GENDER AND EQUITY ISSUES IN LIQUID BIOFUELS PRODUCTION

MINIMIZING THE RISKS TO MAXIMIZE THE OPPORTUNITIES

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WHY LINK GENDER, EQUITY ISSUES AND LIQUID BIOFUELS PRODUCTION?

The production of liquid biofuels is rapidly increasing in developing countries, due mainly to the establishment of large-scale biofuel feedstock plantations[1]. This results in potential socio-economic benefits[2], particularly in terms of agricultural employment, as well as risks, which tend to be context-specific. This paper explores the potential gender-differentiated[3] risks associated with the large-scale production of first-generation liquid biofuels (see box 1) in developing countries. The objective of this study is to engage in an in-depth discussion of some hypothetical risks and identify research and policy strategies to address them, in order to maximize the opportunities offered by biofuels production. A subsequent paper will explore the benefits of small-scale biofuels production for energy generation in rural areas.

The potential environmental and socio-economic risks that may arise from the establishment and operation of large-scale plantations for the production of biofuels are considered. In addition, some potential risks for food security resulting from an increase in food prices due to the growing use of agricultural crops for biofuels production are discussed. This paper represents a first attempt to go beyond the traditional gender and biofuels debate, which has focused on the gender-differentiated health impacts of household use of solid biofuels.

For a comprehensive evaluation of the potential effects of liquid biofuels production on people's economic and social well-being in developing countries, understanding the gender-related implications of such production in these countries (particularly in specific socio-economic and policy contexts) is essential.

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[1] As explained in the next section, biofuel feedstock production is characterized by important economies of scale.

[2] Biofuels production may also result in macroeconomic benefits for developing countries, such as increased export revenues, which are not discussed in this paper.

[3] "Gender" refers to the social roles and relations between women and men. This includes the different responsibilities of women and men in a given culture or location (FAO, 2000).

The potential gender-differentiated risks of liquid biofuels production in developing countries should be taken into account and addressed by the climate change mitigation and biofuels policies that are currently being developed and implemented in several countries around the world. Acknowledging such risks and addressing them through appropriate policies would contribute to maximizing the potential economic development opportunities of liquid biofuels production for both men and women in developing countries. This would also ensure the consistency of biofuels policies with other important policy objectives, such as sustainable rural development, gender equality, and adaptation to climate change, strengthening the potential synergies – and reducing the risk of trade-offs – between them.

Box 1
Liquid biofuels facts

Liquid biofuels are liquid fuels that can be produced from agricultural and forest products or the biodegradable portion of industrial and municipal waste. The two most common forms of liquid biofuels are bioethanol and biodiesel, which account for more than 90 percent of global liquid biofuel usage (mainly in the transport sector). Bioethanol is produced from agricultural products such as starchy and cereal crops (sugarcane, corn, beets, wheat and sorghum), while the main feedstock used in biodiesel production are oil crops and trees such as rapeseed, soy, sunflower, palm, jatropha or coconut. Recently, so-called "second-generation" liquid biofuels have started to be developed. Second-generation, lignocellulosic bioethanol is made from forestry products such as short rotation coppices and energy grasses, while new biodiesel technologies synthesise diesel fuels from wood and straw to a gasification stage (Dufey, 2006).

The scale of the biofuel industry and the number of countries involved in its production are rapidly expanding. Global production of liquid biofuels amounted to 0.8 EJ in 2005. USA, Brazil, and the EU are the main biofuels producers. However, biofuels production is growing quickly also in several developing countries such as Indonesia and Malaysia. The most promising regions for the large-scale supply of liquid biofuels (up to 20 EJ have been judged technically possible by 2050) are Sub-Saharan Africa, East Asia, Latin America, and the Caribbean (Doornbosch and Steenblik, 2007).

INTRODUCTION

Most of the climate change mitigation policies that have been established in the last few years at the international, national and local levels (particularly in developed countries) included measures aimed at promoting the production and use of biofuels, due to their expected lower carbon content compared to fossil fuels[4]. Such measures, coupled with high oil prices, have generated a growing global demand for liquid biofuels[5]. A significant and increasing share of this type of fuel is being provided by tropical and subtropical developing countries and emerging economies, which have a comparative advantage in the production of biofuels feedstock such as sugarcane and palm oil (Jank et al., 2007). Brazil, for instance, is the main bioethanol producer, while Malaysia and Indonesia are leading producers of palm oil for biodiesel and are rapidly expanding their plantations[6]. Given the significant economies of scale associated with biofuel feedstock production[7], in most cases large-scale plantations represent the most efficient and economically competitive option for producing such feedstock. In Brazil, for instance, production of sugarcane (the main ethanol feedstock) is dominated by large estates (Johnson and Rosillo-Calle, 2007).

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[4] The greenhouse gas mitigation potential of certain biofuel production technologies and systems has been challenged in several recent studies (e.g. Fargione *et al.*, 2008). Policies supporting biofuel production and use, however, are also being established to pursue, either explicitly or implicitly, one or more of the following aims: diversify the energy supply and increase energy security; reduce non greenhouse gas emissions; increase economic competitiveness; and promote rural employment and development.

[5] The demand for biofuels is expected to continue to grow in the medium term, as is the production. The world output of biofuels (assuming current practice and policy) is projected to increase almost fivefold, from 20 Mtoe in 2005 to 92 Mtoe in 2030 (UNEP, 2007).

[6] In 2005, there were 12 million hectares under palm oil production worldwide, four million of which were in Malaysia and 5.3 million of which were in Indonesia. These two countries have recently announced that they will set aside 40 percent of their palm oil output for biodiesel. Together, they aim to supply 20 percent of the EU demand for this biofuel (Tauli-Corpuz and Tamang, 2007).

[7] Feedstock represents the largest cost of production in all current biofuels production systems (Peskett *et al.*, 2007); according to Schmidhuber (2007), in large ethanol production plants, feedstock costs can account for about 70-80 percent of total costs.

The contribution of developing countries to global biofuels production has the potential to grow considerably in the future (see box 1), giving rise to significant environmental impacts and leading to major socio-economic transformations (Doornbosch and Steenblik, 2007; UN-Energy, 2007; Dufey, 2006). At the present time, much of the development of biofuel feedstock production in developing countries is arising from the expectation that there will be significant opportunities for export, particularly to countries in the European community.

Both the potential socio-economic benefits and risks of liquid biofuels production in developing countries have been extensively discussed in several studies (see Hazell and Pachauri, 2006), with the scale of the analysis ranging from the international level down to the household level. There is, however, a lack of understanding and consideration, within both the literature and the policy debate, of the differentiated socio-economic impacts of liquid biofuels production on male- and female-headed households, as well as on individual men and women at the intra-household level.

The environmental and socio-economic transformations prompted by the growing global demand for liquid biofuels might have different impacts on men and women in developing countries. Men and women within the same household as well as male- and female-headed households, could face different risks, particularly with regard to their access to and control of land and other productive assets, their level of participation in decision-making and socio-economic activities, employment opportunities and conditions, and their food security. This reflects men's and women's different roles and responsibilities within rural economies, as well as pre-existing socio-economic inequalities between them. Both the nature and the magnitude of the gender-differentiated impacts of liquid biofuels production will depend on the specific technology and on the socio-economic and policy context considered. However, a number of general trends, discussed below, may be identified.

1 POTENTIAL SOCIO-ECONOMIC RISKS FOR MEN AND WOMEN

The large-scale production of liquid biofuels and the conversion of significant portions of land to energy crop plantations have begun only recently in developing countries. Thus, there is a lack of data (including sex-disaggregated data) on the socio-economic effects of such phenomena. However, based in part on evidence from other forms of commercial agricultural production, a few hypotheses can be made about the potential gender-differentiated risks associated with the establishment of large-scale plantations for biofuels production.

Large-scale plantations for the production of liquid biofuels require an intensive use of resources and inputs to which smallholder farmers (particularly female farmers) traditionally have limited access. These resources include land[8] (see box 2) and water, plus chemical fertilizers and pesticides to which women do not readily have access[9]. In most developing countries, there are significant gender gaps particularly in land ownership. For instance, in Cameroon, while women undertake more than 75 percent of agricultural work they own less than 10 percent of the land. In Brazil, the percentage of land owned by women is 11 percent, while, in Peru, it is slightly higher (13 percent). Similar disparities have been identified in Tanzania, Kenya, Nigeria and other countries in Sub-Saharan Africa (UNICEF, 2007). In addition, women, due also to the impossibility (in most cases) of using land as a collateral, generally lack access to formal credit schemes, thus being limited in their ability to acquire such productive inputs (FAO, 2004; World Bank, 2003). In Nigeria, for instance, only three

[8] Gender disparities in access to land are discussed more in depth in box 2.

[9] Indigenous peoples tend to have limited (if any) access to land as well. Land rights are one of the most contested and violated rights of these peoples (Tauli-Corpuz and Tamang, 2007). In East Asia, particularly Malaysia and Indonesia, the rapid expansion of palm oil plantations has been accompanied by violations of the rights of smallholder farmers and indigenous people, and, in some cases, by the displacement of the latter (UNDP, 2007; GRAIN, 2007).

percent of women receive credit from banks, against 15 percent of men; moreover, although the average value of the loan obtained by women is only 42 percent of that of men, the percentage of collateral required is regularly higher for women (Saito, 1994). Therefore, female-headed households, in relation to male-headed households, might face more barriers to accessing the market for these external inputs[10] and thus participating in biofuels production. The economic development and income-generating opportunities created by the increasing demand for biofuels might in the beginning benefit men (and male-headed households) more than women (and female-headed households), due to underlying differential access to resources which would need to be addressed over time.

Liquid biofuels production might contribute to the socio-economic marginalization of women and female-headed households through another process. The growing global demand for liquid biofuels, combined with the high land requirement that characterizes the production of such fuels, might put pressure on the so-called "marginal" lands, providing an incentive to convert part of these lands, which may be perceived as less important and of less 'use', to biofuels production. The Government of India, for instance, through its National Mission on Biofuels, aims to bring around 400,000 hectares of marginal lands under cultivation of non-edible oil seed crops (mostly jatropha) for biodiesel production (Rajagopal, 2007). These marginal lands (also called "wastelands") are considered to provide little economic or ecological benefits. As shown in several studies, however, these lands, the majority of which are classified as common property resources (CPRs) in India, represent an integral part of the livelihood of rural poor, to which they supply essential commodities such as food, fodder, fuelwood, building materials, and so on (Rajagopal, 2007). So-called marginal lands provide therefore key subsistence functions, particularly to the most vulnerable (GBEP, 2007). According to Gundimeda (2005), in India, common property resources contribute between 12 percent and 25 percent of poor households' incomes - the poorer the household, the higher the contribution[11].

Marginal lands are particularly important to women. There is evidence, for instance, that in several Sub-Saharan African countries, women are often allocated low quality lands by their husbands. It has been documented, for example, that in Côte d'Ivoire and in the northern part of Ghana, women tend to be allocated land that has already been under cultivation for several consecutive years and is therefore low in fertility[12] (Lubbock, 1998; Dey Abbas, 1997). Another study has also found that, in Burkina Faso, women tend to be pushed to marginal plots as a consequence of environmental problems affecting the quality of agricultural land (Saito *et al.*, 1994). On marginal lands, women have traditionally grown crops for household

[10] According to Saito *et al.* (1994), female-headed households in Nigeria possess less than half of the farming equipment owned by male-headed households, while in Burkina Faso most female-headed households can only rely on hand tools.

[11] According to Gundimeda (2005), CPRs, being accessed more by the poor than by the rich, contribute to rural equity. For more on the concept of "marginal" lands and a description of the activities traditionally performed on them by women, see: FAO (2004); FAO (2004b); and Wooten (2003).

[12] Further research is needed in order to understand the factors driving the processes described in these studies.

consumption, rituals and medicinal uses. The conversion of these lands to plantations for biofuels production might therefore cause the partial or total displacement of women's agricultural activities towards increasingly marginal lands[13], with negative repercussions for women's ability to meet household obligations, including traditional food provision and food security. Furthermore, if land traditionally used by women switches to energy crop plantations, the roles men and women play in decision-making concerning household agricultural activities may be altered. In particular, women's ability to participate in land-use decision-making may be reduced as the amount of land they control will decline (FAO, 2004; FAO, 2004b; Wooten, 2003).

Box 2
Gender differences in access to land: what does the evidence say?

Land is the basis for shelter, food production and several other socio-economic activities. For this reason, access to land is a prerequisite for participating in many income-generating activities (as well as gaining access to credit) and benefiting from them. Although aggregate data are not available, it is well established that women in developing countries tend to be disadvantaged in terms of property rights and security of tenure in comparison to men. In some developing countries (such as Burkina Faso), there are statutory laws preventing women from holding rights to land independently of their husbands or male relatives. Also when national legislations do provide for women's independent land rights, mechanisms to implement and enforce them are often absent and customary norms tend to prevail (e.g. in Uzbekistan and Zambia). Such norms tend to limit women's direct access to land through purchase or inheritance. Only in a very limited number of instances, both statutory laws and customary norms recognize men's and women's equal access to land (and sons' and daughters' equal inheritance rights)[14].

In Sub-Saharan Africa, historically women have enjoyed access rights to land through a male relative, depending on the lineage system in particular communities. In North Africa and the Middle East, inheritance laws and practices are mostly based on the *Sharia* law, according to which the woman's share of land is half that of a man when there are both female and male heirs. In South Asia, land is acquired through inheritance, which is passed, in most places, through the male line. Finally, in Latin America[15], women become landowners mainly through inheritance, which has historically been skewed toward men[16].

Unequal rights to land create an uneven playing field for men and women (and male- and female-headed households), who will not have the same opportunities to be involved in biofuels production and to benefit from it.

[13] As land values increase in biofuel producing regions, the poor are more likely to be displaced from their land (GBEP, 2007).
[14] FAO (2006); FAO (2002); FAO/IFAD/International Land Coalition (2003).
[15] Only an estimated four to 25 percent of the beneficiaries of Latin American land reforms in the 1960s and 1970s were women (Crowley, 2001).
[16] UN Millennium Project (2005); Deere and León (2003).

2 ENVIRONMENTAL IMPACTS AND ASSOCIATED GENDER-DIFFERENTIATED RISKS

Feedstock production is the most important factor in determining the sustainability of liquid biofuels production (GBEP, 2007). The growing use of agricultural commodities for the production of such fuels and the establishment of large-scale energy crop plantations might exacerbate the pre-existing competition for land between forests, agricultural and urban uses, leading to deforestation[17] (e.g. in Indonesia[18] and Malaysia). In addition, energy crop plantations might expand into areas rich in biodiversity, such as riparian areas and peatlands[19]. Finally, large-scale biofuels production may replace low-productivity agricultural areas (which are characterized by a high biodiversity value) with biodiversity-poor monocultures[20] (UNEP, 2007). Each of these processes would cause a biodiversity loss[21], whose magnitude will depend on the type of crop grown, what it is replacing and the methods of cultivation and harvesting (UN-Energy, 2007).

This potential loss of biodiversity might affect men and women differently. The establishment of large-scale plantations for the production of liquid biofuels on fallow fields and wildlands may threaten, in particular, the wild edible plant species that grow on these lands. This

[17] According to the World Energy Outlook (IEA, 2006), the area of cropland devoted to liquid biofuels production will increase from the current 1 percent to 2-3.5 percent by 2030 (when using current technologies).

[18] In Indonesia, according to Colchester et al. (2006), there were around 18 million hectares cleared purportedly for oil palm in 2006. This is causing a considerable biodiversity loss and is seriously endangering, for instance, the survival of orangutans, which are native to this region (Nellemann *et al.*, 2007).

[19] In Brazil, the increase in the area under cultivation, due also the growing production of bioethanol, is jeopardizing entire ecoregions, including the Cerrado, one of the world's biodiversity hot spots (UNEP, 2007).

[20] The socio-economic effects of this process are described in the next section.

[21] Some of these processes, particularly deforestation, also cause significant greenhouse gas emissions. CO_2 emissions from conversion of peat swamp forests, in particular, are far greater than the gains from the substitution of fossil fuels with palm oil (Nellemann *et al.*, 2007). There is growing evidence that biofuels may cause more emissions than traditional fossil fuels, if they are produced unsustainably (Fargione *et al.*, 2008).

would have negative repercussions on poor rural households, who are largely dependent on natural resources and biodiversity for their food security and livelihoods, particularly in areas prone to food shortages (FAO, 1999; IUCN/DFID, no date). The loss of wild edible plant species would also threaten the knowledge and skills associated with the collection and the utilization of such species, particularly among women, who are often responsible for their collection, preparation and consumption and thus have a more highly specialized knowledge than men of wild plants used for food, fodder and medicine (FAO, 1999).

The potential biodiversity loss associated with biofuels production might also lead to a "narrowing of future options", through the loss of genetic information and genetic material (and of the associated knowledge) that could be introduced into domesticated crops and stock through breeding (IUCN/DFID, no date).

Another important aspect concerns the potential depletion of natural resources (including land and water degradation) due to the high input requirement of energy crop plantations. There is evidence, for instance, that the production of bioethanol may require considerable amounts of water, especially in certain countries[22]. In China, for example, it takes (on average) 2,400 liters of irrigation water to produce the amount of corn for one liter of ethanol, versus 400 liters in the US (where mainly rainfed corn is used). Similarly, while in Brazil it takes 1,150 liters of water to produce the amount of sugarcane for one liter of ethanol, in India (where sugarcane yields and conversion efficiencies are lower) 3,500 liters of water withdrawals are required (De Fraiture *et al.*, 2007). Large-scale plantations for biofuels production may also be associated with increased soil and water pollution (from fertilizer and pesticide use), soil erosion and water run-off, with subsequent loss of biodiversity (UNEP, 2007).

The potential depletion (or degradation) of natural resources associated with biofuels production may place an additional burden on rural farmers' work and health, in particular on female farmers. In a study of three Sub-Saharan African countries, Rosen and Vincent (1999) found that women spend, on average, more time than men on water provision: 700 hours a year in Ghana, 500 hours in Tanzania, and 200 hours in Zambia; women also tend to collect higher volumes of water compared to men. According to another study (Malmberg Calvo, 1994), women spend, on average, more than 800 hours a year in Zambia and about 300 hours a year in Gambia and Tanzania collecting firewood. If biofuels production competes, either directly or indirectly, for water and firewood supplies, it could make such resources less readily available for household use. This would force women, who are traditionally responsible, in most developing countries, for collecting water and firewood, to travel longer distances, reducing the time available to them[23] to participate in decision-making processes and income generating activities (Lambrou and Laub, 2006).

[22] Other claims on water resources are growing as well, particularly for urban water supplies, and water scarcity is already acute in many regions (UNEP, 2007).

[23] Firewood collection times have risen due to the increasing scarcity of locally available biofuels (Barnes and Sen, 2003).

3 AGRO-ECOSYSTEM SIMPLIFICATION AND ASSOCIATED GENDER-DIFFERENTIATED RISKS

The replacement of local crops with large-scale mono-cropping for the production of liquid biofuels might lead to the simplification of agro-ecosystems[24]. This would cause a reduction in the level of agro-biodiversity, which can be defined as the variety and variability of animals, plants and micro-organisms – including crops, livestock, forestry and fisheries – that are used directly or indirectly for food, fodder, fiber, fuels and pharmaceuticals (FAO, 2004a).

With fewer crop varieties and species grown over large areas, there might be an increase in the susceptibility of agro-ecosystems to disease and pests, making such systems more dependent on pesticides (IUCN/DFID, no date). This would further increase farmers' reliance on external inputs – with the associated gender-related impacts already discussed – exposing such farmers to potential market shocks such as rapid increases in the prices of these inputs. The livestock sector may be particularly affected by the production of liquid biofuels. This is due to the potential conversion of part of the grazing lands to energy crop plantations, and to the increase in the price of livestock feed caused by the growing demand for agricultural commodities for the production of biofuels. This rising demand might also give rise to a potential competition for land between food and feedstock production. The land-use changes associated with the establishment of large-scale energy crop plantations might affect, in particular, ruminant production (cattle, sheep and goats), which depends critically on the availability of grazing lands.

[24] For a discussion of the gender-differentiated impacts of a shift from subsistence farming to sugarcane monoculture on agro-biodiversity, local knowledge and food security in Swaziland, see Lupupa *et al.* (forthcoming).

The processes described above would make farming systems less stable, robust, and sustainable, reducing the resilience of rural livelihoods to both bio-physical and socio-economic shocks. These shocks include pathogen infestation, uncertain rainfall, fluctuation in the price of cash crops and external inputs, and socio-political disruption (Lambrou and Laub, 2006).

The resilience of rural livelihoods might be further reduced by the decline of traditional local knowledge linked to the loss of agro-biodiversity. Women, in particular, tend to have specialized knowledge about the patterns and uses of local agro-biodiversity (Howard, 2003). The replacement of local crops with energy crop plantations would threaten especially the extensive knowledge and the traditional set of skills of smallholder farmers in the management of local crops. It would also threaten the knowledge related to the selection and storage of seeds and crops, all activities traditionally performed mainly by women (FAO, 1999).

The potential reduction in the number and the variety of animals (particularly ruminants) raised by smallholder farmers, due to biofuels production, would contribute to the decline of traditional local knowledge. This process would threaten, in particular, the knowledge related to the use of different animals and animal-derived products (as well as to animal breeding) particularly among men, who are often responsible for the management of large ruminants such as buffalos and cattle (while women and children are often responsible for smaller livestock such as poultry) (FAO, 2006a).

4 EMPLOYMENT OPPORTUNITIES AND DISCRIMINATORY WORKING CONDITIONS ON PLANTATIONS

The growing global demand for liquid biofuels has been seen as a way to create new employment opportunities in rural areas, thus leading to increases in income generation and rural development. In Brazil, for instance, around one million workers (of which only 14 percent were female in 1995[25]) are employed in sugarcane production (which is directly related to bioethanol production), while in China the liquid biofuel programme is expected to create more than nine million jobs in the next few years (Bhojvaid, 2006; Moreira, 2005; Balsadi, 1998).

However, with the increasing mechanization of agricultural production that is occurring in most developing countries[26] (mainly on large-scale plantations), the number of agricultural jobs associated with the production of liquid biofuels is likely to decrease over time[27]. A sugarcane harvester (a machine), for instance, can replace up to eighty cutters (people). In some southern African countries, however, there are also mixed systems in place, in which a machine cuts the cane that is then collected and gathered manually. This mixed system may be particularly suitable for biofuels production, since the gathering of residues can be done at the same time that cane is gathered. As the cutting of the cane is the hardest part physically, this type of system would also contribute to opening up the labour force for women (Johnson and Rosillo-Calle, 2007).

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[25] In the same year (1995), women represented about half of the workforce in the vegetable sector in Brazil (Balsadi, 1998).

[26] Mechanization has occurred at a faster rate where labour costs have increased, such as in part of Latin America, in some Asian countries and in South Africa (Johnson and Rosillo-Calle, 2007).

[27] According to Schmidhuber (2006), bioenergy production may reduce poverty and hunger when it is labour-intensive and, at the same time, capital- and technology-saving (i.e. it does not require large investments and an intensive use of advanced technologies).

Other important factors to be assessed are the working conditions and the health and safety risks associated with the agricultural jobs created by the expanding biofuel industry. It has been argued that a large share of these jobs would be of poor quality and conditions and targeted mainly to low-skilled seasonal agricultural workers (often migrants), who tend to be particularly vulnerable (SDC, 2006). Specific studies and data on the working conditions on dedicated energy crop plantations are still scarce. However, the cultivation of biofuel feedstocks such as sugarcane and palm oil has been linked, in several developing countries, to unfair conditions of employment, health and safety risks, child labour and forced labour (Dufey, 2006; ProForest/IIED, 2003).

There is also evidence that, in some cases, working conditions on plantations (including those of biofuel feedstocks) tend to have a differentiated gender impact. Landowners tend to prefer women workers, as they are able to pay them less than their male counterparts[28] and find them a docile and dependent workforce, and are therefore more exploitable (ILO/FAO/IUF, 2007). According to a recent report by Oxfam (2007), in Brazil sugarcane plantation workers are prevalently employed on piece-rate arrangements, that is are paid according to how much sugarcane they manually cut. It is well known that piece rate work can contribute to child labour and also discriminate against women, especially when they are drawn into unpaid work in order to help their husbands meet production targets, such as reported by Oxfam on Indonesian palm oil plantations (Oxfam, 2007).

Women working on plantations generally tend to be disadvantaged, compared to men, also in terms of employment benefits and exposure to occupational safety and health risks. A significant (and growing) number of agricultural workers in developing countries are employed on a seasonal and often a casual or temporary basis (with limited, if any, social security, including medical assistance); an increasing share of these workers are women. Reliable data on the share of women waged agricultural workers are difficult to obtain, given the prevalence of informal labour arrangements. There is evidence, however, that this share has been rising worldwide and women now account for 20-30 percent of total waged agricultural workers. In Latin America and the Caribbean, the figure is 40 percent, while, in African countries, this percentage is likely to be higher (ILO/FAO/IUF, 2007). There is evidence that women tend to receive on average less training and instruction than men, they often do repetitive work that can result in health problems, and face reproductive hazards as a result of exposure to agrochemicals (Loewenson, 2000). In Malaysia, for instance, women, who represent about half the workforce on plantations, are often recruited as sprayers of chemical pesticides and herbicides, without proper training and safety equipment. This may have serious implications for the long-term health of these women workers (Oxfam, 2007).

[28] The gender gap in earnings is particularly high in informal employment, such as casual and subcontracted labour (ILO, 2002).

5 INCREASED FOOD INSECURITY FOR MEN AND WOMEN

A number of developing countries that produce, or have the potential to produce, biofuels (or simply biofuel feedstocks) are also food insecure. For this reason, it is important to assess the potential impacts of biofuels production on the food security of men and women living in these countries.

The establishment of energy crop plantations and the impacts of the increasing demand for liquid biofuels on food prices might affect at least two key dimensions of food security – availability and access (Nyberg and Raney, 2007). This could have gender-differentiated impacts.

As discussed above, large-scale plantations for biofuels production, with their high input requirements, "could threaten the availability of adequate food supplies by diverting land and other productive assets [such as water and chemical fertilizers and pesticides] away from food crops[29]" (UN-Energy, 2007, p. 33). Energy crop plantations, due to their high profitability, may be established on high-quality lands, leaving subsistence crops to the low-quality lands (UN-Energy, 2007) In addition, biofuels production may negatively impact the livestock sector, which is key to the food security of rural households, through a reduction in the availability of land for grazing and an increase in the price of fodder (due to the growing use of agricultural commodities for biofuels production). The potential loss of both biodiversity and agro-biodiversity discussed in the sections above presents risks to food production as well, posing a serious threat to rural livelihoods and long-term food security. In particular, the potential deforestation associated with the establishment of large-scale plantations for biofuels production may negatively impact the peoples who depend on such forests for their livelihoods, increasing their food insecurity[30].

[29] This is problematic due also to the continued increase in the global demand for food. By 2050, this demand is expected to grow by between 2.5 and 3.5 times the current figures (UNEP, 2007).

[30] For instance, the area of three million hectares that the Government of Indonesia is planning to convert into palm oil plantations in Borneo (under the Kalimantan Border Oil Palm Mega-Project) includes forests used by

Biofuels production might also have gender-differentiated impacts on food access, through both price and income effects. There is growing evidence that the increasing demand for agricultural commodities for the production of liquid biofuels is contributing to reverse the decrease in the price of both agricultural commodities and food that has occurred in the last few decades. This may have negative food security impacts, particularly for households that are net purchasers (as well as countries that are net importers, including most Least Developed Countries[31]) of agricultural commodities and food (OECD/FAO, 2007; Schmidhuber, 2007). This implies that, on one hand, rural households actively involved in the cultivation and the sale of crops for the production of biofuels would stand to benefit, also in terms of access to food, from an increase in the price of agricultural commodities (through an income increase). On the other hand, urban households and rural households who are net purchasers of food and are excluded from biofuels production (especially female-headed households), may be negatively affected by an increase in the price of food; in particular, the access to food of these households may be reduced.

The rising demand for liquid biofuels could also make the prices of agricultural commodities and food more unstable, exposing a significant number of households and individuals to the risk of food insecurity (Schmidhuber, 2007; UN-Energy, 2007). Sudden increases in food prices would have negative repercussions in particular for poor households and vulnerable groups, particularly women and female-headed households, which tend to be particularly exposed to chronic and transitory food insecurity, due also to their limited access to income-generating activities.

The potential loss of biodiversity and agro-biodiversity associated with biofuels production would also affect the relative contributions of men and women to the food security of rural households. As already discussed above, the establishment of energy crop plantations on "marginal" lands might negatively affect women's ability to meet household obligations, including traditional food provision and food security[32]. The establishment of such plantations might also lead to a loss of wild edible plant species, which women are usually responsible for collecting and preparing and which play a key role in the food security of rural households (FAO, 1999). At the same time, biofuels production might also affect men's contribution to household food security, due to its potential negative impact on ruminant production (cattle, sheep and goats), which men are often responsible for. The combination of these processes would have a negative impact on the food security of rural households.

[31] Most Least Developed Countries (LDCs) are net importers of both agricultural products (38 out of 52 in 2002/04) and food (43 out of 52) and have rapidly growing multibillion trade deficits for both these commodities (Schmidhuber, 2006).

[32] In developing countries, rural women produce 60-80 percent of the food. In Sub-Saharan Africa and in the Caribbean, women produce about 80 percent of household food, while in Asia women perform 50-90 percent of work in rice fields (rice represents one of the main staple crops in Asian countries) (UN Millennium Project, 2005).

Box 3

Cassava-based bioethanol: a threat to the food security of the world's poor[33]

Cassava is a tropical potato-like tuber, also called "manioc". In many tropical countries, it serves as an important reserve when other crops fail (due mainly to its resistance to droughts) and is the food people turn to when they cannot afford anything else. In Africa, in particular, cassava represents the primary staple for more than 200 million poor people and provides around one third of the caloric needs of the population in Sub-Saharan Africa. Cassava, thanks to its high-starch content, is also an excellent bioethanol feedstock. As the conversion technology improves, many countries, including Thailand, China, and Nigeria, are considering using increasing quantities of this crop to produce bioethanol. The production of cassava-based bioethanol may seriously compromise the food security of the poorest among the poor, leading to an increase in the number of poor people struggling to feed themselves.

[33] This box is based on: Runge and Senauer (2007).

6 SUMMARY OF FINDINGS

This paper shows how the potential environmental and socio-economic risks associated with large-scale production of liquid biofuels in developing countries might affect men and women (at the intra-household level) and male- and female-headed households differently, depending also on the specific socio-economic and policy context considered. This reflects men and women's different roles and responsibilities, as well as pre-existing gender-based, socio-economic inequalities, particularly in terms of access to and control of land and productive assets in general, as well as historic discriminatory practices. As was discussed, liquid biofuels production might even exacerbate such inequalities, contributing to the socio-economic marginalization of women and female-headed households and threatening their livelihoods, with negative implications in particular for their food security. Men and women might also have different employment opportunities and conditions on plantations of biofuel feedstocks, and might therefore be exposed to different work-related health risks. The environmental and socio-economic risks associated with biofuels production might also lower the resilience of rural communities and individuals to exogenous shocks, for instance reducing their ability to cope with the impacts of climate change. This would be the case in particular for women and female-headed households (which are already among the most vulnerable to the impacts of climate change[34]), if liquid biofuels production threatens their socio-economic activities, their natural resource base, and associated knowledge.

[34] See FAO (2007).

7 RECOMMENDATIONS: MINIMIZING THE RISKS TO MAXIMIZE THE OPPORTUNITIES

7.1 RESEARCH

More research is needed on the **identification and substantiation** of the potential **gender-differentiated, socio-economic risks and opportunities** of liquid biofuels production at both the intra-household level (i.e. on both men and women) and the inter-household level (i.e. on male- and female-headed households). The **generation** of reliable **sex-disaggregated data** on the socio-economic effects of liquid biofuels production is essential for **testing the hypotheses** discussed in this paper.

A **field-assessment** of the gender-differentiated effects of liquid biofuels production should be conducted among a **sample of households** from selected geographical areas and with different socio-economic characteristics (e.g. household income, age and gender of household members, etc.). The **employment opportunities** and **working conditions** on biofuel feedstock plantations, and the associated **health and safety risks**, need to be evaluated as well, through the collection of **sex-disaggregated data**.

As **second-generation liquid biofuels** (and policies supporting their production) start to be developed, it is important to **investigate** and take into account the **potential gender-differentiated risks and opportunities** associated with these new technologies. Second-generation liquid biofuels are expected to have different socio-economic and environmental implications compared to first-generation biofuels. Although these technologies, being based on lignocellulosic feedstock, should not compete with food production to the same extent as first-generation crops (such as maize and sugarcane), they may put additional pressure and cause additional stress on forest resources. These hypotheses need to be verified over time and in different ecological and socio-economic contexts.

7.2 POLICY

In order to ensure that liquid biofuels production benefits men and women in developing countries, policies should be adopted in these countries to **reduce the potential environmental and socio-economic risks** (with their **gender-differentiated impacts**) of liquid biofuels production discussed in this paper. This would also ensure the consistency of biofuel development policies with the Millennium Development Goals, particularly Goal 1 (Eradicate extreme poverty and hunger), Goal 3 (Promote gender equality and empower women), and Goal 7 (Ensure environmental sustainability).

At the international level, **rules governing the international liquid biofuels market should be agreed on and adopted**, and the **social and environmental sustainability** of biofuels production **should be ensured**. This could be done by establishing one or more of the following: codes of conduct, voluntary schemes, certification, bilateral agreements, and multi-lateral frameworks[35](UN, 2007). A number of national and international initiatives aimed at ensuring the sustainability of biofuels production and processing are already underway, such as the International Bioenergy Platform (IBEP) and the Global Bioenergy Partnership (GBEP), both housed within FAO, and the Roundtable on sustainable biofuels[36].

The **social and environmental sustainability of biofuels production** (i.e. goals 1 and 3) **should be pursued through an integrated approach**. This approach may consist, for instance, of measures aimed to promote the adoption of sustainable farming practices[37] and the use, for the production of biofuels, of perennial, non-edible crops like jatropha. Some of these crops require relatively low water inputs and, if grown on degraded lands[38], they may reduce some of the potential tensions between fuel and food production. However, the use of perennial crops for the production of liquid biofuels presents some drawbacks as well. For instance, the long maturation phase that characterize perennial crops (up to four years for jatropha and up to eight years for pongamia), combined with the uncertainties associated with their cultivation and marketing, limit their adoption by smallholder farmers (Rajagopal, 2007).

In order to **ensure that biofuels production contributes to reduce poverty and hunger**, policies should be adopted, in developing countries, to **strengthen the participation of smallholder farmers** in biofuels production (particularly biofuel feedstock production), by increasing their access to land, capital and technology. This could be done, for instance, by promoting the establishment of cooperatives, to which both men and women, as well as male- and female-headed households, should have equal access. By organizing themselves in cooperatives,

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[35] According to the UN, priority should be given to flexibility and scope for incremental improvements (UN, 2007).
[36] For a description of these and other initiatives, see GBEP (2007).
[37] Several studies have shown that ensuring the environmental sustainability of liquid biofuels production is essential for exploiting the greenhouse gas mitigation potential of such fuels (see, for instance, Fargione *et al.*, 2008).
[38] Jatropha, for example, can be grown on degraded lands and improve the quality of such lands by storing moisture and stabilizing soil (UN-Energy, 2007; Dufey, 2006). However, jatropha yields per hectare are considerably higher if it is grown on high quality land and it gets irrigated during the initial few years of development (5.25 – 12.5 tonnes per ha with irrigation vs. 1.2 – 2.77 tonnes per hectare without) (Rajagopal, 2007).

smallholder farmers might also take advantage of the economies of scale associated with biofuels production[39]. This would reduce the risk that the economies of scale sought by producers and subsequent land concentration (as in the case of Malaysia[40]) may further reduce access to land by the poor (Peskett *et al*., 2007). The participation of smallholder farmers in biofuels production could also be supported through the Kyoto Protocol's Clean Development Mechanism. To this goal, a small scale CDM methodology for liquid biofuels should be established (Peskett et al., 2007).

In order to implement a **pro-poor biofuel development strategy**, developing countries should also adopt measures aimed to ensure that the establishment of dedicated energy crop plantations **integrates** – rather than replaces – **existing local agri-food systems**. A key objective of these policies should be to **protect smallholder farmers' traditional agricultural activities, skills and specialized knowledge**, which are crucial to the food security and long-term resilience of rural communities. One of the possible measures would be to promote the small-scale cultivation of multi-purpose, short-duration annual crops that can either be grown in rotation with food crops or simultaneously yield fuel along with food and/or fodder (Rajagopal, 2007). This would have the advantage of providing additional seasonal income for smallholder farmers, without dismantling their existing livelihoods[41] (Johnson and Rosillo-Calle, 2007).

The **biofuels strategies** that are currently being developed and implemented in several countries around the world, mostly as part of broader climate change mitigation policies, should be **gender-sensitive**. They should take into account the gender-differentiated effects of liquid biofuels production in order to maximize the potential synergies (and reduce the trade-offs) with other policies and their respective goals, such as sustainable rural development and gender equality.

Biofuel development policies should also be consistent with (and, possibly, contribute to) **the promotion of gender equality and the empowerment of women**. To this goal, measures should be taken to ensure that **women and female-headed households** have the same **opportunity** as men and male-headed households to **engage in and benefit from the sustainable production of liquid biofuels**. This is important, especially in light of the increasing feminization of the agricultural workforce and the growing number of households headed by females (42 and 35 percent of the total, respectively, in Southern Africa and the Caribbean[42]), particularly in the poorer and more food insecure countries of the world, (Deutsch et al., 2001) often due to male

[39] Economies of scale are particularly important in the production of biofuel feedstock, which represents the largest cost of biofuels production (Peskett *et al*., 2007).

[40] In some countries, the production of biofuel feedstock is heavily concentrated. In Malaysia, for instance, 60 percent of the area under palm oil production is owned by corporations, while only nine percent of it is owned by individual landowners (GRAIN, 2007). The concentration, in this sector, is expected to continue to increase in most tropical and sub-tropical developing countries, due to the multi-billion investments that several multinational groups are currently undertaking in biofuel development projects (GRAIN, 2007).

[41] Several studies have shown that ensuring the environmental sustainability of liquid biofuels production is essential for exploiting the greenhouse gas mitigation potential of such fuels (see, for instance, Fargione *et al*., 2008).

[42] (UNDESA, 2000).

out-migration or loss of male labour force due to HIV/AIDS (FAO, 2004c). Ensuring women have increased access to and control over land and other productive assets would improve women's welfare and their bargaining power within the household, and would also enhance agricultural productivity. According to Alderman et al. (1995), if men and women farmers in Burkina Faso were given equal access to quality agricultural inputs (as well as education), agricultural productivity could rise by as much as 20 percent. Ensuring equal opportunities for men and women would entail reducing (and eventually eliminating) pre-existing gender-based, socio-economic inequalities, particularly in terms of access to and control of land, credit and productive inputs, as well as ensuring decent and equal employment opportunities and conditions for female and male plantation workers.

When pursuing **biofuels development strategies**, there is also a strong case for considering how such strategies could **affect the abilities of women and female-headed households to adapt to climate change impacts**, in comparison to men and male-headed households. Ignoring these gender concerns would reinforce the "differential gender dimensions of vulnerability" (Denton, 2004). As shown in this paper, efforts to mitigate climate change through the promotion of liquid biofuels production can reduce people's socio-economic resilience (especially among the most vulnerable groups, including women), weakening their ability to cope with exogenous shocks such as climate change. Making sure that biofuels production is beneficial to both men and women in developing countries would therefore strengthen their ability to cope with the impacts of climate change. This would also ensure a better integration between climate change mitigation policies and adaptation needs[43].

[43] Policy-makers have recently acknowledged the need to examine climate change mitigation and adaptation in tandem, so as "to explore trade-offs and synergies between the two responses" (IPCC, 2007, WG III, Ch. 18).

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