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Contribution by farmers**

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Introduction

1. Agriculture and climate change issues are closely linked. Agriculture is at the heart of climate change issues. Indeed, it is one of the sectors that contributes to greenhouse effects and a sector that experiences climate change effects. At the same time, agriculture worldwide has a huge potential to provide answers with respect to mitigating and adapting to the consequences of climate change. One of the key answers for farmers with respect to climate change mitigation and adaptation lies in the development of sustainable sources of energy.

2. Farmers around the world already bear the consequences of climate change: some crops will not be resistant to the changes brought about by climate change and harvests will wane. Costs associated with climate change mitigation and adaptation already represent an added burden for farmers. However, they cannot bear this burden alone. Thus, all stakeholders need to be involved and play their part. Climate change is everybody's concern.

3. It is crucial for an activity, like agriculture, that is so dependent on climate conditions to clearly identify these changes and to find out how to tackle them.

4. The role of agriculture in combating climate change is important and must be recognized as such. This should lead to a change in the relationship the agricultural sector and community have with Governments, society and the environment. Agriculture around the world already affects the management of land, the environment and climate. It already provides sustainable produce with low food miles while protecting the environment. Agriculture is already responding positively to climate change mitigation through substitution of fossil fuels, continued energy efficiency and carbon sequestration.

5. There is no denying that agriculture currently accounts for more than 20 per cent of the human-induced greenhouse effect (including fossil fuel emissions and deforestation — mainly in tropical areas). Because of the significant role agriculture plays in emitting greenhouse gases, any reductions that can be made by farmers are important.

6. Indeed, despite the difficulties they face, farmers are doing much to adapt to climate change and also to mitigate its effects. Farmer initiatives to mitigate and adapt to climate change exist. However, their actions are not sufficiently recognized or properly documented. To preserve the livelihoods of farmers and support the growing world population, adaptation and mitigation measures are both essential responses in planning for climate change.

7. Agriculture covers approximately one third of the world's land surface and farmers are the largest group of ecosystem managers. Therefore, farmers will be an integral part of ecosystem management designed to handle the burden brought on by climate change.

8. One of the key challenges that farmers have to deal with entails the pressure to provide food for a world population that will double to reach 9 billion people by the year 2050. In rapidly developing nations, demand for energy-intense foods, like meat, is growing, increasing the total amount of fossil fuels used. The challenge for farmers is, on the one hand, to meet food demands while on the other hand to protect the environment through minimizing the use of fossil fuels and providing bioenergy, carbon sinks, etc.

I. Agricultural sources of greenhouse gases

9. Of the six greenhouse gases identified by the Kyoto protocol[1] to the United Nations Framework Convention on Climate Change[2], carbon dioxide and methane, both carbon compounds, are the two that contribute most to the greenhouse effect. Agricultural soils are currently a net source of atmospheric carbon dioxide. Process, transportation and distribution of agricultural goods, as well as use of farm machinery that operate based on the use of fossil fuels, contribute to the production of atmospheric carbon dioxide. Agricultural methane emissions, on the other hand, are largely generated from biological decomposition, livestock digestion, anaerobic decomposition of agricultural wastes and anaerobic activity in irrigated rice cultivation. Certain fertilizers and other agricultural chemical inputs are also known for their ability to contribute to the greenhouse effect.

10. Although the activities described above result in the emission of greenhouse gases, most are necessary and, in many cases, unavoidable. The key is for policymakers to remove barriers and provide incentives for farmers to adopt alternatives. This would facilitate farmers' efforts to minimize greenhouse gas emissions.

II. Barriers: lack of resources

11. Increased research has led to the development of more climate-friendly farming practices. Unfortunately, lack of financial resources and policy regulation make these practices difficult to implement.

A. Deteriorated resource base

12. Farmers rely on natural resources to carry out their activities. Soil erosion, waterlogging and salinity, predicted to increase with the onset of climate change, all contribute to land degradation and desertification, leading to overexploitation of the land. Greenhouse gases are released from certain fertilizers and pesticide inputs, and from the clearing and converting of non-agricultural lands.

13. Diminished biodiversity, due to habitat encroachment, fragmentation and pesticide misuse, also leads farmers to rely on greenhouse gas generating chemical inputs to increase their yields. Because decreased biodiversity results in less-resistant crops and loss of ecosystem services, pest infestations and weather variability increase agricultural stresses. Producing substantial crop yields without greenhouse gas generation from chemical inputs or intensive fossil fuel use is a challenge.

14. Pressure on water resources due to increased crop intensity brings about increased water resource competition in areas where water resources are scarce. Therefore, this situation may lead to conflicts. Unfortunately, the decreased water resource base is a reality that must be addressed in a long-term perspective. Without access to fertile land, uncontaminated water and a healthy biological ecosystem, farmers' livelihood is in danger.

B. Local knowledge generation and dissemination

15. Given the lack of detailed regional information on climate change impacts, specific predictions and adaptations are difficult to make. Modelling error and lack of specificity mean that even the most sophisticated models may not allow farmers and growers to adapt to future changes. There is obviously a lack of guidance on climate change adaptation and also a lack of capital with which to put necessary adaptations into place.

16. In particular, there is a lack of communication between researchers' and farmers' communities. In fact, researchers fail to address the full scope of the challenges faced by farmers and therefore do not bring adequate solutions that would meet the farmers' needs. Besides, farmers' needs and concerns often vary from one country to another and even from one region to another. Indeed, often research developments for increasing yields apply only for specific conditions, or require a high degree of knowledge transfer for the realization by farmers of the yield gains. Poor rural frameworks hamper the knowledge dissemination needed for farmers to benefit from research developments. These failed attempts may discourage them from adopting new methods in the future.

17. There is a lack of pro-poor farming research. Because poor farmers lack financial resources to commission research projects and lack access to research institutions, many of their needs remain unrecognized or unmet. These needs include research on farming systems that do not require purchased inputs or advanced technology but that would make efficient use of existing technologies, local knowledge and traditional practices.

C. Insufficient policy frameworks and regulation

18. At the national level, two inadequacies must be addressed. First, policy frameworks for addressing climate change impacts and adaptation measures are often incomplete; and second, government policy frameworks and regulation objectives are often inconsistent with climate change adaptation and mitigation goals.

19. Appropriate policies and regulations that are needed to create incentives and remove barriers to climate change adaptation and mitigation have not always been fully implemented. These need to be implemented so that markets can guide farmers' choices concerning farm management and energy, agricultural input and natural resource use. When these policy frameworks and regulations are only partially implemented, there is insufficient support for the full-fledged undertaking of climate-related activities, and market trends may lead farmers to make unsustainable farming choices.

20. There is often a lack of synergy between policy (such as climate change policy) goals developed under environmental ministries and policies developed under other ministries. In order for climate change policy and regulation to be effective, policy goals developed under different government structures must be harmonized.

D. Insufficient infrastructure and services

21. In many rural areas, deteriorating and outdated infrastructure has lost its resilience to climate-related extreme events such as hurricanes and droughts. Also, there is a general lack of services, hindering knowledge access. Without sufficient infrastructure, roads, storage facilities and irrigation services are susceptible to physical damage from climate-related events, and farmers become increasingly vulnerable.

22. The need to develop climate-related codes for infrastructure design and prepare for the onset of specific climate events will also require sufficient services for early warning so that farmers may make appropriate decisions concerning their crops and livestock. In developing countries, many of these required services are insufficient.

E. Financial capital and resilience

23. Climate change brings widespread weather events that affect whole communities at the same time. Traditional insurance markets and informal insurance arrangements between farmers and community members are inadequate in respect of preparing for climate change. Farmers who try to insure themselves through asset accumulation, savings and access to credit may also have trouble at the onset of a crisis, as these are often insufficient and may be easily damaged. For example, at the onset of a flood, physical assets such as property and land may be damaged, while community financial aid will be severely stretched as a result of the widespread effects.

24. Farmers living in areas where food security and resources are scarce lack financial capital. Often, they cannot afford to invest in new sustainable practices to prepare for climate change. For example, switching from traditional till agriculture to a more climate-friendly agricultural practice such as conservation agriculture may result in decreased crop yields for the first few seasons while farmers perfect their techniques. However, in the long run, the gains accruing from climate change mitigation will pay off. Extreme events, such as droughts, floods and hurricanes, will be less extreme and less frequent with successful mitigation. Unfortunately, there is often a conflict between long-term investment directed against climate change and short-term food security.

III. Farmers and agriculture as key to mitigating and adapting to climate change: farmers-driven initiatives as offering new opportunities to expedite implementation

25. In the context of economic development and a growing world population, farmers are already making efforts to mitigate climate change consequences by increasing the efficiency of their farming practices, reducing emissions and adopting carbon sequestering practices.

A. Support for climate-friendly initiatives and technologies

26. For farmers to work on combating climate change effectively, they need to stay up to date and informed on the most appropriate sustainable farming technologies and practices and have the means to adopt them. Farmers should also look beyond their own farms, and participate in efforts of the whole rural sector to mitigate climate change. For example, those engaged in commercial agriculture can choose to extend business partnerships with companies committed to sustainable operations. Those farmers who do not have the means to do so should benefit from support incentives from Governments. The role of the international community in terms of resource mobilization is also very important in this regard.

B. Support by farmers' organizations of individual farmers in adaptation and mitigation initiatives

27. Being aware of climate change as a threat to the farming sector and community, some apex farmers' organizations throughout the world already promote renewable energy policies, and support agricultural initiatives aiming at mitigating and adapting to its adverse effects. For instance, the National Farmers Union of England and Wales is anticipating likely climate changes and is helping the farming and horticulture sectors to understand, adapt to and play a full role in mitigating the effects of climate change.

C. Sustainable farm management practices and conservation agriculture to foster carbon storage

28. Farm management techniques in the context of tillage, crop management, water management and chemical inputs are already used by farmers as the means to optimize productivity while reducing greenhouse gas emissions.

29. Through conservation agriculture practices, farmers contribute to reducing emissions while combating land degradation. Conservation agriculture promises economic and environmental benefits. Leaving crop residues on the soil changes the surface characteristics. It increases rainfall efficiency, as water gets caught by and then percolates through the residues and soil. Generated run-off is less erosive and less polluting as crop residues reduce sediment transport into river waters.

30. No-till or minimum tillage agriculture is also less labour-intensive, as it reduces wear and tear on machinery and reduces fuel consumption. The lands concerned stock twice as much carbon as other lands. Well-managed forests also constitute net carbon sinks.

31. Therefore, adopting conservation agriculture contributes to changing farmlands from net carbon sources to net sinks. Besides, adoption of sustainable agriculture practices helps reduce food miles.

32. Farmers also adopt other crop management strategies to mitigate climate change impacts. These include crop rotation, increased crop diversification, and introducing integrated pest management systems.

33. Appropriate management of fertilizer and pesticide use can increase farm yields. While some chemical inputs generate greenhouse gases, some farmers choose alternatives, or specially treated inputs to reduce their emissions. They also use techniques such as: precision use and timing of fertilizer applications to meet crop needs, use of advanced control-release fertilizers and systems delivering fertilizers to plant roots through leaves. These can reduce total chemical inputs and at the same time help farmers maintain or increase yields. Other examples include use of additives in cattle feed to increase milk production or growth rates and decrease methane production per unit beef.

34. Methane emissions from agriculture are a source of greenhouse gas. Their reduction can be achieved through changing feed ingredients in livestock farming so as to improve the digestibility of forage. Farmers support innovations in feeding practices for methane reduction in ruminants.

35. *Sustainable management of forests: carbon sequestration*. Forests contain just over half of the carbon residing in terrestrial vegetation and soil. The carbon stored in the soil and litter of forest ecosystems also makes up a significant proportion of the total carbon pool. Carbon is stored in living biomass, including standing timber, branches, foliage and roots, and in dead biomass, including litter, woody debris, soil organic matter and forest products.

36. Increasing carbon accumulation in forests can be achieved by creating or enhancing carbon sinks (through afforestation, reforestation, improved silvicultural practices) or by preventing or reducing the rate of release of carbon already fixed in existing carbon sinks (through preventing deforestation; improved silvicultural practices).

37. Carbon emissions can be reduced through increasing the use of wood (which is a renewable resource), either for durable wood products or for biofuel, in place of fossil fuels. The role of forests and forestry for energy is growing. The case of a country such as Finland is telling. About 99 per cent of farms in this country use wood for heating purposes. In 2004, 68 per cent of farmhouses were heated by wood. For agricultural production, farms use light oil for tractors and other machinery and also for grain drying. Farmers are developing markets for forest residues and other wood by-products. Farmers and forest owners also produce heat and electricity which they sell to small and medium-sized enterprises in industry and the public service sector.

38. The use of wood products in place of materials that are associated with the release of large volumes of carbon dioxide could lead to significant net reductions in carbon dioxide emissions. However, forestry measures alone are not sufficient to halt the increase in atmospheric concentrations of carbon dioxide, although they can complement efforts by reducing carbon emissions. One of the primary measures to be taken to address climate change encompasses reducing the utilization of fossil fuels and combating desertification.

39. When addressing climate change through forestry measures, other aspects of sustainable forest management (economic, social and ecological) should be taken into consideration. Cross-sectoral dialogue and cooperation are needed to achieve best practices to combat climate change, as well as coordination and integration of sector policies having an impact on climate change.

D. New opportunities and challenges

40. In order to encourage farmers to use biofuels as a response to climate change, Governments must help to provide access to the necessary infrastructure and markets.

41. To reduce anticipated negative effects of climate change, preventive measures need to be developed and implemented.

42. Strategies devised to fight climate change must take into account the double role of the agricultural sector as both an emitter of carbon dioxide and a promoter of carbon sequestration.

43. There is a need to continue to expand scientific research on global climate change with a view to deepening knowledge on the impacts of climate change and also to coming up with new approaches and agricultural practices that are "climate-friendly" and, at the same time, with a view to achieving greater production efficiency and developing bioenergy sources.

44. There is also a need to develop links between research communities and farming communities to allow information to reach the latter in a farmer-friendly format. There is a vital need for better-focused farm-specific climate change information.

45. Increased funding opportunities are needed for climate change adaptation as well as mitigation measures.

46. A greater dialogue among the members of the farming community is needed to improve the documentation of their position on the issue of climate change and also in order to exchange knowledge.

47. There still is a need to raise awareness on the following:

(a) The important role of agriculture in combating climate change;

(b) The consequences of not adapting to climate change;

(c) Short- and long-term aspects of dealing with climate change.

48. *Involving farmers' organizations in decision-making processes through the creation of follow-up commissions on climate change*. It is of the utmost importance that climate change issues and problems be identified so as to enable the design of appropriate instruments and tools with which to mitigate their effects. The establishment is needed of a follow-up commission that would be in charge of implementing and monitoring strategies aimed at fighting climate change. In this regard, farmers and rural communities would need to be involved in this commission along with other stakeholders, including relevant public authorities and non-State actors at large.

49. It is essential to recognize the important role of farmers and growers as representing not only one of the sectors most affected by climate change but also a sector with a huge potential in the design of instruments and tools with which to address this problem. Participation of farmers is vital through representative professional organizations which must play an essential role in decision-making, design and implementation in respect of actions related to climate change strategies.

50. Many farmers believe that climate change offers them a real opportunity to develop new crops. They are ready to adapt to new conditions.

IV. Reduction of greenhouse gas emissions through renewable sources of energy, non-food production and carbon storage

51. Developing sustainable sources of energies is, without any doubt, one of the keys to mitigating climate change and its adverse effects. Concerns about global warming and production of greenhouse gases from fossil fuels are stimulating increasing interest in renewable energies.

52. Renewable energy is intimately and inextricably bound up with farmers and farming activities. Renewable energy is increasingly becoming a key issue in the international agenda. Global oil production is already peaking, yet consumption is expected to continue rising in the coming years. Moreover, fossil fuels, the largest single source of world energy, will eventually run out. It is not a question of *if* but rather of *when* this is going to happen.

53. All sources of renewable energy require large land areas within which to gather relatively large collectors in order to produce meaningful amounts of energy. Farms are generally the only places where large enough areas are available to construct large wind generators and large solar power voltaic cells and cultivate large areas of suitable biomass for energy.

54. Farmers are therefore well placed to take advantage of the growing attention to renewable energy supplies. Increased utilization of renewable energy will have a significant impact on agriculture in both the short and the long term. Agricultural sources of energy are becoming the new paradigm for the food and energy business.

55. Renewable energies include: biomass for fuel (wood and straw), biogas, biofuel (bioethanol and biodiesel), electricity cogenerated from sugar cane, solar energy, wind energy, thermal hydroelectricity, and fuel cells.

56. Bioenergy can be marketed, depending on the needs of the customer, as a source of electricity, heat or fuel.

Renewable energies from agriculture

57. *Biomass.* The increased use of biomass for energy production and heating should be fostered as one of the most effective climate protection measures.

58. The development of local sustainable energy networks based on biomass production can play an important role through locally based combined heat and power plants.

59. *Biomass as a source of energy in Germany*. Over the past three years, private investors have invested more than 3 billion euros in generating energy from wind, water, sun and biomass. By expanding the use of bioenergies, the farming and forestry sector in Germany is making an important contribution to fulfilling national climate protection obligations.

60. It is important to note that renewable energies currently account for about 9 per cent of gross electricity consumption in Germany; this translates into a cutting of carbon dioxide emissions by 50 million tons per year.

61. *Wood*. The burning of wood in private stoves represents the oldest and still the most common form of biomass use. Increasingly, wood is used in pellet heating systems (using pellets made from dried natural wood chippings). There are currently about 1,000 biomass heating stations in Germany, each with an output of over 1 megawatt (MW). Forty million solid cubic metres of wood are harvested each year from forests in Germany; some 60 million cubic metres are growing, which would make a further 20 million cubic metres available as fuel for heating. As a result, in the long term, approximately 3.5 million tons of heating oil could be replaced, hence 12 million tons of carbon dioxide emissions could be avoided.

62. *Straw and cereals*. With prices of finite fossil fuels rising and cereal prices falling to record world market levels, it is becoming economically interesting to use cereals, in addition to straw, for energy production.

63. In respect of biomass as a source of energy in the case of Kenya:

(a) Causes of depletion of energy sources. Increasing pressure on agricultural land due to a growing world population has led to encroachment on forest reserves. Poverty and unemployment have pushed people indiscriminately into activities that might provide a living, for example, the felling and selling of firewood and the production of charcoal. At the same time, replacement of the depleted trees is not forthcoming. This situation results in scarcity of fuelwood and charcoal and pushes many farmers to use elementary forms of energy sources such as cow dung and maize stoves;

(b) More sustainable energy production. In order to escape from this unsustainable situation, farmers in Kenya are making significant efforts to use available sources of energy in a more sustainable way. These efforts include:

(i) The use of improved stoves. These firewood stoves use only two to three sticks of firewood at a time, thereby reducing the consumption of firewood. Some stoves use dust or residues from processed rice, maize and other crops or from sawdust. These stoves are more economical than the traditional charcoal stoves;

(ii) Fireless cookers. These are baskets made out of reeds whose inner sides are well lined with warm and insulating materials that prevent the loss of heat from a boiling pan inside them. The pan is brought to a boil on the fire and then removed, wrapped up in a dark cotton cloth and placed inside the fireless cooker where it continues to boil without a source of fire. These cookers are also used to keep food warm, thus eliminating the need to warm food over an energy source;

(iii) Mud-coated charcoal chips. The effort to use these chips represents savings in terms of the proper use of charcoal through the utilization of what would otherwise be thrown away as waste;

(iv) Kahawa coal. These are pellets made by grinding the wastes from coffee husks and mixing them with clay and water. The pellets are then granulated and dried in the sun. As charcoal chips, these forms of energy prevent farmers' misuse of trees.

64. *Biofuels.* Liquid biofuels are renewable transport fuels made from plant materials. Biofuels come in two forms: biodiesel used as a fossil fuel diesel substitute; and bioethanol used as a fossil fuel gasoline substitute. Biodiesel which is made by processing rapeseed oil and other vegetable oils, is widely available globally, particularly in France and Germany. Bioethanol, which can be made from processing maize, sugar cane and beet, wheat, potatoes and a variety of other starch and sugar crops, is widely used in Brazil, the United States of America and parts of Europe.

65. Biofuels offer some 60 per cent carbon dioxide saving on their fossil fuel equivalents. They represent a key tool in the fight against global warming, as their production process results in fewer greenhouse gases emissions.

66. Biodiesel is already commercially available in Europe and the United States and interest in producing increased volumes of biodiesel is intense. In Brazil, bioethanol has been used as a commercial liquid fuel for many years. In countries south of the equator, specifically in African countries, fuel is relatively expensive and in some areas not available at all. These countries are generally poor and find it hard to generate enough foreign exchange to import sufficient quantities of crude oil-based liquid fuels.

67. Farmers are in favour of giving higher priority to this renewable energy production. They are willing and able to produce biofuels and have the potential to produce much more than what they are already producing.

68. Besides, it is more efficient to reward energy conservation rather than to simply penalize energy use. Some apex farmers' organizations already promote an alternative carbohydrate-based renewable energy policy. Adaptation measures should be focused on efficiency and conservation.

69. *Biofuels as a source of energy in Europe.* At the end of the past century, when heat engines appeared, people were conducting experiments with ethanol derived from beet as fuel. In 1974, prices of petroleum had risen sharply, and in 1980, Governments were fighting against air pollution generated by the transportation sector. At that time, ethanol began to be developed as a source of energy and as a "clean" fuel. Today, several countries in the European Union (EU), including France, Sweden and the Netherlands, are implementing a sugar beet fuel network. In Sweden, 200 buses and 200 vehicles are working with ethanol as fuel. The process is different from the one implemented in France: in Sweden, ethanol is used pure as fuel, whereas in France it is mixed with isobutylene to yield ethyl tertiary butyl ether which is then blended with traditional fuel.

70. In EU, oilseed plants, particularly rapeseed, are used more often than sugar beet to produce biofuel. The ester methylic, obtained from rapeseed, is used in France for diesel vehicles; it is used in Germany without mixture, and as heating fuel in France and Italy. In 1995-1996, the size of areas devoted to rapeseed growing for fuel reached 615,000 hectares, representing a large part of the 968,000 hectares devoted to non-food crops.

71. *The United Kingdom of Great Britain and Northern Ireland and the European Union (EU) biofuels directive.* The EU biofuels directive,[3] adopted in 2003, is concerned with the substitution of conventional oil-derived transport fuels, diesel and petrol, by biofuels derived from agricultural crops. The primary motive of this directive is to ensure security of European-derived energy supplies and

environmental sustainability relating to climate change, Kyoto targets and the unsustainable increases in EU transport energy consumption (which currently accounts for 28 per cent of EU carbon dioxide emissions and is predicted to account for 90 per cent of the increase in these emissions to 2010[4]). To achieve its objective, the directive is accompanied by an energy tax directive,[5] together with which it sets indicative targets for biofuel substitution and sets out a legal framework for fiscal and other national measures to promote biofuels.

72. These directives set out indicative targets for the biofuel share of all transport fuels at 2 per cent by December 2005, and 5.75 per cent by December 2010. Member States set their own targets but must report annually on progress. The Commission will evaluate progress of member States, cost-effectiveness, environmental and economic impacts, life-cycle analysis and impact on greenhouse gas emissions. The Commission can propose changes to targets, including mandatory targets, if member States cannot justify non-compliance.

73. In the United Kingdom, the latest research shows that 70 per cent of CO_2 emissions can be eliminated by utilizing current technology biofuels from crops.[6]

74. *The National Farmers' Union biofuel policy*. The National Farmers' Union (NFU) of the United Kingdom:

(a) Wishes to see a thriving domestically supplied United Kingdom biofuel industry develop;

(b) Believes the EU target of a 5.75 per cent share of renewable road transport fuel in the United Kingdom by 2010 is realistic — provided government policy and strategy proactively promote and support the industry;

(c) Acknowledges the financial support of a 20 pence per litre duty rate cut but concludes that this alone is not enough to meet United Kingdom and EU targets, nor to kick-start the United Kingdom biofuel industry;

(d) Wants a renewable transport fuel obligation (RTFO) to be put in place and also wants to see increased cooperation across government departments, involving non-governmental organizations and a firmer government commitment, in order for the United Kingdom to succeed in fulfilling EU indicative targets and a longer-term strategy beyond 2010. Following intensive government lobbying by the biofuel industry and the National Farmers' Union and through National Farmers' Union alliances with NGOs, the Government has accepted a clause in the energy bill that would give the Government the primary powers in respect of introducing a renewable transport fuel obligation.

75. The main advantages for the United Kingdom in producing liquid biofuels include the following:

(a) Immediate introduction into modern gasoline and diesel supply systems without the need for costly development or engine modification;

(b) Uptake of the unique opportunities of Common Agricultural Policy (CAP) reform and rapidly emerging EU biofuel markets;

(c) Maintenance of Great Britain's biodiversity through encouraging mixed cropping and continued active agricultural land management. Through support of a domestically fed biofuel industry, a base will be placed in the cereal and oilseed

market and new markets found for the restructured sugar beet industry, without which marginal land is predicted to become a monoculture of grass;

(d) The fact that biofuels are biodegradable, and are ideal for inland waterways and other environmentally sensitive areas. Bioethanol has been shown to reduce nitrogen oxide emissions by 50 per cent;

(e) Utilization of current low-value exportable surpluses in cereals and oilseed rape, ensuring minimal-land use change required to supply a 2 per cent biofuel target.

76. *Liquid bioenergy sources in Germany.* In 2003, German farmers planted about 460,000 hectares of oilseed rape to produce about 650,000 tons of biodiesel. Depending on the requirements of crop rotation and location, the area for the cultivation of oilseed rape for biodiesel could be expanded to 1 million hectares, covering approximately 5 per cent of German diesel demand in the medium term. The production of bioethanol, the raw materials for which are cereals and sugar beet, is expanding. With an estimated total capacity at three locations of 500,000 tons, this is a very promising beginning to the opening up of a new sales channel in the area of motor vehicle fuel.

77. The oilseed crop comprises three essential parts. The leaves may be utilized as green manure or forage. The straw may be burned on the farm to provide heat or electricity. The seed is pressed to extract its oil content and the remaining cake can be either used as high-protein-content cattle fodder or burned as an energy source for the production of electricity.

78. *Importance of biodiesel in South Africa.* South Africa is at present highly dependent on imported crude oil for the production of transport fuels and more specifically diesel (71 per cent of South African diesel demand is supplied from crude oil). In 2000, the Government asked the Department of Science to produce a study on how to reduce South Africa's dependency on crude oil products. Biofuels were recommended as one of the technology options that required further investigation.

79. The process in question involves the reaction of vegetable oils with an alcohol (ethanol or methanol) in the presence of a catalyst to produce the diesel (with glycerol as the by-product). Depending on the oil used, the filtration step leaves a protein-rich filter cake, which could be used as animal feed or for human consumption. It is worth noting that South Africa imports oilcake and glycerol to a value of over 1 billion rand per annum. Oil sources include soya, sunflower, jatropha, groundnut, cotton, canola and a number of others.

80. Biodiesel production has many benefits:

(a) Environmentally friendly;

(b) Limited energy resources;

(c) Domestic economic considerations (leverage farming activities, increased domestic protein production);

(d) Reduced oil import dependency;

(e) Excellent lubricant characteristics.

81. However, it entails some risks as well, involving:

(a) Domestic availability of soya beans;

(b) No long-term availability of feedstock;

(c) Climatic conditions;

(d) Unpredictability of forecasting;

(e) Price volatility;

(f) Exchange rate;

(g) Unrelated price benchmarking.

82. One problem stemmed from the contention that there could be no justification for producing renewable fuels from food sources while people were starving. However, a study by the South African Government concluded that by producing fuels from soybeans on a commercial basis, the country would be able to produce significantly more food in the form of protein-rich soy oilcake and maize at the same time. The South African study proved that the production of biofuels would not reduce food production in African countries, but rather would increase it.

83. The targeted farmers do not just sell seed, as is the case within the edible oils industry, but own, in a cooperative venture, the technology platform for extraction of the oil and enter into a separate agreement with the petrochemicals company that is buying the oil to have access to the oilcake and glycerol for a separate venture, in which the targeted farmers hold a significant interest.

84. The price of feedstock used in the production of biodiesel relative to petroleum prices is a key determinant in the feasibility of biodiesel. The economic feasibility of producing biodiesel in South Africa will always be determined by the ratios among the international price of crude oil, the local diesel price and the prices of oilseeds such as sunflower and soybean.

85. It is expected that South Africa will lead other African countries in the commercialization of biodiesel.

86. *Alcohol from sugar cane provides fuel in Brazil.* After 400 years of transforming sugar cane into sugar, bio-alcohol from sugar cane managed to dethrone sugar in only one decade, supported by two petroleum shocks. The last 50 years clearly demonstrate the change that began with the PROALCOOL programme in 1975-1976. Prior to that, alcohol had absorbed only 15-20 per cent of total sugar cane production. It was part of the federal government policy to use alcohol as an instrument with which to absorb the constant surplus of sugar cane production. This was achieved by virtue of the splendid adaptation of the sugar cane culture in the centre-south region of Brazil; the better security offered to the producer by sugar cane; the Brazilian experiences with the utilization of fuel alcohol; and the known risks of agriculture related to climatic variations. Beginning with the PROALCOOL programme, with its incentives for the expansion of alcohol production, sugar cane production in Brazil rose very steeply in only 10 years, or within two full plantation cycles.

87. Brazil is leading the way with a high consumption level of ethanol and the great success of flexi-fuel cars. These can be run on both gasoline and alcohol in

any proportion. It is worth noting that, in May-June 2005, flexi-fuel vehicle sales in Brazil overtook sales of gasoline cars for the first time.

88. The indirect results have been:

(a) Valorization of the sugar cane agro-industry and its decentralized development in practically all States of the country, with all the favourable impacts already known;

(b) The creation of direct jobs: 1 million in rural areas in Brazil;

(c) Research aimed at achieving a better tonnage of sugar cane per planted hectare, with modern techniques of planting, cultural treatments, phytosanitary control, and use of seed cane varieties resistant to diseases and pests and with a greater production of sucrose per area planted being just some of the aspects of this research;

(d) The fertilizing characteristics, with a high content of organic matter and potassium, of the effluents from distilleries.

89. The organic matter is important in soil reclamation, mainly in the areas of the Brazilian Cerrado, and potassium is the most important element lacking in the soils, being the main component in the fertilizer formulae used in sugar cane production. The cultivation of different energy crops will in future enrich crop rotation and hence improve plant diversity. Soil protection can be maximized through the use of direct sowing methods for energy crops. Closed loop systems enable the amount of fertilizers that is used to be reduced. In addition, in the case of liquid manure undergoing digestion in a biogas facility, for example, nutrient recovery is more efficient and methane emissions and smell are considerably reduced.

90. Sugar beet and cane growers worldwide are struggling to cope with inflation of production costs and drastic decreases in real revenues. However, the increase in demand for ethanol offers an alternative output and better prices on world markets, and should help the sugar economy and encourage young people to continue family farming of beet and cane.

91. *Biogas: gaseous bioenergy sources in Germany.* There are currently about 2,000 biogas plants in Germany, the majority operated by farmers. Their total output is approximately 255 megawatts. Besides commercial fertilizers and food waste, biogas plants increasingly process energy crops such as cereals, maize (whole plants) and grass. This could potentially cover 5.5 per cent of Germany's energy needs. In order to exploit this potential to the full, the German Farmers' Association calls for the promotion of bioethanol production from sugar and/or cereals in a manner corresponding to that of biodiesel. Industry is ready to make the necessary investments.

92. *Sugar cane cogeneration of electricity*: *bagasse from sugar cane generates electric energy in India*. In a sugar cane-rich country like India, bagasse can play a very important role in meeting the raw material requirements of the pulp and paper industry as well as allied products like particle board. Apart from this, there is enormous potential in the Indian sugar industry for producing surplus electric energy for outside sales. India is currently producing about 270 millions tons of sugar cane annually, about 50-55 per cent of which is utilized for the manufacture of crystal sugar generating over 40 million tons of bagasse annually. The rest of the sugar cane is diverted for the production of jaggery (uncrystallized sugar), etc.; the

mill wet bagasse produced per tons of sugar cane crushed contains electrical energy to the tune of 790 kilowatt-hour units out of which only about 30-35 kilowatt-hour units are required for the production of crystal sugar. Thus, there is an enormous potential for producing surplus electric energy in a sugar plant. All the sugar factories are located in rural India. This has led to the tremendous development of rural areas. These factories become the focal point of rural development in the area of operation. They help in the following ways: economical development, educational development, agricultural development, health improvement, and better living conditions. In brief, the combination of biofuel and biomass technologies offers greater environmental benefits and the two technologies complement each other. Cogeneration of electricity is also taking place in other sugar cane producing countries, for example, Mauritius.

Wind energy

93. The energy context in Canada:

(a) Sustainable energy use in the Canadian agriculture sector is currently limited. Canadian farmers in the past have benefited from relatively inexpensive and reliable sources of non-renewable energy and, as a result, the agricultural industry is predominantly reliant upon oil and gas. Sustainable energy has been able to compete with non-renewables only in very select niche markets;

(b) The key challenge for Canadian farmers in relation to energy use is the increasing cost of non-renewable energy upon which they are predominantly dependent. Part of the solution may be the adaptation of energy conservation measures. In some instances, energy consumption can be reduced by 50-80 per cent depending on the current level of use efficiency. However, for the majority of farm activities, there are substantial economic and technological barriers to further reducing energy use. Switching to sustainable energy sources may also be part of the solution to high energy costs; however, sustainable energy currently has a low penetration in the agricultural industry and faces many challenges including early adaptation of technologies, geographical location, high capital costs, and cost competitiveness with respect to traditional energy sources;

(c) The Canadian Federation of Agriculture is a farmer-funded national umbrella organization representing provincial general farm organizations and national commodity groups. The Federation supports several policy initiatives related to climate change that are indirectly linked to farm energy use. The Federation has urged the Canadian Government to increase resources directed towards research on renewable energy technology as well as the development and strengthening of renewable energy markets; and has also requested that the Government offer industry direct support for adopting renewable energy practices and programmes that encourage all types of renewable energy.

(d) Unfortunately, in Canada, a comprehensive strategy to address high energy costs in the agricultural sector or to encourage sustainable energy use on farms has not been developed. Farmers who are interested in the adaptation of sustainable energy must look to general non-specific industry programmes to find funding, support or policy direction.

94. Wind Power Production Incentive (WPPI):

(a) Canada's wind energy resources are among the best in the world and it has installed more than 500 megawatts of wind energy capacity across the country. Wind energy can make a significant contribution to Canada's electricity needs while providing a broad range of economic and environmental benefits. Much of Canada's best wind resources are found in rural areas and wind energy can diversify rural economies, provide lease income to farmers, as well as jobs and property tax revenues for hard-pressed areas;

(b) The Government of Canada Wind Power Production Incentive (WPPI), announced in the December 2001 budget, is intended to encourage electric utilities, independent power producers and other stakeholders to gain experience in respect of this emerging and promising energy source. The Incentive will provide financial support for the installation of 1,000 megawatts of new capacity over the next five years. The incentive will cover approximately half of the current cost of the premium for wind energy in Canada compared with that of conventional sources;

(c) Over the past several years, wind developers have been prospecting windy sites across Canada and many large-scale wind farms have been proposed in Quebec, Ontario and Alberta. In many areas, rural landowners, especially farmers, have received offers to lease their land from these wind power developers. A wind farm can be integrated on farmland over thousands of acres but farmers who lease the land lose only about 1-2 per cent of their crop production and have the potential to earn from $20,000 to $30,000 in annual rent or royalties.

V. Key obstacles/barriers and challenges to be overcome

95. There is a lack of understanding and awareness among the general public about renewable opportunities arising from biomass, heat and biofuels. There is also bad publicity about renewable energy failures. Indeed, there is a large urban population that has little awareness of rural issues and little knowledge of non-food agricultural opportunities.

96. There is a need for public support for renewable energy production via planned usage, for example, public-procured renewable energy or planning demands for renewable energy options.

97. Another key obstacle at the governmental level involves existing regional and local governments with disparate skills, awareness and knowledge. Responsibility is often divided among multiple government departments. In the United Kingdom, for instance, four government departments cover biofuels. At the local level, it is difficult to create successful agricultural cooperatives designed to supply renewable energies.

98. Biodiesel made from plant oils is undoubtedly the most technically and commercially advanced renewable fuel today. However, this renewable source of energy — as well as most renewables — demands large initial investments both in new commercial agricultural enterprises and in biodiesel refineries.

99. The number of entrepreneurs who possess sufficient technical know-how to run a biodiesel refinery as well as the experience to develop new commercial agricultural projects is very small, and they generally cannot provide equity capital.

The challenge is to raise sufficient venture capital and to identify a sufficient number of knowledgeable entrepreneurs willing to seize the opportunity to develop the agricultural sectors and run biodiesel refineries in remote rural areas. Should this obstacle be overcome, agriculture in poor countries of the South could play a significant role in revitalizing local economies, and contribute significantly towards the replacement of dwindling crude oil supplies.

100. Economic advantages of renewable energies:

(a) A viable alternative for farmers to producing food and to buying energy;

(b) A positive effect on balance of payments of countries and reduced import dependency;

(c) Strengthening of domestic rural agricultural economies by actively contributing to integrated rural development planning. In fact, renewable energies can provide an economic impetus for agricultural and rural development and help rejuvenate rural economies with a significant financial impact on farmers and agricultural businesses;

(d) Utilization of agricultural surpluses: creation of commercial opportunities from by-products such as glycerol and oilcake;

(e) Allowing a more efficient use of the farming potential of land and plants. Increased production of agricultural crops for non-food purposes offers the opportunity to utilize land that would have otherwise been an unexploited resource. Several animal and vegetable oils are being displaced in the food market as a result of health factors; biodiesel from these resources could offer a high-value alternative market for oilseed and tallow producers. The cropping of oilseeds takes place annually, thereby reducing long-term investment requirements. Annual crop residues (including pressed seedcake) can be burned throughout the year in local electricity generation plants, thereby smoothing out the production income cycle. Existing agricultural distribution facilities can also be utilized to convey increased oilseed production, which is not the case for any other sustainable transport fuel;

(f) Creation of additional employment. The utilization of set-aside and underutilized land by the agricultural sector has been shown to increase employment potential by 1 person per 20 hectares dedicated to energy crops. Studies in Ireland and France indicate that the resultant regeneration of the agricultural sector can create between 11 and 15 jobs per 1,000 tons of biodiesel produced. Given that most of the production processes involved are carried out in rural areas, this provides a much-needed boost to rural agricultural economies where new job opportunities would be created.

VI. Conclusion

101. Agriculture covers approximately one third of the world's land surface and farmers are the largest group of ecosystem managers. Climate change therefore poses real challenges to farmers in terms of adapting farming methods to new weather conditions and reducing greenhouse gas emissions. The present paper demonstrates the progress that has been achieved by farmers in mitigating and adapting to climate change effects by increasing the efficiency of their farming practices, reducing emissions, and adopting carbon sequestering practices.

102. Farming is not only one of the sectors that is most affected by climate change but also a sector with a huge potential for carrying out the design of instruments and tools with which to address this problem, particularly through providing renewable sources of energies. Participation of farmers is vital through representative professional organizations which must play an essential role in decision-making, design and implementation in respect of actions related to climate change strategies.

103. However, no matter how significant their efforts, farmers and their organizations cannot bear the responsibility of adaptation and mitigation alone. The contribution of all stakeholders is of the utmost importance. Farmers are ready to propose policy orientations and provide part of the answers to different stakeholders, but they must be involved as key actors and as real protagonists.

Notes

[1] FCCP/CP/1997/7/Add.1, decision 1/CP.3, annex.

[2] United Nations, *Treaty Series*, vol. 1771, No. 30822.

[3] Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport.

[4] "Promoting biofuels in Europe: Securing a cleaner future for transport", brochure of the EU Directorate-General for Energy and Transport (available from http://europa.eu.int/comm/dgs/energy_transport/index_en.html).

[5] Council directive 2003/96/EC of 27 October 2003 on restructuring the community framework for taxation of energy products and electricity.

[6] See "The Environmental Case for Liquid Biofuels", a briefing note by Dr. Bruce Tofield and members of the CRed project at the University of East Anglia, October 2003.