United Nations A/68/308

General Assembly

Distr.: General
19 August 2013

Original: English

Sixty-eighth session
Item 19 of the provisional agenda*
Sustainable development

Agricultural technology for development

Report of the Secretary-General

Summary

At the United Nations Conference on Sustainable Development, Heads of State and Government renewed the commitment to freeing humanity from poverty and hunger as a matter of urgency. Consensus is growing that meeting the existing challenges associated with reaching this vision requires a shift to sustainable and resilient agriculture and food systems in order to ensure food and nutrition security, contribute to poverty eradication and protect natural resources, to support equitable development for all. Agricultural technology for development has a key role to play in this regard. Access to capital-intensive technologies is unevenly spread, especially across developing countries, and capacity for knowledge-intensive technologies needs to be augmented. Effective responses necessitate improved and innovative approaches to the development, transfer and dissemination of sustainable agricultural practices that are resilient, accessible and beneficial for the most vulnerable people, including women and men smallholder farmers. Creating an enabling environment and the right incentives for the shift to sustainable food systems is imperative.

* A/68/150.

13-42545 (E) 200913

Contents

I. Overview

1. The present report has been prepared in response to General Assembly resolution 66/195, entitled “Agricultural technology for development”, in which the Assembly requested the Secretary-General to submit to it at its sixty-eighth session a report on the implementation of that resolution.

2. At the United Nations Conference on Sustainable Development, held in Rio de Janeiro, Brazil, in June 2012, Heads of State and Government renewed the commitment to sustainable development; to ensuring the promotion of an economically, socially and environmentally sustainable future for our planet and for present and future generations; and to freeing humanity from poverty and hunger as a matter of urgency.[1]

3. The Secretary-General’s Zero Hunger Challenge calls on Member States and all partners to scale up their efforts and turn the vision of an end to hunger into a reality. The Zero Hunger Challenge entails the following objectives: 100 per cent access to adequate food all year round; zero stunted children less than 2 years of age; all food systems becoming sustainable and resilient; a 100 per cent increase in smallholder productivity and income; and zero loss or waste of food.

4. Consensus is growing that meeting the challenges associated with reaching those commitments requires an urgent shift to sustainable and resilient agricultural and food systems in order to ensure food and nutrition security, contribute to poverty eradication, protect natural resources and ensure environmental sustainability to support equitable and sustainable development for all. Achieving this shift requires an enabling environment, including through the development, transfer, dissemination and deployment of sustainable agricultural technologies and practices.

5. The present report examines the current status and trends of agriculture technologies and highlights suggestions that have been put forward in order to further progress towards sustainable agricultural systems.

II. Broader context of and challenges to sustainable food production

6. In moving towards the sustainability of agricultural production and food security, the broader context in which food production systems operate and the constraints they face have to be taken into account. In particular, land degradation, competition for land, loss of biodiversity, natural resources management, climate change and the role and needs of small-scale farmers, including rural women, are important factors that have to be considered.

Land degradation

7. There are 5 billion hectares of land available for food supply worldwide, 1.5 billion of them used for farmland and permanent crops and 3.5 billion as grassland, grazing land and extensively used steppe. Nearly 2 billion hectares are degraded due to intensive and improper use, with continued degradation amounting

[1] General Assembly resolution 66/288, annex, paras. 1-2.

to an annual loss of $400 billion per year. Some 80 to 90 per cent of the 868 million food-insecure people in the world reside in regions with strongly degraded or severely depleted soils.

8. Agricultural intensification during the Green Revolution achieved the doubling of cereal production over 40 years, with only a 12 per cent increase in global cropland area. However, at the regional level, there were significant differences: in Asia, yield increases were achieved through intensification and increased irrigation, while in Africa most increases in yield were achieved through extensification. Land area for cereal production in Africa has increased by about 80 per cent over 40 years.

9. Poor soil fertility is the most critical factor constraining agricultural production in sub-Saharan Africa; soil moisture stress has a negative impact on the productivity of 85 per cent of the soils in Africa. In South Asia, estimated annual productivity worth $5.4 billion is lost because of water erosion and $1.8 billion because of wind erosion.

Competition for land

10. Globally, both fertile and total land available for agriculture has become increasingly scarce owing to unsustainable cultivation practices and a rise in competition for productive land, involving such factors as large-scale land acquisitions and pressure from biofuels.

11. The conversion of some foods for non-human uses (i.e. animal feed) is another factor in the competition for productive land. While a substantial percentage of the world's grain output today is fed to animals, at least 11 per cent of the world's corn crop is destined for cars and trucks in the form of biofuels, as are many other food crops, such as soybean, canola and sugar cane.

Loss and waste of food

12. Currently more than twice the necessary calories are produced globally; yet 30 to 40 per cent of all food is wasted before it is consumed. Every year, consumers in rich countries waste almost as much food (222 million tons) as the entire net food production of sub-Saharan Africa (230 million tons). In wealthier countries much of the loss occurs at the retail and consumer levels, while in poor countries it is due to poor post-harvest technologies, including at the processing, storage and preservation stages. A study by the Department of Economic and Social Affairs of the Secretariat notes that in the United Kingdom of Great Britain and Northern Ireland, approximately one third of all food purchased is not eaten, while in the United States of America food waste accounts for nearly 13 per cent of municipal solid waste, according to the United States Environmental Protection Agency. The World Bank reports that in developing regions, annual physical grain losses prior to processing are estimated to range between 10 and 20 per cent, their value totalling $1.6 billion a year, or about 13.5 per cent of the total value of annual grain production.

Environmental impacts

13. The economic success of increased agricultural intensification in past decades came at a significant environmental cost. Since the 1960s, use of global fertilizer has increased by about 700 per cent. By 2009, the global share of nitrogen in

applied N-P-K fertilizers had increased to 74 per cent — twice the average amount of nitrogen required by plants (37 per cent) — resulting in soil acidification, depletion of essential humus content and eventual loss of economic viability.

14. Intensification created other negative impacts as well, including salinization of soils, soil fertility loss and overgrazing, as well as impacts beyond the field level because of unsustainable water usage, greenhouse gas emissions and chemical runoff leading to eutrophication and dead zones at river mouths. These environmental challenges are reflected in diminishing returns from synthetic fertilizer application and declining growth in yields.

Biodiversity loss

15. Biological diversity is crucial for sustainable food production, but is under threat. At present, there are still over 50,000 edible plants in the world, but, according to the Food and Agriculture Organization of the United Nations (FAO), humans are drawing on only 150 of them, and more than half of the world's food comes from only 3: rice, corn and wheat. We rely on only 15 plants for 90 per cent of our food. Mirroring market concentrations in the global seed market, the wealth of cultivars suitable for a variety of growing conditions has shrunk as a few globally grown high-yield crop cultivars have risen to dominance. It is estimated that 75 per cent of all economically useful cultivars have vanished from the world's farms. Comparable trends have been affecting livestock, with similar consequences.

16. While concentration can present some economies of scale, it can also increase risk. Biodiversity acts as a safeguard against pest problems and supports higher productivity, adaptation and maintenance of ecosystem functions. A lack of diversification at the farm level is expected to increase the vulnerability and marginalization of small-scale farmers.

17. With every disappearance of a species, potentially valuable genetic material is lost. The consequences include lost access to potentially useful genetic characteristics, and nutritional diversity — important for health — can also be at risk as fewer and fewer food crops dominate our research and trading systems. A number of low-income countries depend heavily on one food crop, and many are net importers of that crop. For example, the Department of Economic and Social Affairs has reported that people in Bangladesh, Cambodia and Myanmar depend on rice for nearly three fourths of their caloric intake, while the populations of Malawi, Zambia and Lesotho depend on corn for well over half of their calories.

Water use and management

18. Current industrial farming practices, population growth and urbanization have led to a decrease in water availability, and the demand continues to increase. Currently, 70 per cent of all human water use goes to irrigation. In countries and regions such as China, India, North Africa, the Middle East and North America, groundwater depletion exceeds recharge rates. According to FAO, 93 per cent of depletion from aquifers is due to agriculture, and irrigated areas of cropland in low-income countries are projected to expand by 20 per cent by 2030. The effects of climate change are expected to accelerate these trends owing to higher temperatures and changes in precipitation patterns. Water is especially problematic for impoverished women farmers, who make up a large portion of the farm community

in many countries, because they lack access to affordable, small-scale irrigation systems.

Climate change

19. Current estimates of the impact of climate change on agriculture forecast increased pressure on soils, water cycles and use, and crop and livestock production. More frequent and intense extreme weather events are expected to accelerate soil erosion and run-off. Higher temperatures are projected to increase the turnover rates of organic matter, thus negatively affecting soil composition and water-holding capacity, while at the same time affecting the health of plants, animals and farmers, increasing pests and reducing water supply, resulting in a greater risk of increased desertification and land degradation. Furthermore, increased ozone levels will harm key crops and cause negative impacts on the nutritional quality of various foods.

20. It is estimated that climate change will increase vulnerabilities across the food system and will necessitate massive investments — in roads, irrigation efficiency and expansion, and agricultural research — in order to avoid negative impacts on nutrition.

Smallholders and rural women

21. The International Assessment of Agricultural Knowledge, Science and Technology for Development concluded that overcoming constraints to innovation and improving farming systems to make them appropriate to the environmental, economic, social and cultural situations of resource-poor small-scale farmers, while ensuring that farm products are fairly and appropriately priced, are essential elements for supporting smallholders and achieving sustainable farming.

22. Larger-scale farmers generally benefit from better access to irrigated land, fertilizers, seeds and credit, resulting in earlier adoption of capital-intensive technologies. During the Green Revolution, the lack of irrigated or high-potential rain-fed agricultural land impeded the adoption of capital-intensive technologies. As a result, many small-scale farmers in Asia, for example, adopted Green Revolution technologies relatively late. Lack of diversification at the farm level tends to increase the vulnerability and marginalization of small-scale farmers. An important lesson learned was that it is imperative to develop scale-neutral technologies grounded in the realities of marginalized farmers.

23. Women make up 50 per cent of the agricultural labour force in sub-Saharan Africa and East Asia, compared with 20 per cent in Latin America. However, compared with men across developing regions, they lack access to many productive inputs and services, such as land, livestock, education, labour, financial services and technology. FAO estimates that addressing this gender gap would increase women’s yields by 20 to 30 per cent and global agricultural output by 2.5 to 4 per cent. Such a productivity increase is estimated to be capable of lowering the global percentage of hungry people by 12 to 17 per cent.

Broader policy environment

24. While the multidimensional positive effects of sustainable food-system practices on the economy, society and the environment is being recognized by many, rewards for the provision of such effects remain limited, in particular in developing

countries. The effects include ecosystem benefits, such as soil and biodiversity conservation, pollination, natural pest control, watershed management and the reduction of greenhouse gas emissions. They also include social and economic benefits, such as strengthening rural communities and development, improving gender equality, reducing poverty and creating jobs, all of which can provide incentives for food-system actors to adopt more sustainable practices.

25. International trade and economic policies can have positive and negative effects on different development and sustainability goals. The organization of the trade system and access to domestic and international markets influence how agricultural raw materials and processed goods are produced, distributed and consumed, and have important consequences for the redistribution of goods and benefits. Although the majority of agricultural goods are not traded internationally, world market prices influence domestic prices.

26. In recent decades, public neglect of agriculture in developing countries, even as their food needs increased, combined with distortionary subsidies, led to a shift in a number of developing countries from being net exporters to becoming net importers of food, especially of grains. According to FAO, the current trajectory indicates that by 2030, developing countries are likely to become even more import-dependent, with estimates of net grain imports amounting to some 265 million tons annually — almost three times present level.

27. Trade liberalization and deregulation have deepened the integration of many previously controlled markets into the global economy. The existence of more open markets has contributed to a diversification of food and supplies, new market opportunities and efficiency gains related to comparative advantage. However, the benefits of trade liberalization have not been without costs, particularly as less affluent producers adjust to the creation of a new competitive landscape in which they are often at a disadvantage. The increasingly global nature of markets and agribusiness presents a challenge for smaller-scale agriculture.

28. The determination expressed in 2005 by the World Trade Organization (WTO), in its Ministerial Declaration, for the elimination of all forms of export subsidies and disciplines on all export measures with equivalent effect to be completed by the end of 2013 has not been fulfilled. Furthermore, escalating import tariffs (i.e. tariffs rise along with the stage of processing of agricultural goods) provide disincentives to developing countries to export processed goods, which can cause the addition of value through processing stages to be delayed, stalled or even decreased, and the associated benefits for the building of local economies and jobs in developing countries to be missed.

29. The issue of food price volatility poses additional and urgent challenges to food security and rural livelihoods. As food prices have become increasingly volatile in recent years, evidenced by the number of price shocks, investments have become harder to predict and therefore riskier.[2] With the vast majority of farmers and rural communities depending on agriculture for their livelihoods, price volatility can exacerbate poverty and hunger and may even be a cause of riots or intra-State conflict, as observed during the food price crisis in 2008.

[2] High-level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, *Price Volatility and Food Security* (Rome, 2011).

III. Trends in and current state of agricultural technologies in developing countries

30. Since the mid-twentieth century, industrialized and developing countries have achieved tremendous growth in agricultural production and, with the major exception of sub-Saharan Africa, productivity. According to the United Nations Environment Programme (UNEP), public and private investments in advanced component technologies have increased farm-level productivity through the development and successful dissemination of hybrid seeds and the introduction of irrigation and inorganic inputs, such as synthetic pesticides and nitrogen fertilizer.

31. Such investments made significant contributions to food security and socioeconomic development up to the end of the twentieth century. According to the World Bank, the resulting agricultural growth and increased agricultural productivity at the farm level spurred a significant reduction in poverty rates, reducing the number of people living below the one-dollar-a-day poverty line three times as fast as growth outside the agricultural sector. Nevertheless, the adoption of agricultural technology in developing countries has been limited mainly to cash crops and exports for animal feed, thus diminishing its contribution to food security and poverty reduction and failing to translate growth into nutritional improvements across the board.

Crop varieties and seed systems

32. FAO has reported that high-yielding varieties of maize, wheat and rice have improved nutrition by leading to higher incomes and lower prices for staple foods. Models of the International Food Policy Research Institute suggest that, without these genetic crop improvements, by 2000 there would have been an increase in global food prices, an estimated 11 to 13 per cent lower caloric availability and a 6 to 8 per cent increase in malnourished children in developing countries.

33. Globally, the production of high-yielding varieties of wheat, rice and maize more than doubled within 25 years after their introduction in 1961. In developing countries, the area cultivated with those varieties, 20 to 30 per cent in the 1970s, increased to about 70 per cent by 1990. The increase in the production of high-yielding varieties of those crops increased per capita calories, but also led to a rising demand for irrigation, fertilizers and pesticides.

34. Genetically modified crops are currently grown by more than 17 million farmers, of whom 90 per cent are small, resource-poor farmers in developing countries. The four major genetically modified crops are soybean, cotton, maize and canola. Globally, in 2012 the genetically modified versions of soybean and cotton accounted for 81 per cent of the total planted, while genetically modified maize and canola accounted for 35 per cent and 30 per cent, respectively, of the global planting of those crops. Twenty developing countries and eight developed countries are currently producers of genetically modified crops, and in 2012, for the first time, the former grew more of such crops than the latter.[3]

[3] The developing countries are: Argentina, Bolivia (Plurinational State of), Brazil, Burkina Faso, Chile, China, Colombia, Costa Rica, Cuba, Egypt, Honduras, India, Mexico, Myanmar, Paraguay, Pakistan, Philippines, South Africa, Sudan and Uruguay. The developed countries are: Australia, Canada, Czech Republic, Portugal, Romania, Slovakia, Spain and United States.

35. The first generation of genetically modified crops focused mainly on the single-gene traits of herbicide tolerance and insect resistance, while, according to FAO, the second, new generation is expected to offer higher output and better quality. As the use of the technology has been mainly limited to cash crops and exports for animal feed its contribution to food security and poverty reduction remains open to question.

36. The shift towards biotechnology and enhanced intellectual property rights has accelerated the privatization of agricultural technologies, especially seeds. The incentives to develop private sector technologies for developing countries or agroecological technologies are limited. The United Nations Conference on Trade and Development reports that intellectual property rights often interfere with the development and adoption of locally adapted varieties.

37. Plant-breeding capacities are in decline in most national programmes and furthermore are not linked to development of the seed sector, either by public or private partnerships. This impedes farmers' access to improved varieties and high-quality seeds.

38. New technologies for spatial analysis, such as remote sensing and geographic information systems, help to identify stress-tolerant varieties that will survive under future growing conditions from within a certain region or global seed bank. In addition to crop relocation, improved monitoring and knowledge about shifts in climate will allow for the adjustment of planting dates and crop varieties within a country and region. Advanced remote sensing techniques have also been instrumental in creating early warning systems for increased pest pressures faced by farmers, such as those involving locusts and fungi.

39. Given its low adoption rates of external inputs and hybrid seeds, sub-Saharan Africa is identified as a "low-hanging" intensification opportunity. National maize yields across six countries in sub-Saharan Africa, as reported by the World Bank, average less than 2 tons per hectare, whereas optimal on-farm demonstration trials can achieve from 3 to more than 5 tons per hectare, even when using only open-pollinated varieties. With the use of sustainable agricultural methods, yields of crops such as maize and teff have doubled or even tripled.

Sustainable land management and sustainable use of natural resources

40. Sustainable farming to augment soil fertility includes agroecological practices, agroforestry and optimal irrigation and nitrogen inputs and timing to enhance the soil's capacity to sequester carbon and mitigate greenhouse gas emissions. Better management of ecosystems leads to benefits such as rainwater control and improved soil health, which are significant sources of yield growth and stability.

41. Agroecological methods, based on a combination of locally adapted practices and new science, increase the efficiency of inputs and realize multifunctional synergies among species and systems. Agroecological practices with proven soil fertility benefits include composting, ploughing in cover crops or green manure, and zero or reduced tillage under a multi-year crop rotation pattern. Furthermore, agroecological methods — given their high degree of crop and animal diversity — are resilient to changing environments and climates, and bring the added benefit of higher water retention rates.

42. Agroforestry has proved effective in restoring soil health in previously degraded landscapes by drawing on nutrients and water not available to crops, halting soil erosion and providing shade and mulch.

43. Increasing agricultural biodiversity by planting multiple crops for subsistence and markets can reduce the social and ecological vulnerability resulting from monocropping. At the farm level, UNEP reports that integrated crop and livestock systems, innovative crop management systems, adoption of integrated pest management and increasing agricultural biodiversity have proved to be successful. The Consultative Group on International Agricultural Research System-wide Programme on Integrated Pest Management reported a 71 per cent reduction in pesticide use, with associated yield increases of 42 per cent and net benefits to farmers in the range of $100 to $536 per hectare.

44. Meta-studies cited by FAO show that in developing countries yield increases from adopting sustainable agriculture are substantial, possibly even when compared to high-input systems in developing countries. Some studies have also highlighted the spillover effects of organic agriculture for improving health and nutrition, as well as reducing pesticide exposure, in Africa.

45. The global market for organic agriculture has grown fourfold since 1999, reaching value of $63 billion by 2011, with growth in health-conscious consumer demand for organic products outpacing that for non-organic food sales. Accounting for 0.9 per cent of global land, organic land, including area for extensive grazing, grew by 3 per cent in 2011. This consumption-driven growth has spurred organic agricultural production in developing countries. Of an estimated 1.8 million producers globally, more than 75 per cent are located in developing regions.

46. India has the largest number of organic producers, of which there were nearly 550,000 in 2011. Between 2010 and 2011, China and India increased the area of certified organic agricultural land by more than 500,000 and 300,000 hectares, respectively, following strong demand from consumers. Organic agriculture also plays a significant role in Latin America. In Brazil, mixed cropping by small farmers was identified as a key factor in rural job creation. FAO has reported that, compared with mechanized monoculture, where only one job is created per 67 hectares, mixed cropping — a common practice on organic farms — creates 1 job per 8 hectares.

47. Although Africa accounts for only about 3 per cent of global organic land, in terms of the numbers of producers, three out of the top five countries are in sub-Saharan Africa: Uganda (188,625 producers), United Republic or Tanzania (145,430 producers) and Ethiopia (122,350 producers). In Uganda, for example, with the support of the Export Promotion of Organic Products from Africa programme, certified export trade for coffee, cotton, pineapples, bananas, cashews, vanilla and shea butter was established. As a result, the value of organic exports increased from $4.6 million in 2002/03 to more than $35 million by 2009/10. Organic agriculture is making a growing contribution to the economy in terms of foreign exchange earnings and value added earnings at the household level. Beyond its direct economic impact, a review by FAO highlights the spillover effects of organic agriculture for improving health and nutrition, as well as reducing pesticide exposure.

48. In developed countries, long-term trials by both the Rodale Institute and the Research Institute of Organic Agriculture have demonstrated positive results: conversion to organic agriculture not only increases yields, but also sequesters an additional 3 tons of carbon per hectare per year, improves water infiltration rates and water-holding capacity, increases soil moisture content and results in more stable yields over time.

49. The adoption of capital-intensive, labour-saving and land-saving technologies in developing countries depends on access to secure land holdings, irrigation and capital for purchasing additional inputs, in conjunction with public investments in infrastructure and research on improved varieties. Where inequalities in access to these technologies existed, the overall impact has been uneven or limited, at both the regional and national scales.

50. Given that capacities through the traditional extension networks are limited, innovative partnerships and platforms have been successfully developed, especially drawing on the advantages of increasing mobile phone ownership. For example, the Farmer Communication Programme in East Africa supports national extension services in order for small-scale farmers to receive the benefits of sustainable technologies via a monthly farming magazine, radio and an online platform (www.infonet-biovision.org), in addition to mobile phone-based feedback mechanisms. Such programmes have been especially successful in reaching women through registered farmer groups: between 60 and 70 per cent of participants in the Farmer Communication Programme have been women.

51. As noted in my last report on this topic, two years ago, 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 high. The requirements of large buyers of food, such as supermarket chains, and the proliferation of ethical and environmental certification processes in recent years, while opening up new opportunities for the creation of value chains that link small holders to larger export markets, have also created additional obstacles for small farmers. FAO has noted that standards aimed at food safety, quality and traceability and good agricultural practices, which are mainly developed by large firms in major markets, tend not to ensure price premiums and may harm small-scale growers by significantly raising the costs they incur to meet the standards.

Water use and management

52. FAO reports that in sub-Saharan Africa only 6 per cent of arable cropland is equipped for irrigation, compared with 49 per cent in South Asia. Africa is also lagging behind in adopting mechanization, with 65 per cent of farmland still cultivated by hand. These disparities are reflected in the uptake of other agricultural methods across regions (e.g. the vast majority of no-till agriculture is practiced in North America and South America).

53. More efficient water use is crucial to sustainable agricultural production, including rain-fed agriculture in developing countries. Case studies in developing countries have demonstrated the ability to save considerable amounts of water while producing equal or higher yields. Examples of commonly adopted innovations in developing countries include subsoil drips for orchard crops, microdosing of nutrients through drip lines and modern mulching techniques. African examples of rain-fed systems include raised seedbeds to trap water and keyhole gardens using

wastewater. Improved irrigation systems include mini-sprinkler and drip systems, precision timing in watering and crop systems, such as that of rice intensification, that use less water than traditional systems. Improved water harvesting and retention are also fundamental for increasing production.

54. In some areas, water resources can be better managed through community-focused solutions such as community rainwater harvesting systems. There are considerable urban and rural benefits of better wastewater systems that allow for the reuse of some urban wastewater for agricultural irrigation. These practices can help to conserve water resources while also providing a free source of nutrients for crops. Accelerated development of water storage and aquifer recharging technologies, in addition to better crop diversity and curbing meat production and consumption, are important for reducing water use in agriculture. Such innovations — drip irrigation, treadle pumps, etc. — are also extremely important for improving the lives of women farmers because they help to reduce labour and increase yields, according to the Department of Economic and Social Affairs.

Loss and waste of food

55. The FAO programme of providing metal silos to support production at the household and community scale has not only reduced post-harvest losses, but nearly tripled the prices fetched by farmers four months after their maize harvest. In West Africa, according to FAO, similar advances were made using regionally manufactured bags of the Purdue Improved Cowpea Storage system, which extend safe storage by four to six months.

Agricultural research and development

56. Investments in public agricultural research and development have had significant results. Figures cited by the World Bank show that developing countries achieved an estimated return on investment from agricultural research and development of over 40 per cent between 1953 and 1997. These returns from public investments in agriculture have not declined and are higher than investments in social capital or other public sectors. In terms of return on investment for sustainable agricultural methods, integrated pest management and biological control have shown particularly high levels of return.

57. The trend of declining public agricultural research and development expenditure between 1976 and 2000 was reversed in developing countries by 2008, as Brazil, China and India significantly increased their investments. As a result, by 2008 nearly half of global public spending — $15.6 billion — was taking place in developing countries. In sub-Saharan Africa, however, the negative annual growth rates in public research and development of the twentieth century continued between 2000 and 2008 for nearly half of the countries measured in that region. Combined with low investments in infrastructure and agricultural capacity, that limited the impact of agricultural research and development on rural development and poverty reduction.

58. Since 2000 there has been a trend of increased private spending on research and development by emerging economies. In India, private agricultural research and development spending has increased fivefold since 1994/95 and biotechnology investments tenfold, and the number of cereal cultivars has almost doubled as a

result. That trend reflects the establishment of multinational companies in emerging markets.

59. In sub-Saharan Africa, on the other hand, the largest advances in private research and development have been in breeding, particularly of maize; public sector investment continues to dominate in terms of its share of total investment, but it needs to be strengthened in absolute terms for sustainable agricultural research, extension in agronomy, pest management and pre- and post-harvest management.[4]

IV. The way forward

60. It is now well recognized that in order to address the challenges facing our food systems, it is necessary to embrace a systemic approach that moves away from a singular focus on per capita productivity and innovations that address only one problem at a time, and focuses instead on the broader contribution of agriculture to economic, social and environmental outcomes.

61. Effective responses to the challenges posed to food security and nutrition and the sustainability of food systems are based on innovative approaches to the development, transfer, dissemination and deployment of sustainable agricultural practices. Shifts in agricultural investment towards sustainability and increased productivity, both at the farm level and in terms of labour, are at the heart of these processes.

62. Multidimensional approaches drawing on agriculture's multifunctionality are necessary to enhance sustainable productivity in the medium and long run and to address existing inequalities among farming households.

63. Diversifying away from the three major cereal crops towards other food crops, such as teff, sorghum, millet or vegetables, and using sustainable production systems are key factors for reducing vulnerabilities to climate change and volatility in commodity markets.

64. The shift to sustainable and resilient food systems must be supported by actors along the entire food value chain, including farmers, the input and processing industries, retailers and consumers.

65. Small-scale agriculture plays an essential role in the conservation and promotion of agricultural biodiversity, relying on the practices of farming communities and their extensive field knowledge. In this context, supporting diverse smallholder farming systems, including intercropping and the use of farmer-selected seeds, can be an important tool for fostering genetic diversity and environmental resilience.

66. Strengthening the rights of indigenous communities is important for sustainable agriculture, including by enabling participatory breeding, increasing local control over genetic resources and protecting traditional knowledge.

67. Mainstreaming gender into agricultural policies and the legal and regulatory frameworks that govern the use of technologies is critical. Participatory guarantee systems, successfully established in Brazil and India and recently introduced in East

[4] High-level Panel of Experts on Food Security and Nutrition, *Investing in Smallholder Agriculture for Food Security* (Rome, 2013).

Africa, can also contribute to women's improved marketing access by reducing costs and lowering entry barriers.

68. Literacy campaigns focusing on rural women and strengthening public research capacities in developing countries are essential to enable the transfer and adoption of knowledge-intensive technologies. The recommendations of the Special Rapporteur on the right to food regarding the protection of farmers' rights should be seriously considered.

69. Efforts towards sustainable intensification in agriculture may require additional skills and knowledge on the part of farmers, as intensification will entail more complex mixes of domesticated plant and animal species and improved management techniques. Furthermore, it will be important for farmers to understand the conditions under which agricultural inputs can complement biological processes and ecosystem services and the conditions that make them run counter to such processes and services. While innovative information and communication technologies can help, extension services on the ground also need to be strengthened.

70. These technological innovations are often less capital-intensive, yet they require investment in human and social capital because they are more knowledge-intensive. Needed capacity-building includes improving resilience at the household level, enabling more even distribution of access to water by farmers and overall improvement of governance of this shared resource.

71. The FAO publication *Save and Grow: A Policymaker's Guide to the Sustainable Intensification of Smallholder Crop Production* provides a toolkit rooted in a new paradigm of agriculture based on sustainable ecosystems. For instance, FAO provides guidance and relevant tools to countries on how to use and conserve the pollination services that sustain agroecosystems and how to formulate policies that will ensure the sustainability of those 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.

72. Developing solutions, locally and regionally, that are applicable for smallholders is of great importance. More research will need to be directed towards agricultural growth that is ecologically sustainable, conserves biodiversity and ecosystems, and ensures fertile soils for current and future generations.

73. A new paradigm for agriculture will require smallholders to be at the centre of innovation systems helping to shape the agenda for research and development and extension services so that the crops, fish and livestock products that matter to them as producers and consumers receive adequate attention. Increased knowledge-sharing and capacity-building for participatory seed breeding projects, and the development of local seed production and distribution systems, can strengthen important existing or dormant indigenous seed knowledge.

74. Publicly funded research, according to the Department of Economic and Social Affairs, 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, and increasing resilience and adaptation to market conditions and climate change. Key areas for publicly funded

research investments are crop management practices and agroforestry, implemented through a landscape approach.

75. 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. Plans need to include practical actions and targeted policy measures that create greater linkage and collaboration among plant breeding, seed systems and conservation stakeholders to make available climate-ready crops and seeds worldwide.

76. To help farmers cope with intra-annual changes in weather, new technologies that identify stress tolerance need to be complemented with long-term investments and with integrated efforts to increase the organic matter in the soil and the use of year-round cover crops.

77. In order to advance these alternatives in the food system, there is a substantial need for more systematic analyses comparing different technologies and food systems in developing countries, including systematic household-level studies on the benefits and risks of adopting technologies, such as hybrid seeds or certified organic agriculture, where inputs are relatively inaccessible or expensive, in addition to an improved understanding of coping strategies to address climate change. Investment in research and development infrastructure and institutions and facilitating a participatory approach to research and development with an emphasis on women farmers is paramount in order to obtain the results needed to help to transform agriculture.

78. Building the capacity of rural institutions is paramount, including farmer cooperatives, participative education and research arrangements. Farmer field schools have proved highly successful in East Africa, as reported by FAO, with 80 to 100 per cent yield increases observed; even greater benefits can accrue to female-headed households.

79. Building knowledge and expertise can be supported by robust exchange and interaction among farmers themselves, and with agricultural extension and information services. Agricultural cooperatives and farmers' organizations have a key role to play in this regard.

80. Innovative agribusiness and non-governmental organizations partnerships, such as the Sustainable Food Laboratory (www.sustainablefoodlab.org), are creating opportunities for scaling up the dissemination of sustainable agriculture. Such partnerships need to take place in a participatory and transparent manner, and require investment through public funding.

81. Improvements in harvesting techniques, post-harvest technologies, storage and cooling facilities in difficult climatic conditions, infrastructure, and packaging and marketing systems are also needed to be able to support sustained improvements in the delivery of quality food to market, and hence in farmers' incomes, in developing countries.

82. Monopolistic practices in food markets must also be prevented. Better access to information, credit and risk insurance would also leave smallholders in a better position to engage in mutually beneficial partnerships with the private sector.

83. According to the World Bank, improved knowledge and new market information systems or marketing groups are some of the main needs in upgrading

value chains. In addition, cost-effective certification can ease access to export markets, and fair-trade certification can offer a valuable stepping stone for the adoption of agroecological practices.

84. In response to the proliferation of voluntary sustainability standards, it is critical to enable a better shared understanding of the impacts of those standards on various dimensions of sustainable development in a comparable way. Pioneering work in that direction, such as that done by the non-profit, volunteer-based consortium Committee on Sustainability Assessment, should be encouraged.

85. Newly emerging governance challenges involve land use, traditional knowledge and intellectual or cultural property rights, as well as mechanisms to ensure the active involvement of women who are often at the centre of decisions on food production and consumption around the world. These governance challenges will likely require a blend of public and private interests to creatively address them. Processes that strengthen the ability of farmers and communities to engage with both agribusiness and government are likely to lead not only to better resource management and technology use but also to improved productivity and well-being.

86. To ensure that private investments into agriculture are made in a way that benefit food security and nutrition, foster rural prosperity and maintain natural resources, regulatory frameworks need to be developed, implemented and monitored. In this regard, the ongoing discussions on responsible agricultural investment in the framework of the Committee on World Food Security will become particularly relevant and should be rigorously followed by all stakeholders.

87. Well-functioning information, monitoring and accountability systems are important to ensure that decision makers' responses accelerate progress towards reduced hunger, better food security and nutrition.[5] For example, conducting multi-stakeholder assessments at the country level can help to identify the most vulnerable populations, develop national food security and nutrition strategies and choose actions most appropriate to achieving development goals and targets. As set out in the outcome document of the United Nations Conference on Sustainable Development, the reformed Committee on World Food Security will consider facilitating such country-initiated assessments on sustainable food production, food security and nutrition.[6]

88. Access to markets through liberalized trade can provide greater opportunities for both developing and developed countries when enabling conditions are in place. Fostering the capture of value added by smallholder farmers and rural communities in developing countries can support food security and development goals. Additionally, strengthening developing country trade analysis and negotiation capacity, and providing better tools for assessing trade-offs in proposed trade agreements can improve governance. In this context, it is also important that multilateral trade agreements, in particular through the WTO Doha Round, achieve further progress towards an open, fair, equitable and rules-based multilateral trade system.

---

[5] High-level Task Force on the Global Food Security Crisis, *Updated Comprehensive Framework for Action* (2010), p. 29. Available from: www.un-foodsecurity.org/node/842.

[6] General Assembly resolution 66/288, annex, para. 115.