs, state agricultural universities and extension machinery of the Government of India has served to bolster the farmers' expertise and day-to-day awareness of what needs to be done to cope with myriad agricultural needs. Grameenphone, in collaboration with WIN Incorporate, an international development project, established community e-centres to disseminate agriculture-related information to farmers in their

native language, Bengali. Those models reflect the interests of both the public and the private partners, which complement each other to address the needs of the farmers and rural communities.

41. The dynamics and success of a public-private partnership are shaped by an understanding of the roles and objectives of the public and private sector. The key role of the public sector in implementing e-agriculture is in the preparation and effective dissemination of relevant content (as public information) on such topics as crop cultivation techniques, inputs, disease, soil, and fertilizer dosage. It is also within its mandate to ensure that the necessary infrastructure and connectivity are in place and that target groups, particularly farmers, have easy access to that information. The role of the private sector is to provide efficient, high-quality commercial services. The private-sector actor must identify a profit model and understand its social importance early in the process of forging a partnership with the public sector. The stakeholders need to clearly identify common objectives, stipulate incentives and express what they expect from the partnership if they wish to implement effective e-agriculture that benefits the end users: farmers.

B. The e-Agriculture Community of Expertise initiative

42. In 2007, FAO launched the first phase of the e-Agriculture Community of Expertise with the aim of facilitating information exchange and communication processes for the e-agriculture community by:

(a) Developing virtual communities and networks for information and knowledge exchange between rural stakeholders, as well as for their empowerment through participation;

(b) Building the capacity of rural stakeholders in the use and application of ICT;

(c) Enhancing farmers' and producers' access to information on the market and on farming techniques and practices;

(d) Improving dissemination of and access to scientific and technical information;

(e) Enhancing access to statistics and other types of information for policy- and decision-making.

43. The success of the e-Agriculture Community of Expertise depends to a great extent on the active engagement of a wide range of stakeholders. The Community is coordinated by the e-Agriculture Working Group, and FAO is managing the development, editorial content and maintenance of the web-based platform. Regular bulletins of outputs of the Community are provided to the stakeholders and to relevant global bodies, including the secretariat of the World Summit on the Information Society, the Global Alliance for ICT and Development and the United Nations Group on the Information Society. Resources are being mobilized to support the Community's activities from two main sources, namely the stakeholders themselves and a variety of donors.

III. CONCLUSION

44. Policymakers and other stakeholders need to be aware of how appropriate ICT-based instruments can help to influence agricultural practice as well as support efforts and initiatives to promote food security and sustainable agriculture. With agriculture rapidly moving away from artisanal, labour-intensive, traditional practices towards information-intensive models dialed into the global economy, access to information and modern communication technologies has become a necessity for farmers, especially in developing countries of the Asia-Pacific region.

45. The agriculture of the future will entail more efficient and sustainable production systems, making optimal use of land, water and other natural resources. Sustainable food production will rely more on agricultural information management and communication technologies. The increased knowledge of food production systems through learning applications and access to best-practice data will enable international, regional and national expertise to trickle down to local levels.

46. In this context, information exchange aimed at enhancing food security will be essential to all concerned: the Government, the private sector, the academic community, farmer organizations and civil society in general. However, to realize the full potential of ICT-enabled agriculture, Governments need to provide the following:

(a) A sound, market-oriented ICT regulatory framework;

(b) Universal access regulations and mechanisms that motivate operators to serve regions where it is economically unfeasible but socially desirable for them to do so;

(c) Incentives such as a sound business and taxation environment to encourage investor and donor involvement in ICT infrastructure development in Asia and the Pacific;

(d) The preconditions for interregional collaboration in Asia and the Pacific through, for example, the introduction of common standards and ICT-based monitoring and forecasts;

(e) Support to research institutions and other nonprofit organizations that use ICT tools to assess and transmit commodity prices, thereby allowing markets to emerge;

(f) Support for ICT use to increase the efficiency of knowledge systems in the context of agricultural production, and support for intermediate organizations in terms of transferring knowledge from global or regional levels to local levels, which in most countries will begin with the integration of agricultural extension services into knowledge systems; and

(g) Initiatives that combine existing media channels, such as rural radio stations, with ICT to match potential local demand with global content and to distribute the information widely in the relevant languages.

47. There are many areas in which work could be undertaken to support regional cooperation.

48. Many countries have established online networks, often called agricultural expert systems, at national, provincial and community levels. These networks provide useful information on agricultural production, marketing, technological developments, weather forecasts, and disaster management. A survey on these online networks, examining aspects such as establishment, maintenance and contents could be conducted.

49. Follow-up on the rapid development of ICT-central cutting-edge technologies is of particular importance to an agricultural Asia-Pacific region. In this connection, specific training courses on such topics as precision farming, farm automation and bioinformatics could be organized, to raise awareness in ESCAP member States, especially the developing countries.

50. In all ESCAP member countries, the per capita ownership ratio of agricultural resources, such as land and water, has been dropping in the wake of a rapid population increase and demand for industrial development. How to promote an ICT-enabled, rationalized use of these resources remains at the top of many Government agendas. In this regard, the workshops and seminars to exchange experiences and promote transfer of technologies could be useful.

51. Many countries in the Asia-Pacific region have established national systems for disaster risk reduction. There also exist some intercountry arrangements for information sharing on disaster management. However, all these intercountry systems are currently very limited in both membership and coverage, with many having no specific focus on agricultural sustainability. In that connection, it could be helpful to establish a regional system of networks for information sharing and analysis for disaster risk reduction, in which issues related to agricultural sustainability feature highly.

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