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Agricultural Technology for Development

Report of the Secretary-General

Summary

The return of high food prices and the need to adapt to climate change have revived interest in agricultural technologies adapted to smallholders, in particular women. Sustainable intensification of smallholder production will require a shift to knowledge-intensive agriculture that combines local knowledge and the latest sustainability science to adapt practices to local ecosystems and increase resilience to climate change, price and other shocks. Poor farmers, often women, usually cultivate in more extreme environments in addition to being less connected to markets. A radical change in the focus of national agricultural plans and substantial investment are needed to unleash smallholder production potential, contributing to achieving MDGs and boosting food production to meet the 70% increase needed by 2050. A holistic approach is needed to raise productivity and resilience of agriculture and supporting ecosystems as well as the efficient and equitable functioning of agricultural supply chains.

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I. Overview

1. This report has been prepared in response to the General Assembly Resolution A/RES/64/197 requesting the Secretary-General to submit a report to the General Assembly at its sixty-sixth session on progress made by Member States and relevant United Nations organizations in making appropriate sustainable agricultural technologies available and affordable, especially to smallholder farmers; making agriculture more resilient including to climate change; utilizing local know-how and agricultural technologies.
2. Recent crises have generated wider global political engagement, partnerships, and commitments to food and nutrition security^{1,2}, meeting nutritional needs, the right to food, and investment in small-scale farmers, including women farmers. A consensus is emerging that achieving sustainable intensification of agriculture, food and nutrition security, farmer resilience, and the Millennium Development Goals (MDGs) will require major changes to national agricultural policies, education, partnerships, markets, infrastructure, and institutions. Several recent actions offer good practices that could be replicated and scaled up. This report outlines elements of this emerging consensus.
3. The report benefited from inputs received from the United Nations Food and Agriculture Organization (FAO), Educational, Scientific, and Cultural Organization (UNESCO), the International Fund for Agricultural Development (IFAD), International Labour Organization (ILO), and the High Level Task Force on Global Food Security (HLTF).

II. New Context - New Paradigm

4. The 2008 food crisis and the recent return of high food prices accompanied by heightened price volatility have called into question the current food system that has seen the number of undernourished people increase by almost 10% between 1990-92 and 2010³. Smallholder and family farmers, despite being the major producers of food, especially in developing regions, are the majority of the world's poor people and a very large proportion of the chronically undernourished. Boosting agriculture productivity, in particular of smallholders, is one of the most effective ways of addressing global poverty and food and nutrition security. Output growth in agriculture is two to four times more

¹ Food and nutrition security exists when all people, at all times, can enjoy their right to food, when they have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

² HLTF. 2011. Food and Nutrition Security: Comprehensive Framework for Action, Summary of the Updated Comprehensive Framework for Action. New York, NY: United Nations.

³ UN-DESA, 2011. World Economic and Social Survey 2011: The Great Green Technological Transformation, New York: United Nations). Available from www.un.org/en/development/desa/policy/wess/index.shtml.

effective in reducing poverty than in other sectors⁴. The International Food Policy and Research Institute (IFPRI) finds that investment in agricultural research and development (R&D) has achieved annual economic rates of return of 50-66 percent for investment as varied as development and release of disease-resistant, high-yielding cassava varieties, wheat rust resistance, and hybrid maize research. Returns to agricultural development projects can yield between 20 and 147%⁵.

5. Food production must increase in the context of worsening land and water scarcity and climate-change-related weather shocks. Land degradation is affecting productivity, and yield growth -- despite large investments in yield-enhancing varieties -- is not keeping up with population. Soil compaction alone has caused yield reduction of between 40-90 per cent in western African countries, and nutrient depletion also reduces productivity in Sub-Saharan Africa (SSA) and South Asia. Meanwhile, twenty African countries are already experiencing severe water scarcity and another 12 will face water scarcity over the next 25 years.
6. Land degradation is worse in areas where poverty and hunger are concentrated and climate change disproportionately affects smallholders as they are more likely to depend on rainfed agriculture and degraded land⁶. Resource degradation also has a gender-specific effect, increasing the time required for fulfilment of female responsibilities such as food production, fuelwood collection and soil and water conservation.
7. Sustainable intensification of agriculture is the only way to avoid localized chronic food and nutrition insecurity when between 75 and 90 per cent of staple foods are produced and consumed locally⁷. Unleashing the full potential of smallholders, including that of women farmers, is thus key to global food and nutrition security, creation of decent work, and sustainable agriculture intensification⁸. FAO estimates that giving women better access to land, inputs, and technology could increase yield by 2.5-4 per cent and reduce undernourishment by 12-17 percent⁹.
8. In the future, the path to sustainable agricultural productivity growth will differ considerably from the Green Revolution approach. Smallholders must be at the centre of food systems well adapted to agro-ecosystems in order to increase both environmental and economic resilience. Tailoring sustainable agriculture practices to agro-ecosystems allows for higher diversity and thus greater protection against invasive pests and extreme

⁴ Juma, C. 2011. *The New Harvest: Agricultural Innovation in Africa*. Oxford, UK: Oxford University Press.

⁵ Beintema N. and G-J. Stads. 2011. *African Agriculture R&D in the New Millennium: Progress for some, Challenges for many*. Washington, D.C.:IFPRI and Rome, Italy: ASTI.

⁶ WESS, 2011

⁷ Ibid

⁸ HLTF, 2011

⁹ WESS, 2011

events. It also permits diversification of income while reducing food production's reliance on fossil fuels with their increasingly volatile prices¹⁰.

9. Agriculture -- which includes growing crops, rearing livestock, producing fish and maintaining forests-- in developing countries must undergo a significant transformation in order to meet the above related challenges. This new agriculture paradigm will require that smallholders be at the centre of innovation systems helping shape the R&D and extension agenda so that crops, fish, and livestock products that matter to them as producers and consumers receive adequate attention¹¹. It also requires a radical change in existing policies — a change that would result in a strengthening of currently fragmented systems of innovation, a redesign of the education system, and investment on agricultural development throughout the whole supply chain and in sustainable resource management through innovative partnerships with farmers¹².

Empowerment of women

10. The majority of smallholder farmers and rural entrepreneurs in developing regions are women and they play a vital role in rural economies by providing their families with food, water and fuel. However, their productive potential remains untapped due to gender gaps in access to a range of assets such as land, education, technology and productive inputs. In Africa, for instance, women represent 80% of agricultural producers¹³ and account for half the agricultural output¹⁴. Only 5 per cent of landholders in North Africa and West Africa are women, and 15 per cent in Sub-Saharan Africa, while women represent 40 per cent of the agricultural work force in Africa as well as in East and South-East Asia¹⁵. When they own, women own smaller farms.
11. Science and technology offer several proven solutions to many challenges faced by rural women living in poverty and provide opportunities for their economic empowerment. These solutions include labour-saving technologies related to women's domestic and productive work such as water pumps and community water schemes, improved cooking technologies, improved transport of water, wood and crops, improved cultivation techniques, post-harvest and food processing technologies. Rural women in most parts of the world continue to be underserved by technologies and the poorest women continue to rely on traditional, labour-intensive technologies or use no technologies at all. Because of women's lower education levels, their lesser access to credit, their lack of land tenure

¹⁰ UNGA. 2010. Report submitted by the Special Rapporteur on the right to food. New York: United Nations.

¹¹ FAO. 2011. A policymakers guide to the sustainable intensification of smallholder crop production. Rome, Italy: FAO. Available from www.fao.org/ag/save-and-grow/index_en.html.

¹² WESS. 2011.

¹³ Juma. 2011.

¹⁴ WESS. 2011

¹⁵ Ibid

and other discriminatory practices, men are most frequently the beneficiaries of new and improved agricultural technologies¹⁶.

12. Agricultural extension continues to play a key role in technology dissemination. Extension methods have changed greatly over the years, generally moving towards more participatory approaches and increasingly making use of new information technologies. However, women farmers continue to be disadvantaged in gaining exposure to extension services because of an inherent bias. Women's role in agricultural production needs to be much more taken into account in extension services and technology research on commodities and production processes dominated by women. Participatory research programmes involving women in the evaluation of new technologies and in the decision-making process can greatly contribute to the development of agricultural practices that respond to women's needs. For example, several initiatives of the International Rice Research Institute supported by IFAD, applied a participatory approach by which women suggested new criteria, such as taste and milling qualities, for variety selection and germplasm evaluation for biotechnology research¹⁷. Reducing the education gap for women, increasing the number of women in science and agriculture programs and the number of women extensions agents (only 7% of extension agents in Africa are women) could also increase the contribution of women to agricultural production¹⁸.
13. Mainstreaming gender into the agricultural policies and legal and regulatory frameworks that govern the use of technologies can be facilitated through the Socio-economic and Gender Analysis programme that helps Member States build their analytical and policy making capacities in gender inequalities that affect participation in development, including access to and use of technologies¹⁹.

III. National policies and strategies

14. The 2008 food crisis has helped the world rediscover the need for sound agricultural development plans to achieve food and nutrition security, economic growth and progress on the MDGs. This realization helped reverse a long disinvestment trend in agriculture both by donors and by developing countries themselves.
15. In response to the 2008 food crisis, the G8 and five other donors committed to mobilise \$22 billion over three years in support of country-led plans for agriculture, with a

¹⁶ Ibid

¹⁷ IFAD. 2011. IFAD's Poverty Report. Rome: IFAD. Available at <http://www.ifad.org/rpr2011/report/e/overview.pdf>

¹⁸ ECOSOC, 2011. Commission on the Status of Women (Report on the fifty-fifth session), E/2011/27, E/CN.6/2011/12. New York: United Nations. Available from www.un.org/ga/search/view_doc.asp?symbol=E/2011/27.

¹⁹ FAO, 2010. Focus. Women and Food Security. 2010. <http://www.fao.org/FOCUS/E/Women/Sustin-e.htm>

'coordinated, comprehensive strategy' for agriculture and food and nutrition security . The \$22 billion commitment is known as the L'Aquila Food Security Initiative (AFSI). As part of the Initiative, the Global Agriculture and Food Security Program (GAFSP), a fund administered by the World Bank, was launched to support country-led agricultural development strategies. In Africa, the fund specifically supports countries that have advanced through the Comprehensive Africa Agriculture Development Program (CAADP) process. The CAADP process, launched at a summit of African heads of state in Maputo in 2003, commits African governments to spend at least 10% of their budgets on agriculture and includes a peer and technical review process to ensure development effectiveness. The equivalent of USD 925 million has been pledged so far by Australia, Canada, the Gates Foundation, Republic of Korea, Spain and the United States. Ireland has contributed to the operating costs of the program.

16. The GAFSP has helped speed up the development of national plans. Twenty six African countries have completed their CAADP national plans of action on agriculture and 16 have prepared and peer reviewed their national investment plans, often with FAO and regional commissions support. Following independent technical review of national proposals, the GAFSP has - to date - awarded 12 grants to Bangladesh, Cambodia, Ethiopia, Haiti, Liberia, Mongolia, Nepal, Niger, Rwanda, Sierra Leone, Togo, and Tajikistan, that together amount to USD 481 million (out of the USD 520.2 million received against commitments). Other country proposals - several of which have already been identified as ready for support - will be funded once additional funding is committed to the GAFSP account.
17. The UN system provides increasingly coordinated support to developing countries' national strategies for food and nutrition security. The synergy of this inter-agency work is facilitated by the HLTF that brings together 22 organizations, funds, programmes and departments within the United Nations family, the Bretton Woods institutions, the World Trade Organization and the Organization for Economic Co-operation and Development. The HLTF's work is informed by its Updated Comprehensive Framework for Action (UCFA) which has encouraged alignment of agencies' approaches to food and nutrition security issues and is now increasingly being used by national governments, G20, development partners and civil society to plan their own strategies. Drawing on the work of the HLTF, there is an emerging consensus among national and international stakeholders that sustainable intensification of agriculture, with smallholders at the centre, and systematic protection systems for the most vulnerable, are central both to food and nutrition security and agricultural development plans. This is echoed in IFAD's Rural Poverty Report²⁰, FAO's "Policymaker's guide to sustainable intensification of smallholder crop production", the World Economic and Social Survey, and the World Economic Forum (WEF) roadmap for a "New Vision for Agriculture".

²⁰ IFAD. 2011.

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18. Progress on the Maputo Declaration is variable. The African Union has agreed to a yearly 6 percent growth target for agriculture GDP where agriculture plays a dominant role but, despite 5 percent growth in GDP, agriculture GDP in the region grew by only 3 percent between 2000 and 2008²¹. IFPRI's recent report on R&D in Africa finds that, despite large agricultural investment in eight countries, others such as francophone West Africa are dangerously dependent on volatile external funding sources. Nigeria, South Africa, Kenya, Ghana, Uganda, Tanzania, Ethiopia, and Sudan account for an increasing share of regional public agricultural R&D spending (70 percent) and all researchers (64 percent) in 2008.
19. Renewed government commitment to agriculture has resulted in a rise in public agricultural R&D in Brazil, China, and India. Brazil and India each spent slightly less on public agricultural R&D than Sub-Saharan Africa as a whole (totalling \$1.7 billion). China's spending far exceeds any other country and in 2007 totalled \$4.3 billion (in 2005 PPP prices)²². These governments' investments have led to dynamic innovation systems in support of agricultural development²³. The big African eight above, with well funded agriculture research programs, have led agricultural growth in the region. Growth in spending in Ghana, Nigeria, Sudan, Tanzania, and Uganda—the main drivers of regional growth—was largely the result of significant injections of government funding. Brazil, India and China are also mostly relying on their own investment but many other emerging and developing countries have a limited ability to fill the investment gap, even if official development assistance is included²⁴.
20. The investment contribution of donors and development banks has increased through the launch of sizable projects funded through World Bank loans in a number of countries as part of the West and East Africa Agricultural Productivity Program. Activities focus on generating and disseminating improved agricultural technologies that address both national and regional priorities focusing on roots and tubers in Ghana, rice in Mali and Tanzania, cereals in Senegal, cassava in Uganda, wheat in Ethiopia, and dairy in Kenya.
21. In Africa, Malawi offers an example of a holistic approach and inspirational leadership by President Bingu wa Mutharika, who put in place a series of policy measures that addressed agricultural and overall development. He took charge of the Ministry of Agriculture and Nutrition himself, committing 16% of spending to agriculture to initiate a rigorous assessment and multistakeholder consultation process to develop a plan that involved importing improved seeds and fertilizers to be distributed to smallholders at subsidized prices through coupons. Production doubled but costs were high due to

²¹ IFPRI. 2011

²² Ibid

²³ WESS. 2011

²⁴ FAO. 2011

leakages in the coupon system and poor targeting of subsidies, the exclusion of the private sector, and lack of farmer training, irrigation investments, and post-harvest support. These lessons were used to improve the program before returning the portfolio to the line ministry.

Room for improvement

22. Despite progress, IFPRI's recent review of agriculture institutional developments, investments, and capacity at national, regional, and global levels offers four areas to be addressed by governments, donors, and other stakeholders:
 - decades of underinvestment in agricultural R&D;
 - excessive volatility in yearly investment levels;
 - existing and imminent challenges in human resource capacity; and
 - the need to maximize regional and subregional cooperation in agricultural R&D.
23. Few agricultural plans take a holistic approach that takes into account the required rural infrastructure needed, improvement in market access, provision of extension services and technological capacity-building, coordination among multiple stakeholders in the government, academia, business and civil society, and need to secure property rights while being set within a wider framework of sustainable natural resource management, especially to address land and biodiversity degradation and overuse and contamination of water tables²⁵. Going forward, national plans will also have to take into account adaptation to and mitigation of climate change -- by increasing carbon sequestration in agro-forestry systems and building resilience to climate shocks. No blanket approach will do. In areas where overuse of fertilizers and pesticides has degraded land and water resources, appropriate policies may include removing fertilizer subsidies and facilitate improved soil and water management. In much of Sub-Saharan Africa, by contrast, incentives and means to increase nutrient application in nutrient depleted soils may be needed.
24. Most plans still focus on supply side interventions, not paying enough attention to where the increased production will ultimately go. A supply-chain or cluster approach is needed to increase productivity and income of farmers, especially smallholders mostly remote from markets with little access to credit. A supply chain approach pays better attention to the final market for agricultural goods, taking into account all stages of the agriculture supply chain²⁶. Without proper linkages between rural producers and urban consumers, urban growth cannot spur widespread rural poverty eradication. In Sub-Saharan Africa for instance, growing urban food demand is increasingly met by imports rather than by

²⁵ WESS. 2011

²⁶ McKinsey, 2011. Four Lessons for Transforming African Agriculture: To succeed, African Countries must Narrow Their Focus and Target High-Impact Projects. McKinsey Quarterly, April.

domestic producers. Improvements in harvesting techniques, post-harvest technologies²⁷, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems are also needed to be able to support sustained improvements in quality food produce delivered to market, hence in farmers' incomes, in developing countries. For the most part, national plans do not include activities to foster interactions among farmers, SMEs, and research centres that can add value to unprocessed raw material and to strengthen value chains and small farmers' participation therein and benefit therefrom. They typically do not address the need for working with the private sector and supporting the creation of well-functioning farmer's groups or cooperative to develop equitable aggregation programs for smallholders to reap the benefits of economies of scale and meet volume requirements of the ever concentrating supermarkets. Fiscal policies such as reducing export taxes can also increase export of processed food as experienced by Cote D'Ivoire and Ghana.

25. McKinsey finds that many African countries' plans lack specificity, having a large number of initiatives and activities that are not easily manageable and targets that are not easily measurable. McKinsey recommends concentrating investment on a value chain of importance to the country, a "breadbasket" region positioned for large productivity increases, or an infrastructure corridor. For instance Brazil took the regional approach by investing heavily in the Cerrado region, while Mali is considering a pilot breadbasket approach in the Sikasso region to raise cereal production in a sustainable way. Tanzania and Mozambique-Malawi-Zambia are taking an agricultural development corridor approach concentrating investment in farms and facilities for storage and processing around a major infrastructure project (usually a private sector mining or other infrastructure project).
26. Ensuring that there is a reliable supply of quality seed of adapted varieties requires integrated national strategies for the management of plant genetic resources for food and agriculture. Plant breeding capacities are in decline in most national programs and furthermore not linked to seed sector development, neither by public nor private partnerships. This impedes farmers from accessing improved varieties and high quality seeds. Plans need to include practical actions and targeted policy measures that create greater linkage and collaboration between plant breeding, seed systems and conservation stakeholders to make available climate-ready crops and seeds worldwide.
27. Agriculture in developing countries will need substantial and sustained investment in human, natural, physical and social capital to intensify production sustainably. FAO estimates that average annual gross investment of US\$209 billion is needed in primary

²⁷ FAO (2011) estimates that roughly one-third of food produced for human consumption is lost or wasted globally.

agriculture and in downstream sectors to meet the needed 70% increase in production by 2050²⁸. Investments of \$83 billion annually are needed in developing countries alone.

28. FAO has recently release a policymakers' guide to sustainable intensification of crop production that provides a toolkit rooted in a new paradigm of agriculture based on sustainable ecosystems that should help Member States achieve the above changes²⁹. For instance, FAO provides guidance and relevant tools to member States on how to use and conserve pollination services that sustain agro-ecosystem functions, and to formulate policies that will ensure sustainability of these ecosystem services. It also provides guidance on developing national phytosanitary strategies based on international standards to ensure the safe trade of plants and plant products and secure access to international markets and on support for seed production systems.
29. ILO supports countries to implement the Global Jobs Pact, adopted in June 2009 through seminars, knowledge-sharing tools, and office-wide policy briefs. The Pact places employment and social protection at the centre of extraordinary fiscal stimulus measures, with the view that this will protect the vulnerable and reactivate investment and demand in the economy. The Pact are defined and implemented at the national and global levels, based on social dialogue, employment and social protection measures best adapted to each national situation.

IV. Supporting agriculture research and development³⁰

30. The yields of many staples have been stagnating for more than a decade now, despite huge investment in and adoption of high-yielding varieties³¹. Meanwhile, agricultural production needs to double in developing countries by 2050³². In many countries, the twin objective of food and nutrition security and environmental sustainability will require, inter alia, greater and well-targeted investment in research and development and wider dissemination of information and technological support to small-scale farmers through adequate extension services and stronger multi-stakeholder partnerships. The public sector has to invest in R&D and provide adequate incentives to expand research on crops and processes of relevance to the poor. R&D is now dominated by the private sector concentrated in six major companies mostly focusing on profitable developed country markets³³. Private-sector funding can be by facilitated by enabling policy

²⁸ FAO. 2011

²⁹ Ibid

³⁰ The majority of information in this section comes from IFPRI's Agriculture Science and Technology Indicators (ASTI) that track agriculture institutional developments, investments, and capacity at national, regional, and global levels.

³¹ CIAT, 2011. CIAT Annual Report 2010: From the New World to the Whole World. Cali: CIAT.

³² FAO. 2011

³³ Ibid

environment, including strong intellectual property legislation, minimal barriers to importing and testing new technologies, and tax exemptions on research expenditures.

31. In the case of Africa, some eight countries have increased their R&D in agriculture but several others are grossly under funded. Even in these big eight with well developed research systems support to research varied considerably from year to year, notably in South Africa and Kenya.
32. Nigeria has the largest agricultural research system in SSA in terms of investments, capacity, and the number of government and higher education institutions. Public agricultural R&D more than doubled during 2000–2008 (offsetting earlier decline), salary levels increased, and a freeze on government recruitment was lifted. The role of the higher education sector in agricultural research was also increased during this time.
33. Sixteen African countries have created academies of science (Ghana, Cameroon, Egypt, Ethiopia, Kenya, Madagascar, Mauritius, Morocco, Mozambique, Nigeria, Senegal, South Africa, Sudan, Tanzania, Uganda, and Zimbabwe) that should help in integrating knowledge. However, despite the infrastructure development needed in Africa, only South Africa has an academy devoted to promoting engineering. Regional integration is also helping collaboration and information sharing among national research centres in SSA. The Forum for Agricultural Research in Africa; the Association for Strengthening Agricultural Research in Eastern and Central Africa; the West and Central African Council for Agricultural Research and Development and the Food, Agriculture, and Natural Resources Directorate of the Southern African Development Community have all made considerable progress in coordinating agricultural research activities in their member countries through the establishment of various research networks. They allow specialization of particular national agricultural research systems in certain fields and have proved to be particularly beneficial for small countries lacking a critical mass of agricultural R&D.
34. Lessons from the Green Revolution and the CGIAR are that (1) innovation and development of new technologies requires long-term secure financing and commitment, (2) adoption of new technologies requires an enabling institutional framework and large investment in infrastructure, and capacity development among farmers, as well as access to inputs, credit, and markets³⁴.
35. Public research institutions also require a radical change in their current model of operation so as to improve their responsiveness to the needs of farmers, including through joint experimentation and learning. IFAD is attempting to address these needs through a grant to the International Fertilizer Development Centre to fine-tune and scale

³⁴ WESS.2011

up innovative approaches for developing site-specific integrated soil fertility management options, appropriate (including organic) fertilizer, mechanisms for enabling access to fertilizers by resource-poor farmers, increased adoption of soil management options, and desirable institutional, behavioural and policy changes in West Africa.

36. Participation of women in agricultural research and extension services, especially in Sub-Saharan Africa, will also be critical to ensure their particular needs are met. Some countries such as South Africa, Mozambique, and Botswana have larger shares of female professional staff in agricultural research and higher education (32, 35, and 41 percent, respectively), while others had very low levels such as 6 percent in Ethiopia, 9 in Togo, 10 in Niger, and 12 in Burkina Faso³⁵.

Consultative Group on International Agricultural Research (CGIAR)

37. Budgets allocated to the CGIAR grew from \$15 million in 1970 to \$305 million in 1990 to reach \$600 million in 2011. The cost-benefit ratio of the CGIAR research has been estimated to range from 1.9 to 17.3 based on a subset of its research.³⁶ This institution that supported the Green Revolution is undergoing significant reform. The 2010 reform resulted in a new structure based on a results-based management approach for strategic planning, management, and communications centred on continuous learning and accountability. The new System Level Outcomes that inform the design of CGIAR Research Programs are: (1) reducing rural poverty, (2) improving food security, (3) improving nutrition and health, and (4) sustainable management of natural resources. Priority is increasingly given to responding to local needs (including applied and operational research), validating and disseminating field experience and good practices and building capacity of national institutions.
38. In 2010, IFAD approved US\$13.6 million of grants to the 15 CGIAR-led programmes (extended now to the Global Forum on Agricultural Research) which promotes worldwide collaborative research partnerships. Through information sharing and assessment of innovative policies and programmes, IFAD partnerships with the various CGIAR centres support efforts to improve access to productive assets and new markets for high-value commodities. For example, IFAD works with Biodiversity International to raise the profile of neglected and underutilized species or support provision of improved seeds to poor rural communities of Bolivia, India, Peru and Yemen.

UN System

39. FAO assists 60 member States with capacity building technical assistance projects. These projects assess the current state of agriculture innovation systems; strengthen the capacity

³⁵ IFPRI. 2011

³⁶ Raitzer and Kelley (2007). Benefit-cost meta-analysis of investment in the CGIAR. *Agricultural Systems* 96 (2008):108-123.

of the research, extension, education, information and communication institutions and services; provide methods and tools to strengthen the linkages between traditional and scientific knowledge generation; and develop management and policy mechanisms to strengthen the agriculture innovation system and to make it more sustainable.

40. FAO leads several initiatives that enhance the communicate the outputs of agriculture research and innovation including: (1) the Coherence in Information for Agricultural Research for Development initiative providing a framework of good policy and practice supported by a range of open tools and services for organizations to make public domain outputs truly accessible, now supported by more than 100 major research organizations and universities; (2) the Access to Global Online Research in Agriculture programme that providing free or extremely low-cost online access to 2,700 online published scientific to over 2,500 registered institutions in 107 low-income countries; (3) the conceptual model for a Virtual Extension and Research Communication Network promoting the use of internet-based technologies and communication to increase linkages among agricultural policy, research and extension institutions and other key stakeholders.

Integrating local know-how

41. An interesting trend in supporting knowledge-intensive agriculture is the recognition of the role of decentralized universities as agents of regional knowledge transfer. The decentralization of knowledge to a variety of local institutions will be key to integrating local knowledge and new technology to adapt them to local agro-ecosystems and to climate change. For instance, the government of Ghana established the Multi-campus University for Development Studies in 1992 with the goal of making tertiary education relevant to rural communities in northern Ghana using resources from the region. The pedagogical approach emphasizes practice-oriented, community-based, problem-solving, gender-sensitive and interactive learning applied to local poverty problems³⁷. Students are expected to internalize the importance of local knowledge and to find ways of combining it with science through practical field programs involving participatory learning and appraisal during which students live and work in rural communities³⁸. The majority of graduates of this university are now working in rural communities. Uganda has developed a similar community-based agricultural education.
42. FAO supports the integration of local know-how by providing links and building communication channels for knowledge exchange between UN agencies and other stakeholders. FAO also provides advice and technical assistance to Member States in identifying communication needs and in applying innovative, cost-effective communication strategies for specific audiences. Communication for Development

³⁷ Juma. 2011

³⁸ Ibid

supported by FAO is a critical component of any development initiative to ensure knowledge is effectively shared amongst people and institutions. UNESCO also fosters the use of traditional knowledge in several selected biosphere reserve projects around the world (Cuba, Morocco, etc.) that provide lessons for member States.

Land and Water

43. Agriculture and land are closely linked as well. Addressing the nexus of food, land, water and energy security, environment and climate change is vital for an agricultural sector able to meet an increasing demand of food staples and to be environmental, social and economic sustainable. Agriculture and water are closely linked. Worldwide agriculture consumes seventy percent of all freshwater withdrawals, an increasingly scarce resource. Agricultural water productivity has to be increased significantly to raise yields and cope with climate change. Adaptation efforts must begin now to avoid building infrastructure that locks agricultural users into unsustainable behaviour for years to come. Integrated land and water resources management, efficient use of water resources and safe reuse of waste water will be vital in both adaptation to and mitigation of climate change. African examples of rainfed systems include raised seedbeds to trap water, and keyhole gardens using wastewater. Improved irrigation systems include mini-sprinkler and drip systems, precision timing in plant watering and crop systems such as the intensive rice system which use less water than traditional systems. Improved water harvesting and retention are also fundamental for increasing production. For instance, one pilot project using an earthen dam to collect rainwater to permit irrigation during the dry season has doubled rice yields in Costa Rica, Mexico and Nicaragua³⁹.

V. Supporting technology transfer and extension services

44. Radical reform of and support to technology transfer and extension services are needed to meet the challenges of food and nutrition security, poverty reduction and environmental sustainability. After decades of under-investment, many developing countries have weak agricultural innovation systems, fragmented and poorly linked with farmers, civil society organizations and the private sector. Yet, agricultural extension workers are still an important vehicle for the transmission of knowledge, information and training for small farm holders, provided that they have adequate training themselves, a clear mandate and adequate remuneration.
45. Examples of successful adoption of sustainable practices have in common:
- technical knowledge is made relevant and accessible to farmers and farmers are directly involved in learning and innovation aimed at adapting knowledge, technology and management practices to the local context;

³⁹ CIAT. 2011

- active participation of various actors including Governments, non-governmental organizations, private companies, and multilateral organizations in scaling up innovations, disseminating knowledge, building capacity among farmers, fostering trust and reducing the risks of new technology and agricultural practices;
 - adjustments in institutions governing agricultural R&D to induce farmers to adopt new practices, redefining the role of women and establishing closer interacting networks⁴⁰; and
 - an enabling environment within which farmers can overcome the constraints they face in adopting new technology and agricultural practices⁴¹.
46. Several effective collaborations among multiple stakeholders have been successful in designing and deploying innovations with large-scale impacts including Farmer Field Schools (FFS) and the System of Rice Intensification, among others (WESS, 2011).
47. The experience of the Farmer Field Schools—operating in 87 countries—shows that innovation and flexible natural resource management can be advanced through farmer-to-farmer learning, with participation from formal and informal research institutions. FFS involve a participatory approach that allows small farmers to test technical alternatives and adjust them to local conditions and ecology. A partnership between the Government of Indonesia, the US Agency for International Development and FAO has expanded FFS from Philippines and Indonesia to Bangladesh, Cambodia, China, India, the Lao People's Republic, Nepal, Sri Lanka, and Viet Nam as well as extending the content to a range of management skills. Scientific evaluations is needed, however to ensure FFS is an effective tool to dissemination knowledge. Davis and several others find that FFS are not easily scalable and that they have had contestable impact on the sustainability of agricultural intensification⁴².
48. In-service and on-the-job training and distance education via mobile telephony, video and radio have also proved effective and are increasingly complementing extension services. FAO facilitates the e-Agriculture global Community of Practice that was established after the World Summit on the Information Society to foster the more effective use of information and communication technologies (ICT). Over 7,000 information and communication specialists, researchers, people in rural institutions, farmers, policy makers, and business people from more than 160 countries share good practices and information about the use of ICTs for sustainable agriculture and rural development.
49. Mobile telephony now provides an affordable and accessible means of communication and support for innovation to rural communities to create economic opportunities and strengthen social networks. The implementation of Local Innovation and

⁴⁰ IFAD, 2011

⁴¹ WESS. 2011

⁴² David. 2006. Farmer Field Schools: A boom or Bust for Extension in Africa? JIAEE 13(1): 91-97.

Communication Plans by FAO has improved the delivery of advisory services, the use of local knowledge and farmers' participation in decision making, enhancing research/extension/farmer linkages. Special emphasis has been given to promoting the sustainable management of natural resources in agriculture. Farmers and communities have used mobile telephony to do e-banking and to access real time weather, price and other information. Meanwhile, FAO uses mobile phones to monitor the incidence and spread of infectious pests and diseases, use and disposal of government pesticide stocks, location of water sources, and regional price changes.

50. Videos of peers practicing improved management have proven to be very effective with African women, more so than training workshops⁴³. For instance, in Benin, they have been used to introduce women to improved rice processing techniques. These can be reinforced through radio programmes as does Radio Guinée Maritime. These low-cost technologies are underutilized in fomenting innovation through farmer-to-farmer knowledge sharing.
51. The system of rice intensification (SRI) was developed outside the formal research institutions mostly by NGOs and farmers through continuous learning and adaptation. SRI implements simple management changes such as hand transplantation in non-flood fields of younger plants, with higher spacing between them and broader use of organic fertilizer and IPM. It has been successfully tested in 40 countries, increasing yields by 50% while reducing water use and input costs thus increasing incomes. The governments of Cambodia, China, India, Indonesia, and Viet Nam have endorsed the SRI and included it in their national strategies for food security.
52. Rapid expansion of quality education in rural areas, including adult and women literacy and training will also be needed to ensure farmers have the ability to innovate, learn from one another and adapt to change in agro-ecological and market conditions.
53. To provide the rural advisory services sector a forum for sharing of experience, FAO has supported the formation of the new Global Forum on Rural Advisory Services. The Forum has 34 regional and national affiliates with whom it is consulting to develop a five-year operational plan and a guidance kit for evaluating rural advisory service systems, and developing evidence-based approaches and policies for improving the effectiveness of rural advisory services and programs.
54. FAO also stimulates the sharing of knowledge between applied research and field extension agents through TECA, an information system that provides an internet based platform for knowledge sharing on applied technologies and practices for small agricultural producers and online Exchange Groups on specific geographical areas or

⁴³ Juma. 2011

themes. The new platform was tested with rural users and reviewed to contain only technologies and practices well described that comply with the needs of rural users (300 technologies and practices). On average about 10,000 pages of the platform are viewed per month and awareness activities is ongoing. The modules can be decentralized to Member States, as was done with Bolivia.

55. ESCAP's Asian and Pacific Centre for Agricultural Engineering and Machinery developed an institutionalize process for testing and promoting safe and sustainable machinery for the region through pilots of harvest and post-harvest technologies in Myanmar and high yielding rice cultivation and seed production technology in the Democratic People's Republic of Korea, Fiji, and Philippines⁴⁴.

VI. Market and financing services

Market services

56. While the private sector has played an increasingly important role in accelerating innovation in agriculture through a variety of mechanisms, the risk of excluding small-scale farmers is large. Large supermarket chains control between 40-50% of the food market in LAC, about 10% in China, 30% in South Africa, and 50% in Indonesia, requiring smallholders to have the capacity to meet strict quality standards and develop aggregation of their products through cooperatives and associations to meet commercialization scales.
57. Three factors are critical in preventing smallholder exclusion from supermarket supply chains that are increasingly dominating developing countries' procurement: (1) focus on products with a pre-identified market; (2) the catalysing involvement of private and/or public organizations with a commercial basis; and (3) sustainable group formation among farmers. Monopolistic practices in food markets must also be prevented⁴⁵. Better access to information, credit and risk insurance would also leave small-scale farm holders in a better position to engage in mutually beneficial partnerships with the private sector⁴⁶.
58. In addition, the proliferation of ethical and environmental certification processes in recent years is opening new opportunities for creating value chains that link small farm holders to larger export markets. Voluntary standards and certification programmes for banana, coffee and cacao address a wide range of issues including environmental protection, labour rights, safety and health at work, social equity and the welfare of local

⁴⁴ ESCAP. 2011. Report of the UN Asian Pacific Center for agrl Engineering and Machinery. E/ESCAP/67/6.

⁴⁵ McCullough, E.B., Pingali, P.L. and Stamoulis K.G. 2008. The Transformation of Agri-Food Systems: Globalization, Supply Chains and Smallholder Farmers, London, FAO and Earthscan, 2008.

⁴⁶ WESS, 2011

communities, while providing farmers with price premia; improving market access and stability.

59. Nevertheless, standards aimed at food safety, quality, traceability and good agricultural practices, which are mainly developed by large firms in major markets, tend not to ensure price premia and may harm small-scale growers by significantly raising the costs they incur to meet the standards⁴⁷. In response to this proliferation of standards, the non-profit and volunteer-based consortium “Committee on Sustainability Assessment” (COSA) has developed a rigorous assessment tool and is now generating science-based information on the social, economic and environmental impacts of any sustainability practices - including their costs and benefits over five years. The tool has broad political acceptance with development agencies and leading firms because of its multi-stakeholder consultation process. COSA is expanding data collection from coffee to tea, cotton, biofuel crops, fruits, etc. and will provide agricultural sustainability information for dozens of countries. Data collection, of more than 5000 data sets so far, is done by strengthening the capacity of leading local organizations in developing countries to execute data collection according to a standard method making state-of-the-art impact assessment publicly available.
60. FAO has also developed a work programme to provide advice on (1) changes in government engagement with the private sector to reflect the diversity and changing markets; (2) the creation of an enabling environment for national agribusiness development; and (3) institutional strengthening and services sector development to support agricultural value chains programs for sustainable and inclusive business development.

Financing investment and innovation

61. Publicly funded research should maintain an explicit focus on strategic priorities for food and nutrition security, including improving yields and resistance of staples, improving the nutritional value of crops, facilitating sustainable use of natural resources and/or reducing the use of external chemical inputs, increasing resilience and adaptation to market conditions and climate change. Investments in agriculture are also a cost-effective way to build resilience and reduce the need for humanitarian aid year after year in regions facing chronic food and nutrition insecurity.
62. Governments and donors are increasing investments in agriculture but more is needed to meet the growing demand for food. Progress on the Maputo Declaration must be stepped up and delivery against the l’Aquila commitments will therefore be an important step forward. With the economic and financial crisis however, public sector contribution to

⁴⁷ FAO. 2011

agriculture and rural development has been very variable, with a significant number of countries showing low or declining contributions⁴⁸.

63. It is estimated that private sector investment in agriculture, including FDI, will need to increase by nearly 50% overall to meet increasing demand (from some \$142 billion per year). Yet, there is evidence that current investments are frequently made with weak consultation with local communities, a lack of transparency over the terms of investment, and poor or non-existent mechanisms to redress grievance over exploitation of natural resources, large-scale land acquisition, and loss of livelihoods in rural communities. There is increasing evidence that alternative models that include smallholders such as contract farming, outgrower schemes and joint-ventures with farmer organizations are more conducive to sustainable economic development than the large-scale land acquisitions model to create mega-farms in developing countries (FAO et al, 2011). Traditional public-private partnerships have also not been very successful in directing innovation efforts toward achieving sustainable development objectives⁴⁹. To facilitate private investment that is responsible and fosters sustainable development, the G20 requested FAO, IFAD, UNCTAD and the World Bank to develop *Principles for Responsible Agricultural Investment that Respects Rights, Livelihoods and Resources*. The G20 has proposed that the agencies pilot the seven principles that arise from consultation in a first phase and use lessons learned to inform a consultation process for the second phase.
64. Approaches which integrate and blend all sources of financing acceptable to each country will be needed.
65. While it still needs to be tested in agriculture, the Advanced Market Commitment mechanism for the production of vaccines, whereby donors make a large advance purchase commitment at a predetermined price, may offer significant lessons for technological innovation for sustainable agricultural intensification.
66. Another innovative mechanisms to engage the private sector is the results-based performance contracts—for the development, for example, of improved seed or crop varieties with higher water-stress tolerance and greater responsiveness to fertilizers—granted on a competitive basis may be one means of stimulating private research.
67. Implemented in conjunction with the African Union, NEPAD and national governments, The World Economic Forum's New Vision for Agriculture encourages partnerships for sustainable intensification of smallholder agriculture - and better functioning value

⁴⁸ HLTF, 2011

⁴⁹ WESS,2011

chains - that involve businesses (including farmer organizations), civil society organizations and governments.

68. Industry partners of the World Economic Forum (WEF) have contributed through regional consultations in Africa and Asia to develop the “New Vision for Agriculture”, whose road map was released at the annual WEF meeting in Davos in January 2011. The road map focuses on public-private-civil society partnerships, with farmers at the centre, to accelerate growth of sustainable agriculture.
69. It is also important to learn from the range of pilot climate funds currently under implementation especially about enabling environments for responsible private sector investment, both small-scale and large-scale, including partnerships with philanthropic organizations and foundations. Including sound agricultural practices in financial mechanisms such as the REDD+ could help finance sustainable intensification. Agriculture contributes considerably to climate change by producing 10-12 % of total global anthropogenic emissions of greenhouse gases. Sustainable agricultural practices can significantly reduce emissions by storing carbon in the soil or in above ground biomass, or by reducing nitrous oxide or methane emissions. Another source of funding being explored is access to the funds made available under the Copenhagen Accord under the fast start finance for enhanced action on mitigation (including REDD), adaptation, technology development and transfer and capacity building and long term support that aim to mobilize USD100 billion per year by 2020.
70. FAO and interested G20 members are working to develop a platform for capacity building in tropical agriculture in developing countries, which will bring together institutions from G20 countries and least developed countries in a virtual, agile and efficient structure to generate and apply agricultural knowledge in developing countries. The Platform is aimed at global coordination of efforts to develop individuals’ capacities using good training practices that support to continuous learning and ownership by national actors.

VII. Way forward

71. Sustainable intensification and sustainable agriculture will remain high on the international agenda as food production has to increase by 70% over the next 38 years and investment by US\$209 billion per year. The UN Conference on Sustainable Development (UNCSD) in 2012 will provide an important opportunity to foster the launch of partnerships that lead to agricultural innovation, agricultural technology transfer and adaptation, and innovative financial mechanisms to support these innovations. Sustainable intensification of agriculture is central to one of the two themes of the Conference, viz., green economy in the context of sustainable development and poverty eradication.

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72. Significant national efforts will be needed to reform the agricultural sector to integrate sustainable agriculture and support to smallholders, including women farmers, into national policies and strategies, supported by regional and international institutions. Greater effort and resources need to be devoted to developing and diffusing the agricultural technologies for effective adaptation to climate change and natural resource scarcities. Agriculture also has the potential to wed techniques for greenhouse gas mitigation with improved livelihoods for poor farmers through low-cost improvements in soil, water, plants and ecosystem management.
73. Investment and cooperation in reducing post-harvest waste in developing countries would go a long way towards addressing food and nutrition security and poverty while saving precious natural resources. Other investments in infrastructure and capacity building for meeting certification standards would help enhance smallholders' national and international market access.
74. The deficit of women in key education, research and extension services supporting agriculture must be explicitly addressed. Gender analysis and targeted initiatives must be incorporated in agricultural education, research and extension services, acknowledging the roles women play in the agricultural workforce as main food producers and in the household as caretakers. Women are to be seen as visible actors and participate on an equal footing in the development of any intervention aiming to promote food and nutrition security.