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Addendum

Contribution by farmers**

Contents

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I. Introduction

1. Farmers are faced with the multidimensional challenge of feeding a growing world population while coping with changing weather patterns and an increasingly strained natural resource base.

2. As the world population continues to grow, food needs will increase accordingly. Transitioning to more sustainable patterns of consumption and production is at the heart of sustainable development. Farmers, farming and the environment must interact harmoniously in order to meet these challenges. Maintaining the sustainability of agriculture and the livelihoods of farmers are key to securing adequate food supplies and the sustainable management of natural resources. In fact, farmers are the custodians of much of the earth's land and freshwater resources.

3. Besides, one out of three people on this planet works in agriculture and, as a consequence, farmers are the most important ecosystem managers.

4. Agricultural development, poverty and environmental degradation are closely interrelated. It is recognized that the development of sustainable agriculture is an essential driving force for poverty reduction and food security. However, the challenges are enormous for agriculture to remain sustainable.

5. Food production would need to increase by 70 per cent by 2050, when the world population is projected to reach 9 billion. Food security has to be integrated in a shared vision for long-term action in order to open the door to sustainability for the agricultural sector as a whole. Food security underpins human life and, consequently, the role of agriculture in providing staples and stability while preserving the environment should be fully recognized.

6. Farmers should be key partners when it comes to implementing sustainable production and consumption patterns. They have the capacity to provide solutions drawing on appropriate existing and new agricultural practices. These practices include conservation agriculture, the sustainable management of water, the production of renewable energies (such as biogas), sustainable livestock breeding and appropriate manure management. Sustainable land management practices are already available and methods to measure and monitor them have been developed in several parts of the world.

7. It is crucial to implement a new agricultural model in which farmers contribute as real entrepreneurs through the development of more sustainable agricultural practices, efficient management of water, use of sustainable land management techniques and by becoming better organized in the marketplace and developing high quality products in order to respond to consumers' increasing demands.

8. The present document contains an analysis of current trends, policy options and practical farmers' solutions aimed at fostering the transition to more sustainable patterns of production and consumption.

II. Challenges and main issues for farmers

9. One of the biggest challenges for sustainable agriculture is the adoption of a farming approach that encompasses environmental sustainability and food security

and includes improved yields, better farmer incomes and reduced costs of production.

10. The balance between environmental, economic and social development, which are the three pillars of sustainability, is thus critical for reducing poverty and hunger. The following paragraphs are an attempt to describe the main challenges that farmers need to overcome to implement sustainable production systems and deal with the problems and opportunities that arise from the use of chemicals and management of agricultural waste.

A. Sustainable consumption and production patterns

1. Deteriorated natural resources hinder sustainable development

11. Farmers rely on natural resources to carry out their activities. Soil erosion, water logging and salinity all contribute to land degradation and desertification, leading to the over-exploitation of the land.

12. Combating desertification and land degradation is one of the most important challenges for ensuring food security and sustainable development. Farmers are among the first victims of the phenomenon of desertification as natural resources such as fertile topsoil, organic matter, plant cover and healthy crops are the most severely affected by desertification. Without fertile soil and without the right tools for sustainable land management, people living in the regions affected by land degradation are unable to break out of the poverty cycle.

13. All over the world, climate variability associated with climate change is leading to an increase in the frequency and intensity of floods, droughts and desertification. Climate variability brings widespread weather events that affect entire communities.

14. Diminished biodiversity, due to habitat encroachment, fragmentation and pesticide misuse, leads farmers to rely on chemical inputs for increasing their yields. Given that decreased biodiversity results in less resistant crops and loss of ecosystem services, pest infestations and weather variability increase agricultural stresses. The production of substantial crop yields without chemical inputs or intensive fossil fuel use is becoming a real challenge.

15. Pressures on water resources owing to increased crop intensity bring about increased water resource competition in areas in which water resources are scarce. This situation may therefore lead to conflicts. Unfortunately, the decreased water resource base is a reality that must be addressed from a long-term perspective. Without access to uncontaminated water, fertile land and healthy biological ecosystems, farmers' livelihoods are in danger.

2. Without rewards farmers are unable to implement sustainable production patterns

16. Effective and sustainable production and consumption patterns must be accompanied by fair incomes, profitable agricultural practices and decent opportunities for farmers to help alleviate poverty, reduce imbalances and enhance food security. In particular, farmers must receive equitable price treatment when they sell their products on the market.

17. Farmers' efforts tend to face two challenges. Firstly, many policies governing the institutional environment that enables farmers to access agricultural markets are generic and do not take into account the specific features of smallholder farming and its forms of economic organization. These adapted policies do not cover competition, taxation or risk mitigation mechanisms. They often fail to develop well-functioning markets through the provision of transparent information, access to up-to-date market pricing information, fair prices, sound infrastructure and regulated speculation. Secondly, the marketing strategies developed by farmers to cope with these challenges are often not feasible within the existing institutional environment.

18. Smallholder farmers, especially those located in developing countries, face an even more difficult situation. In most of these countries, smallholder farming is crucial for poverty reduction, food security and the rural economy as a whole. The importance of small farmers in a country is dependent on their number, their role in agricultural and economic development and their concentration in rural areas. Most smallholders are vulnerable to economic and climatic shocks. They try to minimize the risk by diversifying their sources of livelihood, which often include significant off-farm income. Self-sufficiency rarely exists as there is often some form of local market in which smallholders trade their surplus. However, these markets are not very remunerative and offer limited opportunities for price negotiation. Finding and entering markets with better prospects is challenging.

3. Sustainable bioenergy production: opportunities and challenges

19. Increased utilization of renewable energy has a significant impact on agriculture in both the short and the long terms. Agricultural sources of energy are becoming the new paradigm for the food and energy business. For farmers, bioenergy represents a new market and a way to minimize risk. Many hope that these products will become income and export opportunities. Both developing and developed countries see them as an opportunity to keep expenditures on energy within the domestic economy. Bioenergy also plays an important role for households in terms of local energy use, especially in many developing countries. The result is that these populations become less exposed to increases in energy prices.

20. In spite of this potential, at the global level sustainable energy has gained little ground in the agriculture sector and faces many challenges, including early adaptation of technologies, geographic location, high capital costs and cost competitiveness with traditional sources of energy. Most farmers in the world are not able to make large capital investments in infrastructure in order to consider alternatives such as renewable energy. However, in many regions of the world, bioenergies represent a positive alternative source of energy for farmers and rural development.

21. Even though use of bioenergy has multiple benefits, including addressing energy supply constraints, climate change, national security and economic development issues, there are still doubts about its effectiveness in relation to food security, economic and environmental sustainability and trade. There is indeed a need to weigh the potential benefits of bioenergy against its costs.

22. The policy mechanisms implemented will not be identical for developed and developing countries. However, bioenergy can provide growth opportunities for both types of economies. Increasing the use of bioenergy largely depends on the

policies of Governments, institutions and organizations, which should establish a strong, stable investment environment that will develop this potential in a sustainable way.

4. Lack of resources is a barrier to sustainable production

23. In many developing countries, the lack of financial resources and infrastructure makes the adoption of sustainable practices difficult to implement. In many rural areas, infrastructure, such as water and irrigation systems, energy supply, roads, storage facilities and telecommunications, are either missing or outdated. In addition, there is a general lack of services, which hinders access to knowledge and appropriate technologies. Farmers become increasingly vulnerable without sufficient infrastructure. In many developing countries, inadequate infrastructure and services represent a major constraint on the competitiveness and profitability of the agricultural sector. Support from developed countries is essential, especially in terms of knowledge-sharing and technology transfer.

B. Chemicals

1. Benefits and challenges arising from the use of agrochemicals

24. In most regions of the world, the agricultural sector widely relies on synthetic chemicals, which are used in fertilizers and crop protection and plant-growth regulator products. Agrochemicals are utilized in both crop and animal production to increase yields, influence food quality and control insects, weeds, plant diseases and other pests.

25. Undoubtedly, there are several advantages of using agrochemicals in industrialized countries in terms of economic returns. They guarantee abundant supply of food, quality standards and reasonable food prices. These advantages have led to the rapid adoption of agricultural production systems based on chemical inputs in several regions of the world. In less industrialized countries, the use of chemicals is still limited as these products are often too expensive for resource-poor farmers.

26. However, the use of chemicals in agriculture is not free from concerns: chemicals present potential problems and risks both for farmers and the environment. The undesirable side effects are a consequence of the indiscriminate and overuse of agrochemical products. They often originate from a lack of understanding about the impact of these products on human health and the environment. In particular, many developing countries lack the resources, expertise and awareness necessary for an appropriate and sustainable use of chemicals.

27. Over the past decades, the expansion of agricultural land and the injudicious use of chemical products such as pesticides, herbicides and fertilizers have seriously deteriorated the natural resource base, including water and land, in numerous rural areas.

2. The application of integrated farming practices remains a challenge

28. Integrated agriculture based on the appropriate use of chemicals (such as fertilizers and crop protection products), as well as sustainable agricultural practices, can ensure sustainable farm production. Integrated management

techniques can be seen as a fundamental component of responsible farm management, providing the conditions for economic stability and ensuring respect for the environment and natural resources.

29. Sustainable agricultural practices include integrated crop, pest, plant nutrition and soil fertility management, as well as sustainable fertilizer management practices. These practices promote the responsible use of agricultural inputs in a more efficient and cost-effective way for farmers and the environment.

30. The role of farmers as the guardians of ecosystems is not always fully recognized. There is a need for a shift in thinking that would place farmers at the centre of sustainable agricultural practices. Incentive mechanisms that encourage farmers to promote the development of sustainable agriculture are missing in many countries, in particular in developing countries. Owing to a lack of resources and knowledge, farmers are often not in a position to choose the most appropriate integrated farming systems. Furthermore, the stakeholders involved in agriculture are also not in a good position to offer farmers the best technologies. Knowledge-sharing, adequate tools and technologies on the sustainable use of chemicals are not yet accessible to all farmers.

3. The social and safety dimensions of the use of dangerous chemicals by farmers

31. Agriculture has become a high-risk activity for farmers who handle potentially dangerous agrochemicals. In certain regions of the world, especially in developing countries, farmers who are exposed to dangerous substances often face great health and safety risks owing to a lack of resources, weakness of basic infrastructure, absence of appropriate regulations, inadequate education and inefficient, or non-existent, social security and insurance systems. The promotion of socially, environmentally and economically sustainable practices in the use of chemicals in agriculture is often weak or non-existent. Too often, these practices are not included as part of a broad strategy for improving working conditions and incomes, and promoting, at the same time, the use of safer and sustainable practices in agriculture. Information campaigns, specific training and education are decisive for raising awareness among farmers about the dangers of using chemicals and ignoring safety measures.

C. Waste management

32. Models for sustainable agricultural development must include provisions for the proper management of waste from farming operations. These provisions should aim to minimize agricultural waste and also maximize environmentally sound waste reuse and recycling.

33. Waste management in agriculture helps reduce the need for fertilizers and other inputs such as water and fossil fuel-based energy. Cultivating crops and breeding animals while simultaneously reducing waste, losses and inputs can significantly mitigate the negative effects of the environment and thereby enhance sustainable development.

1. Handling agriculture production losses is crucial for minimizing waste

34. Taking into account production and food losses is key for sustainable development as they have a strong impact on environmental degradation. Resources such as land, water and human labour, as well as non-renewable resources such as chemicals and energy, are used to produce, process and transport food that is not consumed.

35. In many developing countries, a significant proportion of crops is lost because of inadequate pre- and post-harvest support. This loss is caused by use of incorrect harvesting techniques, spillage, exposure to adverse weather conditions or extreme temperatures, contamination by micro-organisms, pests, physical damage caused by inappropriate tools, chemical contamination and improper handling during transport.

36. The main barriers that farmers around the world have to face are related to the difficulties in building local storage facilities and adequate transportation mechanisms, including cold chain storage for food preservation. A lack of resources, awareness, knowledge and information impede the identification of appropriate techniques and management procedures.

37. In addition to production losses, in most countries of the world, large quantities of food are wasted during the production and consumption phases. This waste includes products that are not accepted by consumers in industrialized countries because they do not meet trade, commercial and quality standards. In most cases, these products are wasted. Better information and education on sustainable consumption and production and on the need to reduce food waste are needed to change the behaviour of food chain actors, including consumers.

2. Upgrading efficiency to minimize water waste and secure water quality

38. Water is one of the main inputs for agriculture; it is a public good necessary for ensuring the health and livelihoods of millions of farmers. Water security and efficiency should be recognized as key to poverty alleviation. Farmers and the rural population are the first victims of water problems in terms of quantity and quality.

39. Lack of drainage infrastructure and poorly maintained drainage and irrigation systems are the cause of water waste in many countries. The inefficient use of water resources is often a consequence of weak infrastructure, lack of a functioning water authority with the right competencies, lack of incentives for the efficient use of fresh water resources and the cultivation of unsuitable crops.

40. Maximizing irrigation efficiency is a challenge for many farmers. It is crucial for them to seek an optimal combination of all water uses. This might be done through infrastructure planning, provision of cattle wallows or laundry areas in or adjoining canals, or making sure that irrigation is also available for non-agricultural uses. Increasing the combined value of all water uses is strictly linked to water quality, rather than just quantity issues. The protection of the quality of water represents a prerequisite for sustainable development. In this respect, waste disposal becomes critical for sharing water among different uses. The approach to water waste disposal should be multisectoral.

3. The exploitation of animal waste for biogas is still a challenge for most farmers

41. Every year, the agriculture sector produces millions of tons of organic waste, such as manure and slurry, which could be used to produce biogas. Emissions of methane resulting from the breakdown of organic feedstock may be captured within an anaerobic digestion plant, instead of being released into the atmosphere from conventional manure storage systems or landfill sites. Biogas is a combustible gas derived from decomposing biological waste and normally contains 50 to 60 per cent methane.

42. Biogas production from animal manure standardizes and improves the agronomic value of agricultural and other residues and is beneficial for the environment. Well-managed biogas supply chains contribute to reducing odour and the leaching of nitrates, while at the same time delivering renewable energy and allowing for the substitution of fossil fuels. The reduction of methane emissions from manure helps mitigate climate change because methane is about 26 times stronger as a greenhouse gas than carbon dioxide.

43. The establishment of biogas systems remains a challenge for most farmers in the world owing to the relatively high cost of the initial set-up, the maintenance of the plant and the labour involved. The potential lack of a regular supply of organic material may also be a major constraint for certain farmers who do not have access to a relatively large number of cattle. Furthermore, connecting the electrical generating plants to rural grid networks is still a complex and expensive issue. Finally, the logistics and economics of transport, beyond its local production area, limit the market potential of digestate (the solid material remaining after the anaerobic digestion of a biodegradable feedstock).

III. Review of implementation: analysis of progress and successful experiences

44. Farmers offer a wide array of solutions for providing models for sustainable production systems and the management of chemicals and waste.

A. Sustainable consumption and production patterns

1. Sustainable agricultural practices in coffee production in Peru: soil conservation and reforestation

45. Farmer members of the National Coffee Board (Junta Nacional del Café) of Peru are currently working on the implementation of sustainable agricultural practices. These practices are used in 30 per cent of the total area of coffee plantations managed by the Board and include the implementation of soil conservation practices and reforestation projects that increase productivity and reduce pressure on forests.

46. With the aim of ensuring environmental sustainability, the National Coffee Board is working to encourage the implementation of public policies that support reforestation by promoting, in particular, shade coffee plantations, in which coffee is cultivated under a shading canopy of natural forest or planted trees. The creation of shading canopies in coffee plantations using trees for timber or other uses also plays

an important role in protecting biodiversity and natural resources. The Board is working on developing feasible technical proposals for farmers and providing adequate tools and inputs that would promote sustainable agriculture.

47. With the aim of ensuring social and political sustainability, the National Coffee Board is working on grouping farmers into cooperatives, associations and certification groups with a view to improving farmers' self-management capacities. It is leading initiatives aimed at strengthening producers' representation in policy processes and supporting improvements in road infrastructure and the quality of basic services, such as education and health care in the coffee areas. Finally, the Board is working to increase tax incentives for farmers engaged in sustainable agriculture in Peru.

48. With the aim of ensuring economic sustainability, the National Coffee Board is working for greater diversification of coffee niche markets, which will allow better direct marketing and thus reduce farmers' dependence on retailers. It aims to improve funding and encourage the establishment of incentive schemes for sustainable agriculture.

2. Anti-soil erosion practices in Albania for preventing land degradation

49. In Albania, the progressive deterioration of natural habitats and land threatens the country's biodiversity as well as the livelihoods of family farmers, who widely cultivate on small parcels. The reduction of soil fertility, desertification and the impoverishment of the soil from degradation have intensified over the past decade. In addition, salinization, water logging and inappropriate land management are accelerating soil degradation. This progressive loss of the land's fertility decreases productivity and worsens the vulnerable economic conditions of family farmers. Land degradation is caused by an array of interrelated factors, including deforestation, overgrazing, illegal logging and low investment.

50. In the face of severe erosion threats, Albanian farmers have identified and implemented good agricultural practices in order to maintain soil productivity, conserve water and lower production costs. These practices include adequate crop rotation, intercropping, zero or minimum tillage, mulching, effective irrigation systems and rain collection systems, selection of resistant varieties, composting, and biological pest and disease control. In order to prevent further land degradation, good agriculture practices have been developed, including afforestation, the setting-up of barriers to protect arable land and the improvement of irrigation systems.

3. Farmers in Colombia propose solutions for mitigating climate change through changes in farm practices and production systems

51. In Colombia, dairy and beef cattle are the main contributors to emissions from enteric fermentation and manure. The fertilizers used are also responsible for the nitrous oxide emitted by the agriculture sector. Changes in agricultural soil management practices have been envisaged by farmers. These include practices aimed at reducing soil erosion and use of manure and ensuring appropriate crop rotation and minimum tillage. These practices lead not only to reducing or eliminating the carbon release owing to the loss of fertility and organic matter in the first centimetres of soil, but also to sequestrating carbon through increased organic matter levels. Furthermore, they encourage the rational use of fertilizer in order to reduce production costs and emissions of nitrous oxides. The development of

conservation farming practices in crops such as grains and oilseeds improves the net carbon stock in soil.

52. The cultivation of cassava for industrial uses such as biofuel production presents opportunities for sustainable production through appropriate agricultural practices. About 135,000 small farmers derive their income from cultivation of cassava along the Caribbean coast of Colombia. This crop can be cultivated with rational and efficient use of fertilizers, which maintains the nutritional status of the soil and reduces nitrous oxide emissions. Cassava can be naturally desiccated by solar radiation and this avoids energy-intensive artificial drying practices, which use technology that is not suited to conditions in Colombia.

53. In recent years, the cassava industry has gained importance for the production of biofuel as well as for the production of food and starch. Currently, industrial cassava is the crop that gives the third highest yield of biofuel per hectare (4,500 litres per year), after sugar cane and sugar beets. In Colombia a large area is cultivated by small farmers, with a potential 140,000 hectares of cassava that could be used for ethanol production.

4. Optimization of water resources use in Palestine supports sustainable productivity gains

54. With the aim of optimizing the use of water and preventing water shortages, Palestinian farmers have been encouraged to adopt innovative approaches. The Palestinian Farmers Union supports farmers in optimizing their on-farm irrigation networks as well as in guaranteeing fair access to irrigation water and, as a result, reducing the risk of negative effects on farmers' livelihoods. The Union's water optimization projects in the Jordan Valley provide farmers with optimized on-farm irrigation systems and training on the practical use of such systems. A two-year water optimization project has led to significant results: 30 per cent water savings, 25 per cent input savings and 15 per cent yield increase. The reduction of inputs corresponds to an increase of 15 to 25 per cent of farmers' income.

55. In particular, the project demonstrated that simple improvements and the right application of minimum water bring the same or higher productivity levels. Water savings can help expand the irrigated area. Through the project, about 80 farmers benefited from new irrigation equipment, which enabled them to irrigate more than 50 hectares of agricultural land. Farmers trained in the optimization of irrigation systems contributed to the diffusion of the good practices to a larger number of beneficiaries.

5. The French plan of energy performance for an ecological and productive agriculture

56. Improving the energy performance of French farms is a key issue both from the economical and the environmental point of view. For certain agricultural activities in France, such as vegetable production and horticulture under glass, the energy bill is often a real burden. Therefore, farmers are engaged in efforts to improve the energy efficiency of farms in an environmentally friendly way. The energy performance plan developed by the Ministry of Agriculture and Fisheries is an opportunity for farmers to engage in good practices and it focuses in particular on energy savings. The target set under the plan is to achieve by 2013 a rate of 30 per cent of farms with low dependence and consumption of energy.

57. In France, some energy suppliers are obliged to undertake a minimum amount of energy savings and this can be justified through the so-called Energy Savings Certificates. Suppliers can obtain these certificates by directly contributing to energy savings or by purchasing them from other stakeholders, including farmers, who make energy savings. A real market for the certificates now exists and their price reflects the principle of supply and demand.

58. A correct diagnosis of energy performance is the first step to be carried out at the farm level. Farmers must make an inventory of direct and indirect energy uses. The diagnosis identifies energy improvement possibilities and actions that farmers can carry out to enhance their energy efficiency through their farming practices, their equipment and their buildings. Improvements often include the adoption of more energy-efficient practices (such as modifying the use of agricultural machinery, choosing crops that consume less energy and nitrogen fertilizers), the choice of appropriate equipment (machinery and buildings) that are less energy consuming and, finally, the opportunity of producing on-farm renewable energies.

6. The climate labelling system in Sweden for informing consumers about climate-friendly products

59. Following the establishment of a “climate-certified” label system, consumers in Sweden are the first in Europe to be able to easily identify climate-friendly food products. They are able to choose foods according to the impact that production and transport have on climate. Consumers have the potential to actively select foods that have a lower climate impact. Through the labelling system, consumers are informed that climate-certified food is produced using the best available techniques, including, for instance, the use of renewable fuels for heating greenhouses, the use of mineral fertilizers with low emissions of nitrous oxide, and a limited use of soybeans in high-value conservation areas.

60. The Federation of Swedish Farmers is involved in the development of climate labels in order to help consumers make climate-smart choices while increasing the competitiveness of farmers by being more climate-friendly. The corresponding guidelines cover meat, fish, fruits and berries, vegetables and leguminous plants, potatoes and cereals. These standard guidelines were drawn up in partnerships with the Swedish Board of Agriculture and local researchers.

61. The project also includes monitoring systems for energy use at different levels in order to measure and follow up on the achievements. Each product is independently certified by a third party certification body ensuring that farmers and the food industry comply with climate mitigation measures.

62. The climate-certified labelling system put in place in Sweden corresponds to an estimated reduction in emissions of between 5 and 80 per cent throughout the whole food supply chain. In addition to reducing the negative climate effects of food production through consumers’ informed choices, the labelling system also strengthens the competitiveness of the food businesses. The climate-friendly label covers the entire production chain with measures taken to decrease climatic impact and applies to both Swedish and imported products. The system can be considered as an additional labelling mechanism to be used together with other certifications related to sustainable development production.

B. Chemicals

1. Crop rotation in Madagascar to limit fertilizer use and preserve natural resources

63. Agriculture in Madagascar is dominated by intensive farming and livestock breeding. Unsustainable crop and agropastoral practices are widespread owing to the lack of farmers' capacity and awareness about the use of chemicals and poor infrastructure.

64. As far as crop production is concerned, the use of appropriate crop rotation has been identified in Madagascar as an effective farming practice that limits fertilizer use and preserves natural resources. Rotation is the practice of growing different types of crops in the same area in sequential seasons according to their nutritional needs. Crop rotation seeks to balance the fertility demands of various crops in order to avoid excessive depletion of soil nutrients. In fact, the practice of growing the same crop repeatedly over several years on the same parcel depletes soil and leads to a gradual deterioration of fertility. Crop rotation is a simple and accessible practice that allows farmers to regenerate the soil's organic matter, water and nutrients. This regeneration of the soil provides plentiful production while preserving the structure and texture of the soil. Rotation is an easy solution for farmers to apply and can be linked to other sustainable practices for soil fertilization such as the use of manure and compost.

2. Farming practices in El Salvador: use of cattle manure as a natural fertilizer for fodder crops

65. In El Salvador, there is over a million head of cattle. The main problem for livestock breeders is the accumulation of large quantities of cattle manure whose redistribution is often difficult. The accumulation of manure produces a foul smell and attracts disease-carrying pests.

66. The cooperatives that make up the Central Cooperativa Agropecuaria have developed solutions for reducing the accumulation of manure and for exploiting, at the same time, the nutrient value of this important by-product from livestock production systems. Manure is a fertilizer containing nitrogen, phosphorus, potassium and other nutrients. It also adds organic matter to the soil that improves soil structure, aeration, soil moisture-holding capacity and water infiltration.

67. Each cooperative member has built an area with a concrete floor for the collection of manure, which can be later loaded into a manure spreader. This machine is driven by a tractor and spreads manure in pastures used to produce forage for cattle herds. This operation can be carried out in both the dry and rainy seasons. However, most commonly, farmers collect manure during the rainy season and spread it later during the dry season.

68. This practice has several benefits. Firstly, the use of cattle manure as a fertilizer for fodder crops delivers better profitability in cattle breeding as it decreases the input cost of chemical fertilizers and provides satisfactory fodder yields. It also permits the reduction of pollution from chemical fertilizers in the medium and long terms. It helps improve the soil's texture and structure, thereby increasing microflora and microfauna. Finally, this practice eliminates the source of odours and pests.

69. Having recently implemented this simple practice, farmers within the cooperative believe that they have taken a step forward in putting in place a cattle production system that is economically and environmentally sustainable. A weak point of the system remains the cost of acquisition and maintenance of the equipment, which is not easily available in the domestic market.

3. Natural pesticides: a simple and sustainable solution to limit negative effects in Rwanda

70. The vulnerability of agriculture in Rwanda is exacerbated by soil erosion, landslides and mudslides caused by rugged terrain and dependence on non-irrigated agriculture, deforestation and unsustainable agricultural practices. The high population density and poverty lead to the overexploitation of agricultural land, which has a serious effect on natural resources.

71. In order to limit the negative effects of pests on crops and to find an affordable solution for the protection of crops, a number of farmer members of the Ingabo Livestock Breeders' Union of Rwanda use natural pesticides. This technique is used in association with other simple and sustainable practices such as the use of improved seeds, appropriate crop rotation, the removal of plants affected by viral diseases and limiting cultivation to the growing seasons.

72. Among farmers in the Ingabo Union, the use of natural pesticides is preferred and also encouraged because it protects crops at a minimal cost. Over 10 species of plants are used in the production of natural pesticides, including pepper, onions, leeks, tobacco and tomato leaves, which grow naturally in the country and are useful for controlling flies, termites, caterpillars and other insects harmful to crops. Other natural products such as dung and wood ash are also used. These practices are linked to the traditional medicine that has long been used by farmers in Rwanda.

73. On the other hand, chemical pesticides are scarce in Rwanda. They are expensive and pose a danger to human health if used in excess. Besides, the overuse of pesticides may create unbalanced ecosystems. However, few farmers have the pumps needed to spray pesticides on crops or have received training on the correct amount of chemicals that should be used.

74. The use of natural pesticides started as an initiative supported by some farmers and gradually developed into a stable and wider programme within the Ingabo Union. Each member of the Union owns a small kitchen garden that is vital for its subsistence and in which the use of natural pesticides is particularly important.

4. Fertigation in greenhouses in the Seychelles allows an optimal application of chemicals

75. The Seychelles shows the characteristics of a typical small island developing State: geographical dislocation, very limited natural resources, proneness to natural hazards and external shocks, highly exposed population and infrastructure, limited adaptive capacity and very fragile ecosystems.

76. In the face of forecasted prolonged drought, greenhouse technology and the associated irrigation system that uses low volume water applicators, such as drips, misters and mini-sprinklers, represent viable and sustainable solutions. An effective irrigation system using low volume irrigation water applicators (misters and drips)

combined with a fertigation system allows for the optimal application of water and chemicals such as fertilizers and pesticides.

77. In the Seychelles, the promotion of greenhouses in tropical regions is considered to be part of a broader approach for integrated production and protection management. In the Seychelles, greenhouses currently represent only about 5 per cent of the total area under intensive cultivation and are used to ensure the cultivation of vegetables during the rainy months of November to April. The objective is to reach at least 25 per cent of the area under intensive production. At present, about 10 per cent of crop growers have adopted the system of fertigation. The import of construction materials, such as ultraviolet resistant plastic sheaths and galvanized steel pipes, and the supply of fertigation fertilizers is, however, still a big challenge for farmers in the Seychelles.

C. Waste management

1. Recycling in Uganda: charcoal briquettes transform agricultural waste into energy sources

78. The basic source of cooking fuel in Uganda is wood in the form of wood charcoal or firewood. Urban populations commonly use wood charcoal, while farmers in rural areas exclusively use firewood. This dependence on traditional charcoal and firewood is responsible for the prevailing deforestation and soil degradation that have had a negative impact on the environment. The effects are manifested in phenomena such as irregular rainfall, floods and violent storms. The major cause of this dependence is a lack of affordable and reliable alternative sources of energy. Moreover, even in cases where alternative sources of energy, such as hydroelectric power, kerosene and gas are available, the majority of farmers are too poor to afford them, hence the continuing dependence on charcoal and firewood. To save the forest, recycling agricultural waste to manufacture charcoal briquettes is a simple, low-cost and reliable technology. Charcoal briquettes are an affordable source of energy and can be used for cooking instead of the traditional charcoal and firewood.

79. The first step consists of the fabrication of charring drums and kilns (1-2 days). Kilns are thermally insulated chambers, or ovens, in which controlled temperature regimes are produced. They are used to harden, burn or dry materials. The second phase consists of charring (1-2 hours). Charring is a chemical process of incomplete combustion of a solid. By the action of heat, charring removes hydrogen and oxygen from the solid, so that the char is composed primarily of carbon. This phase is followed by pyrolysis (1 hour). Pyrolysis is the decomposition or transformation of a chemical compound caused by heat. The final step consists of the creation of charcoal briquettes.

80. There are several benefits of this recycling system. From the environmental point of view, these benefits include: provision of energy without the use of fossil fuels; use of a wide range of biomass as raw material; and limited deforestation. Furthermore, training increases farmers' knowledge about alternative sources of energy to wood charcoal.

81. From the social point of view, these benefits include: increased awareness of the farmers about the need for good environmental management; participation of

women in the making and management of the kiln; practical training in several districts in making charcoal briquettes from agricultural waste.

82. From the economic point of view: the technique is easy to replicate and affordable; it constitutes a readily accessible energy source for the farmers' households; and it incorporates social learning and practical skills development for long-term sustainability of conservation agricultural practices.

2. On-farm biogas: capturing methane emissions to produce clean energy

(a) The experience in the United Kingdom and Denmark

83. The production of biogas plants provides multiple environmental and economic benefits. It reduces the impact of agriculture on the environment while, at the same time, delivering renewable energy and substituting fossil fuels. Biogas plants convert manure, energy crops and organic solid waste into clean energy and efficient fertilizer. Biogas improves energy supply security and, at the same time, allows for synergy between farming, energy production and the environment. Biogas plants represent a multifunctional tool for promoting sustainable development in agriculture, the energy sector and rural areas in general.

84. Biogas can be used as a substitute for fossil fuels on the farm or sold as off-farm energy to other users. It is most commonly turned into electricity and heat by on-site cogeneration. The organic material comes from farming operations and is collected and stored in a closed airless container that acts as the digester. After 20 to 60 days (depending on the internal temperature of the digester), the organic matter is broken down by bacteria in the absence of oxygen to produce a methane-rich biogas. The remaining material, called digestate, can be recycled as a valuable nutrient source and soil conditioner. As the nutrient proprieties of the digestate are better characterized than unprocessed manures, it may be matched more closely to the nutrient requirements of crops. Digestate must be well managed and applied in accordance with best practice guidelines in order to reduce risks of diffuse nutrient pollution and habitat damage.

85. Anaerobic digestion systems located either on farms or at a larger centralized management facility offer a well-proven and established technology that is increasingly commercially available to agriculture in countries such as the United Kingdom and Denmark.

86. In recent years, a number of dairy farmers in the United Kingdom have been producing biogas using an on-farm anaerobic digestion system. Biogas and dairy production can be considered an effective partnership. Every dairy farmer can be, in principle, a producer of biogas. Both activities are production industries and dairy farmers can use all their own resources, assets and skills for the production of biogas.

87. Biogas plants are tools that reduce the leaching of nitrates and are also one of the most promising mitigation options for reducing greenhouse gas emissions from animal manure and slurries. Biogas burns more cleanly than fossil fuels such as oil and coal, and emits much less carbon dioxide per unit of electricity and heat produced. By using biogas for combined heat and power production, the emission of greenhouse gases is reduced by more than 200 per cent. When used as a transportation fuel, manure-based biogas can reduce emissions by more than 160 per cent. This high reduction potential is the result of the dual effect of the substitution

of fossil fuels and reduced emissions of methane and nitrous oxides from livestock manure.

88. Biogas production also delivers numerous advantages to farmers. It improves the nutrient value of livestock manure as nitrogen becomes available for arable crops and is an alternative to slurry soil injection equipment, which is energy-consuming, slow and expensive. Biogas plants minimize the odours associated with conventional manure management, protect the aquatic environment and enhance employment opportunities in rural areas, thereby promoting sustainable development in rural areas.

89. The main benefit of biogas production systems is an increase in revenue for farms using or selling the energy produced by the digester and replacing manufactured fertilizer with digestate.

(b) Biogas for rural households: on-farm production and use in Viet Nam

90. Viet Nam has become a major producer of biogas in Asia due to its effective animal, vegetable and human waste management. The significant production of biogas in recent years has been due partly to the establishment of the Biogas Program for the Animal Husbandry Sector, which is part of a rural development policy framework that encourages favourable conditions at the household level for the development of the farming economy and the expansion of livestock production.

91. The programme is a joint collaboration between the Ministry of Natural Resources and the Environment and the Vietnam Cooperative Alliance. It aims to manage animal waste in a sustainable way, while at the same time producing clean and affordable energy for rural households.

92. The biogas programme aims to exploit effectively biogas technology, contribute to rural development and environmental protection, improve the community's sanitation and rural people's health, improve the livelihood and quality of life of rural farmers through the exploitation of the economic and non-economic benefits of domestic biogas and, finally, develop a commercially viable domestic biogas sector.

93. Biogas plants represent a concrete solution for improving livelihoods in remote rural areas. Indeed, in the long term, the use and production of biogas can significantly improve the quality of life of rural farmers. The energy return of the system is high. It is estimated that the programme in Viet Nam provides enough clean and cheap energy to replace the usual sources of energy, such as firewood, agricultural waste, charcoal, kerosene and liquefied petroleum gas.

94. The objective of the programme is to provide a clean and affordable energy source for local people (for cooking and lighting) and thus improve the livelihoods of rural farmers. Secondly, the programme prevents and diminishes the environmental pollution caused by livestock waste. It protects forests by reducing the use of fossil fuels, thus minimizing greenhouse gas emissions. The programme also supports the socio-economic establishment of organizations and enterprises related to biogas production and services. Finally, it provides bioslurry (a by-product of biogas production), which can be used as a soil fertilizer for fodder crop cultivation.

95. In addition to providing a large amount of valuable energy, the Biogas Program in Viet Nam has enabled the construction of over 56,000 biogas plants, the training of more than 500 provincial and district technicians and the promotion of the benefits of using biogas to the rural population through informative workshops. Using biogas instead of firewood means a reduction of costs for family farmers, a relief for the women and children who collect firewood and a significant reduction in deforestation.

IV. Lessons learned and new opportunities to expedite implementation

96. An official recognition of agriculture as a sector with a huge potential to provide solutions for sustainable development and consumption is crucial.

97. Numerous strategies are already available but these are not yet fully appreciated by policymakers and the general public. There is a need to recognize that sustainable management practices already exist and measurement and monitoring mechanisms have been developed in some parts of the world. Increased and coordinated actions are necessary to raise awareness in this regard.

98. Nevertheless, farmers and agriculture are faced with several challenges that urgently need to be overcome. It is recognized that agriculture must nearly double food production to meet the demands of a growing population expected to reach 9 billion by mid-century, while minimizing the impact on the environment. Farmers are increasingly being asked to not only produce food, but to provide a wide range of ecological services to society, such as the protection of landscapes and wildlife habitats, integrated water resource management and conservation of local products.

99. The agricultural community is committed to playing an active role in creating sustainable production and consumption systems while increasing the productivity of agriculture. However, this enormous task needs the commitment of the international community in facilitating the needs of the agriculture sector.

100. A commitment for a substantial increase in investments in and support for agriculture is essential. The sector must be prioritized in international and national strategies and in budgets in order to increase agriculture’s role in boosting economic growth.

101. Investment must be focused on infrastructure, especially roads and drip irrigation, storage and processing facilities that reduce post-harvest losses, market information systems, extension services, credit and insurance, and access to inputs. Finally, national Governments should invest in improving the livelihoods of farming families by providing them with market returns and rewards for their services to nature, the so-called ecosystem services.

102. Significant financial resources and political will are needed to better address food security and sustainable patterns in production and consumption. These resources must be accessible to all stakeholders, including researchers, who are necessary for underpinning needed advances in the effectiveness, efficiency and equity of agriculture approaches, civil society and, in particular, farmers and their associations.

103. The recognition of farmers' organizations as partners, and as the link between farming communities, national Governments and international institutions, is crucial. The road to sustainable agriculture and sound implementation strategies around the world needs to encompass participatory approaches. A farmer-centred approach to agriculture and rural development should prevail.

104. Policy processes need to be empowering and adaptive in order to respond to the needs of local farming communities. They also need to ensure good governance. In particular, increased recognition should be given to the development of smallholder and family agriculture through the development of local food markets. The rights and roles of indigenous and local farming communities, especially those with women and young farmers, must also be recognized in developing national strategies for sustainable patterns.