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TECHNOLOGICAL CHANGE AND PRODUCTIVITY GROWTH FOR FOOD SECURITY: THE CASE OF SHIFTING CULTIVATION AND THE REDD POLICY

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ABSTRACT

In many parts of the forest-agriculture frontiers of the tropics, shifting cultivation is practiced as a way of subsistence farming. In particular, widespread poverty and rural population growth are the prevalent causes that aggravate the need for encroaching into the forestland for subsistence farming in these frontiers. In such areas, economic policies and technological change to improve agricultural productivity are vital to avoid the expansion of agriculture by means of shifting cultivation. In particular, as we are in the age of global climate change, resource use and management practices that rely on the use of land clearing and biomass burning, thus emitting carbon into the atmosphere must get our careful attention, despite the need to bring more land under cultivation for enhancing food security. This situation is quite challenging and requires much more careful attention in the case of shifting cultivation practiced in some Asian and African countries. For instance, shifting cultivation by land clearing and biomass burning recycles phosphorous and other nutrients but contributes to deforestation, emission of greenhouse gases, loss of biodiversity, and increased soil erosion and land degradation, etc, and as yet is an important livelihood and food security strategy for millions of smallholders.

Because shifting cultivation is so different from the forms of agriculture mostly practiced in the lowlands, and by majority population, it is one of the most misunderstood land use systems. Therefore, in the name of forest conservation and land development, governments in Asia and Africa have devised ad-hoc policies and laws seeking to eradicate

shifting cultivation. The reasons usually given for such restrictive state policies are that shifting cultivation is: technologically primitive to improve agricultural productivity; prevents development and thus keeps people trapped in poverty; destructive to forests and soils; and contributing to global greenhouse gas (GHG) emissions by deforestation. However, by adapting appropriate technology and agronomic practices agricultural productivity can be improved in those tropical areas. Such technological changes for more productive and environmentally friendly agriculture, by means of zero tillage/reduced tillage, mulching, integrated plant nutrient management using both organic and mineral fertilizer, improved crop rotations, and improvements in water productivity can not only avoid shifting cultivation, but also contribute to food security, rural livelihood, poverty alleviation, improved soil fertility, and reduced GHG emissions from deforestation. In particular, agricultural productivity can be improved by provision of input subsidies for mineral (inorganic) fertilizers to build on sound ecological principles and agronomic practices; access to finance and micro-credit; improving the infrastructure; capacity development for men and women farmers; and research and development targeting poor rural areas and addressing emerging questions of agro-defence.

This chapter therefore discusses the opportunities for technological change in agriculture by rethinking the Agricultural Input Subsidy Programs (as economic-policy reforms) in Asian and African countries, as well as the new financial incentives arising from REDD (as Payments for Environmental Services from UN-REDD program) for those countries for a land use transition towards more intensified agriculture. It is argued that unlocking the potential of ecosystem markets can provide new income to the farmers for the services they provide anyway, while safeguarding the resource quality and enhancing food security.

Keywords: Economic incentives, carbon credits, subsidy, REDD, environmental quality

1. INTRODUCTION

Deforestation often results from poverty and population growth and the need for land for subsistence farming in rural areas. Policies to improve agricultural productivity could avoid deforestation in those areas and reduce the emissions from deforestation. Tropical deforestation is largely caused by demand for subsistence food crops, especially in Africa. But in Latin America, commercial cattle ranching and soya cultivation are significant drivers. In South East Asia, palm oil and wood pulp production along with large scale timber extraction (logging) are the major causes. At present, the major deforesting nations (by CO_2 emissions) are Indonesia, Brazil, Malaysia, Burma, the Democratic Republic of Congo and Zambia. Together these nations account for over two thirds of emissions from deforestation (WRI, 2009). It is estimated that small scale agriculture by shifting cultivation contributes nearly 45 percent of total area deforested (UNFCCC, 2007). For such areas, policies to improve agricultural yields are necessary to reduce the negative effects of deforestation. It is concerned that improving agricultural productivity could play as big a role in reducing CO_2 emissions as the development of new energy technologies (Wise *et al.,* 2009). Thus policies aiming at improving agricultural productivity and small holder's income can significantly reduce the negative effects of deforestation by shifting cultivators.

Deforestation is considered to be one of the priority environmental problems in some Asian and African countries. Forests and woodlands conversion to agriculture is the main cause of forest loss in these countries. In particular, deforestation by means of shifting cultivation (*slash and burn faming system*) is practiced predominantly in some African and Asian countries, for example, in Indonesia (Angelsen, 1995), India (Jyotishi, 2008), Nepal (Kafle, 2011), Zambia (Kepekele, 2006) and Tanzania (Reed, 1996). Although poverty and rural population growth are usually blamed for deforestation in those countries, the governments economic liberalization policies, such as the Structural Adjustment Programs (SAP) adopted in the 1990s, are the other drivers (causes) that influence forest conversion to agriculture (Reed, 1996). Studies have evidenced the increase in deforestation by the adoption of economic liberalization policies. For example, for many of the Sub-Saharan African countries, withdrawal of agricultural subsides and currency devaluation have caused the expansion of area requirements for crops grown on newly cleared forest land as well as increase in the practice of shifting cultivation (Reed, 1996; Kakeya *et al*., 2006; Kapekele, 2006). It is therefore imperative that agricultural development policies address the factors contributing to the shifting cultivation.

The term shifting cultivation is used to describe a wide range of land-use systems practiced in tropical developing countries, where fallow is a main component for restoring the systems productivity - generally a shorter cropping period of 1-3 years followed by a longer fallow period of 5-20 years. For poor farmers in the tropical developing countries shifting cultivation has been considered as a rational economic and environmental choice, however, the accusations are that shifting cultivation keeps people in poverty and causes environmental degradation (Fox, 2000; Ickowitz, 2006). Therefore, preventing the shifting cultivation and land use transitions towards more intensified agriculture can beneficial. It would be more appropriate if the REDD mechanism reward for this land use transition than simply focusing on the natural forest conservation (Mertz, 2009).

Very few studies relates specifically the problem of shifting cultivation for the REDD mechanism. For example, a case study from Cameroon provides some insights for how a REDD mechanism can work in this type of situation. In this study the potential economic benefits of a shifting cultivation system were compared with that of compensated reductions (CR) in emissions (Bellassen and Gitz, 2008). This study estimates that under local conditions the CR would be economically feasible with a price of \$2.85 tCO_2^{-1} or higher. However the authors also acknowledge a wide range of caveats such as the need for subsistence production in an imperfect market and the problems of ensuring CR payments to farmers in a nation with high levels of corruption. The costs and benefits for shifting cultivators if the proposed REDD mechanism is implemented are therefore not well understood. Local production of staple foods should be considered as important for ensuring food security, especially in areas where market conditions do not provide adequate access to affordable food products of sufficient quantity and quality.

The objective of this chapter is therefore to highlight the financial opportunities arising from the REDD policy. Such financial opportunities are beneficial for implementing agricultural inputs subsidy programs and enhancing technological changes to improve the productivity growth and food security for the small holder farers and shifting cultivators.

This chapter is organized as follows. Section 2 provides an overview of shifting cultivation practiced in Asian and African countries. Section 3 discusses the economic policies and deforestation in Asian and African countries. Section 4 presents an economic model of agricultural production to illustrate the effects of relative (input-output) prices and technological changes on the supply responses. Sections 5 discusses the international REDD policy incentives and payments for the environmental services (such as carbon credits) that can enhance technological changes for productivity growth and food security, following by the conclusion in Section 6.

2. AN OVERVIEW OF SHIFITNG CULTIVATION IN ASIAN AND AFRICAN COUNTRIES

The forest ecosystems provide services at the local level and to the regional and global levels; therefore a forest can affect climate stability at each of these levels. The causes of deforestation are mainly at the local level but the policy-making institutions are both at the local and national level. This situation poses a serious problem for any effective policy related to limiting the rate of deforestation at a global optimum (Daly and Farley, 2004). The key to understanding tropical deforestation (and its related environmental problems) is that it entails large costs that are *not* counted by those who make the decisions at local level. In particular, shifting cultivators are usually poor or subsistence farmers and they transform nutrients stored in standing forests to soils by slashing, felling, and burning forests (i.e., slash-and-burn).

The practice of shifting cultivation first replace newly cleared forest lands by crop lands (Kleinman *et al.*, 1995) therefore it is central to the poverty-environment nexus. It is a key livelihood activity among the huge populations of small-scale tropical farmers with various cultural, ethnic, and social backgrounds, thereby tightly linked with poverty and development in tropics. Shifting cultivation is not only a major cause of tropical deforestation it also associated with forest cover change that leads to multiple environmental problems, such as soil degradation, biodiversity loss and reduced carbon sequestration, thereby conflicting with conservation efforts like protected area and community-based forest management (Fox *et al.*, 2000).

Under shifting cultivation systems farmers clear primary or secondary forests, or both. Shifting cultivators leave depleted land fallow for a period of time for soil regeneration, thereby accumulating secondary fallow forests. However, as the primary forests get scarce in tropics, greater attention is also given to the secondary fallow forests (Coomes *et al.*, 2000). Although clearing secondary fallow forests can be considered as more sustainable than clearing primary forests, short fallow results in less matured secondary forests with limited nutrient regeneration, as well as low biodiversity and weak carbon sequestration. In addition, the secondary forests are less fertile but easier to clear than primary forests (Scatena *et al.*, 1996). A comparison of primary and secondary forests therefore depends on fallow length and the availability of primary forests. An economic modelling approach for the choice between the primary and the secondary forest clearing, in an integrated framework, has not yet been conducted by economists. Shifting cultivators usually clear forests, either primary or secondary, to acquire new fertile soils and this is the key feature of the spatial model presented in this section.

Shifting cultivation is a one of the predominated agricultural system in Asian and African countries. The practice of shifting cultivation is believed to promote deforestation and carbon emission and contributing to the climate change. The slash and burn method of shifting cultivation contribute to an imbalance carbon and nutrient cycles. By continuous annual cropping systems, through conversion of shifting cultivation, brings about substantial losses of aboveground carbon stocks, reductions of soil organic carbon stocks and generally leads to declining soil quality. Shifting cultivation is also a destructive system from an energy point of view as it uses large quantities of biomass for burning. However the slash and burning of trees contributes to soil fertility in the form of ash, an alternative to the inorganic fertilizers, which the farmers would otherwise purchase. The ash is very efficient in terms of crop yield improvement and is more economical from the small-scale farmers' point of view (Holden, 1993).

However, with population growth and shorter fallow periods the lands available for shifting cultivation are shrinking (Rasmussen and Jensen, 1999). Agricultural intensification, under population pressure with increased frequency of land use for shorter fallow periods, can be viewed as the process of shifting cultivation breaking down or becoming unsustainable. On the other hand, shifting cultivation with a relatively short cropping phase and a relatively long forest fallowing phase can be considered as a rotational system in space and time. For the assumption of constant land productivity, food self-sufficiency and land scarcity, population growth would require extension of the cropping phase and shortening of forest fallow phase. This extension would however transform the shifting cultivation into the continuous cropping without fallow or sedentary cultivation (Liang *et al.*, 2009).

Further, farming in shifting cultivation lands can be quite unsustainable and unable to support adequately the livelihood requirement for the farming communities. Having shorter fallow periods are believed to cause environmental damage in the form of soil mining and accelerated erosion, and in combination with national interests in protecting forest resources for other purposes, this situation has also led to a strong resentment by governments towards shifting cultivation practices (Dove, 1996). The traditional shifting cultivation practice is also under external and internal pressures to change, since the circumstances needed for sustainable shifting cultivation systems with long forest fallow phase no longer exist in many countries (Cairns and Garrity, 1999). With increasing population pressure, the practice of long-fallow shifting cultivation becomes difficult, and short-fallow shifting cultivation with associated land degradation can be unavoidable. This poses a challenge for an alternative land use system that could make use of the logic of traditional shifting cultivation, but at the same time, maintain the land quality and improve the productivity (Liang *et al.*, 2009).

Figure 2 shows the proportions of different agricultural systems that causes deforestation in different geographical regions. The causes of deforestation vary for the regions. The causes can also vary between and within countries and are often complex in nature. As shown in Figure 2, the FAO study highlights the general regional differences of the causes of deforestation for the period 1980-2000 (FAO/UNDP/UNEP, 2008). For example, for Latin America, the primary cause of deforestation was a conversion of forests to large scale permanent agriculture. For Africa, the main cause of deforestation was conversion of forests to small scale permanent agriculture and for Asia there was a mix of the causes.

Based on the above graph, the contribution of shifting cultivation to deforestation globally is around 8%. Further, if 25% of carbon emission results from deforestation and if 8% of deforestation is due to shifting cultivation, the share of shifting cultivation in global carbon emission would be around 2%. The variation in causes of deforestation for the regions are attributed to several factors such as governance structures, land tenure systems and law enforcement, market and cultural values of forests, the rights of indigenous and local communities and the benefit sharing mechanisms, and poverty and food production policies. Therefore, policies and/or programs for reducing emissions from deforestation such as REDD should be as specific with respect to the environmental and socio-economic conditions of each country and their institutional capacity for the implementation.

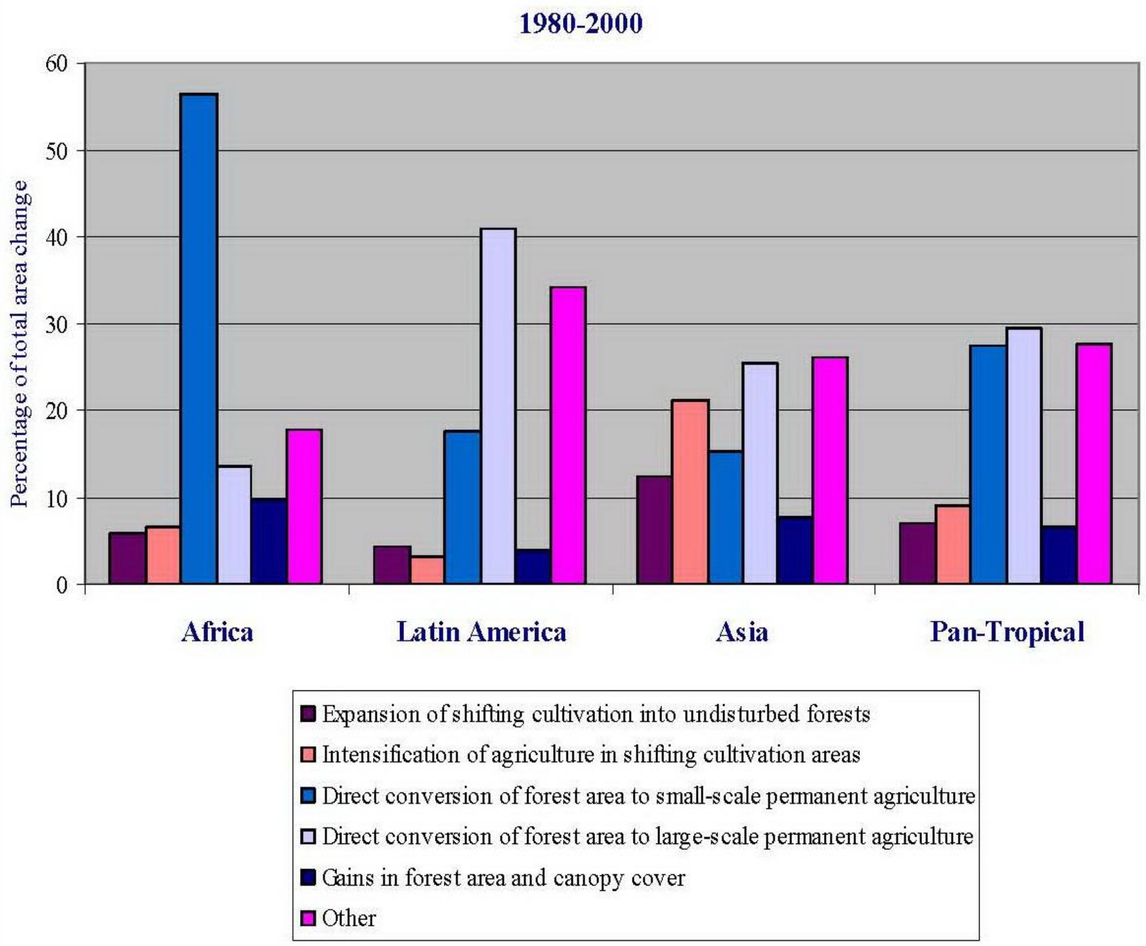

Figure 1: Causes of Deforestation in Developing Countries, by region

(Source: FAO, UNDP, UNEP 2008)

3. ECONOMIC POLICIES AND DEFORESTATION IN ASIAN AND AFRICAN COUNTRIES

In developed countries, agricultural price supports led to investments and intensification in agriculture which allowed the sector to meet demand readily with fewer and fewer farmers. However, when the cost of subsidies became a political issue, the countries sought to offset the price supports by taking the land out of agricultural production, including through tree planting. This has made a demographic transition of farmers abandoning their land for other careers facilitated a return of agricultural land to forest. But in poor countries, farmers simply get poorer and more destitute and some of them migrate to the city. The farmers who cannot migrate are doomed to pursue a cycle of disinvestment. They seek to survive on increasingly poor soils without nutrient inputs and in the environments where soil fertility is chronically low. The poor farmers who are unable to stake claim to better lands often resort to slash-and-burn agriculture as a survival strategy. In areas, where the population following this cycle has increased, the negative consequences for the forest have also increased, because shorter fallow periods keep the soils drained and allow invasive grasses to take root and that farmers are forced to push even deeper into the forest or often further up the hillside to steep lands (Daly and Farley, 2002).

Although the land use system of shifting cultivation depended on the interaction between biophysical and socio economical resources available to farmers, the forestland area to come under the practice of slash and burn system has been on an increase, particularly after the governments have embarked on the Structural Adjustment Programs by end of 1990s (Reed, 1996). The policy measures taken to implement the program such as price deregulation, liberalization of agricultural marketing, reduced government expenditure through the removal of subsidies on fertilizers and credit, have all had their influence on the practice of the slash and burn system in many of the Asian and African countries (Sankhayan *et al*., 1993; Reed, 1996; Culas, 2006).

The structural adjustment policy measures imposed serious economic hardships, specifically on small-scale farmers because they are resource poor and relied heavily on the input subsidies of the past policies (i.e. pre-adjustment period policies). In fact the farmers who had previously reduced their practice of the slush and burn system have now increased this practice due to the hardships created by the structural adjustment programs. Lack of money and access to loans to acquire necessary inputs have contributed to the decisions made by the famers to return to the slash and burn system in many African countries, for example, in Zambia (Kakeya *et al*., 2006; Kapekele, 2006), mainly because this system does not require purchased inorganic inputs (Holden *et al*., 1998; Kapekele, 2006).

In particular, the removal of agricultural subsidies in the 1990s had negative consequences for the rural livelihood of the farmers, and as a result, they had to look for new sources of income to pay for the now more expensive agricultural inputs. Therefore subsidies to promote the use of fertilizers may be justified in terms of higher soil fertility and higher farm yields because they provide a number of benefits to society rather than to individual farmers (Dorward, 2009), for example, reducing CO_2 emissions from biomass burning, recycling of phosphorous and other nutrients, biodiversity conservation and preventing soil erosion and land degradation, etc.

4. ECONOMIC MODEL OF AGRICULTURAL PRODUCTION AND TECHNOLOGICAL CHANGE

The economic model of agricultural production (supply responses) with respect to relative prices (input-output price ratios) and the technological changes are illustrated in Figure 2. The model is illustrated for maize production in relation to fertilizer use as an example. The graph shows that as the relative price (i.e. fertilizer-maize price ratio) decreases the supply responses for maize increases. The model illustrates two issues in relation to the impact of price changes on optimum levels of fertilizer and maize. First, the economically efficient level of fertilizer occurs when the marginal value product (MVP) of the fertilizer equals its marginal factor cost (MFC); that is, when the marginal physical product of the fertilizer (MPP) equals the fertilizer-maize price ratio. Second, it follows that changing the price ratio between fertilizer and maize alters the economically optimum level of maize produced. Further, a farmer may achieve efficiency in both an economic and technological sense. The concept of economic efficiency here refers to the adjustment of inputs and outputs to reflect the relative prices for a given technology, whereas technical efficiency refers to the maximum attainable level of output for a given level of input subject to other factors (Culas and Hanjra, 2011; Hanjra and Culas, 2011).

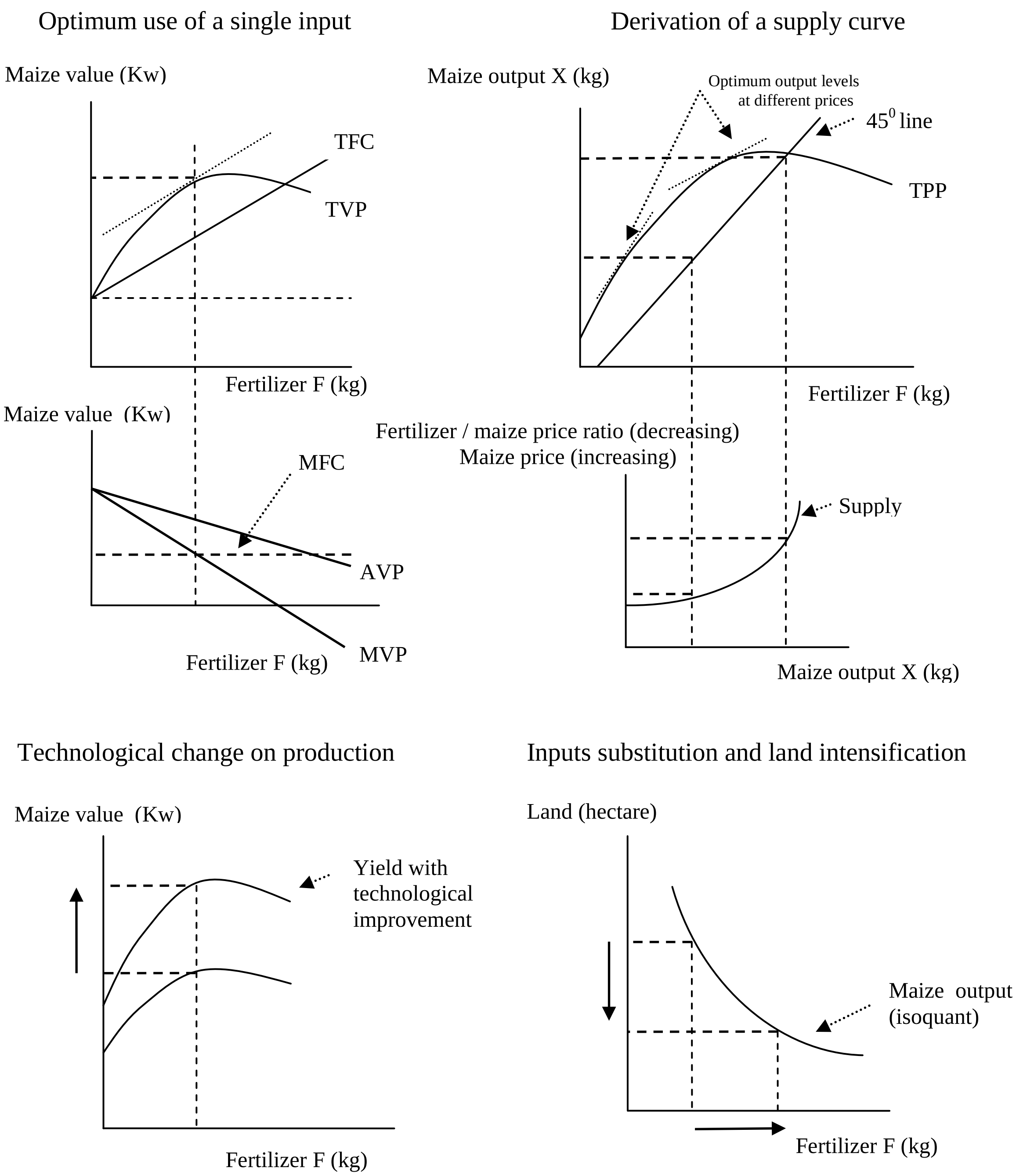

Figure 2. Economic model of agricultural production and supply responses

The implication of this model is that policies for subsidized fertilizers (this may include credit subsidies given for fertilizers and other inputs), as well as improving technical efficiency in production through the provision of infrastructures, access to markets, research and development and education/extension services for the farmers, can enhance the productivity of the land. By technological changes land's productivity can be improved and this in turn can reduce the agricultural land expansion into forests (either primary forest or secondary forest under regeneration). The technological changes, in terms of using sufficient amount of fertilizers (i.e. for the different levels of combination of fertilizer-land inputs) and/or improving the technical efficiency (through factors as mentioned above), can not only enhance the productivity of the land but also improve the food security situations for the farmers. This outcome will also be a desirable one as it can reduce the emissions from the shifting cultivation (deforestation) and this has implications for the international REDD policy.

In general, profitability from the slash and burn system of agricultural production is very low, because the production levels per hectare are low and the quality reduced and also ever lengthening distance to markets further reduces the profit margins. Due to the low profitability, carbon credits can be provided through the REDD mechanism for farmers to restrain from the practice of shifting cultivation. However, this raises the important question of food security in rural areas where the markets are imperfect and access to adequate amount of food could be very difficult. On the other hand, if the carbon credits (in the form of financial incentives from the REDD policy) are offered to the farmers to restrain from the shifting cultivation, this would be an efficient way to avoid deforestation and reduce emission. In tropical rural areas, the slash-and-burn agricultural system is a strategy of survival for the subsistent farmers. In economic terms, the opportunity cost of a farmer’s labor is zero or very near to zero, because of lack of non-farm rural or urban employment opportunities. Further, a farming plot is also regarded as a residence and providing a space for poultry, small animals and a vegetable garden. Therefore, not having access to the farming plot, as their living site, has also an opportunity cost for the farmers. The REDD policy instruments should therefore carefully consider these other situations of the shifting cultivators.

5. REDD POLICY AND PAYMENT FOR ENVIRONMENTAL SERVICES (PES)

The international community has been aware of the deforestation problem in developing countries since 1970’s and tested several policies and instruments to slow down the deforestation, but they ended with mixed results. The 1992 Rio Summit successfully launched the Framework Conventions on Climate Change and on biological diversity, but negotiations on forest management again failed to reach a consensus. Five years later, the Kyoto Protocol only succeeded by including afforestation and reforestation in the Clean Development Mechanisms (CDM), as projects for the reduction of emissions in developing countries. However, this left aside the crucial issue of deforestation. The post Kyoto climate change agreement, which agreed upon at COP15 in Copenhagen in December 2009 provides now a new mechanism - Reducing Emissions from Deforestation and forest Degradation (REDD) - to fund countries at national level for avoided deforestation.

The REDD mechanism, a North-South financial transfer to compensate countries for avoided deforestation, may have both direct and indirect impacts on deforestation. The direct impact is due to the conditionalities of the REDD policy instruments and the way they are designed, and the indirect impact is due to their feedback effects through the drivers (causes) of deforestation such as urban and rural income, poverty rates, agricultural productivity, and foreign exchange earnings. Although the net effects of these policy instruments seem not straightforward to the recipient countries, the large financial transfers from the REDD could actually relieve pressures on forests if they are allocated to poverty alleviation programs in rural areas (Karsenty, 2008), for example, by enhancing technological changes for the agricultural productivity growth and food security in the rural areas through the provision of subsidized agricultural inputs.

The REDD incentives for the countries are considered in two ways: incentives for reducing deforestation in countries with historically high deforestation can be provided through the carbon market while incentives for maintaining forests in countries with low deforestation rates can be provided through a fund-based mechanism (Olander *et al*., 2009). However, whatever the method of provision of the incentive may be, if the REDD implemented successfully after 2012, it would be an opportunity for the shifting cultivators and the smallholder farmers whose livelihood depend on the forests and woodlands. It is often considered that replacing shifting cultivation leads to improvements in environmental services as land-use is intensified in smaller areas and larger areas left for forest re-growth. There are evidences for these changes to be true in some areas (Jakopbsen *et al*., 2007; Klooster, 2003).

The international financial transfers are usually channeled through funds which are allocated to forestry activities according to specific criteria such as defined by the Payment for Environmental Services (PES) and debt-for-nature swaps. Many PES schemes are currently found in developed countries, and the majority of these are state run, rather than private sector schemes. The PES schemes evidences that it is possible to compensate land users directly for environmental services they provide. But for the developing countries, development of PES programs has been constrained by a lack of willingness-to-pay on the demand side, and a lack of implementation capacity on the supply side.

There are four environmental services from the REDD that could be targeted by PES, namely, carbon sequestration and storage, biodiversity conservation, watershed protection, and landscape beauty (Kanninen *et al*., 2007). However, the REDD policy objectives can be extended to include increasing agricultural productivity for food security through financing for the smart subsidies for agricultural production inputs as well as for the rural development and research and development activities (Dorward, 2009; Mertz, 2009; Angelsen, 2009).

6. CONCLUSION

It is important to note that the majority of farmers are small-scale farmers in tropical developing countries. These farmers live mostly in rural areas where their livelihoods depend mainly on the environment and natural resources. The farmers' ability to derive sustenance and income from productively and sustainably managed natural resources is therefore part of a much larger question of alleviating rural poverty and food security, in particular, for the small holders and shifting cultivators (including landless farmers). There is a need for smarter subsidies which target the smallholders and shifting cultivators as technological change for enhancing productivity growth and food security. Future agricultural policies must also support rural income diversification because, given low yield and single season cropping under rainfed agriculture, smallholder crops can only be expected to make a minor contribution to the reduction in rural poverty despite contributing to food security.

Therefore, future economic policies must rethink the role of agricultural input subsidies as well as the uncertainty regarding future food prices and the role of subsidy programs on food security (Dorward, 2009). Such policies are based on the belief that the main barrier preventing the transformation of traditional agricultural technologies to modern and productive technologies is the inability of farmers to purchase the necessary inputs such as chemical fertilizers and hybrid seeds owing to a lack of credit facilities (Taylor *et al.*, 1986). If such subsidized credit policies could facilitate the farmers to purchase the modernized inputs, and complemented with the sustainable soil management practices (Holden and Shanmugaratnam, 1995; Culas and Hanjra, 2011; Hanjra and Culas, 2011), the productivity of lands, and hence the income, of subsistence farmers will improve. The questions remain to what extent the UN-REDD policy will address the complex reality of the subsistence farmers, in terms of both securing reduced emissions from deforestation and ensuring their livelihood through productivity growth and food security.

REFERENCES

Angelsen, A (2009). Policies for reduced deforestation and their impact on agricultural production, PNAS (early edition), 107 (46): 19639-19644.

Angelsen, A (1995). Shifting cultivation and deforestation: A study from Indonesia. *World Development*, 23 (10): 1713-1729.

Bellassen, V and Gitz, V (2008). Reducing emissions from deforestation and degradation in Cameroon - assessing costs and benefits, *Ecological Economics*, 6888: 336-344.

Cairns, M and Garrity, D. P (1999). Improving shifting cultivation in Southeast Asia by building on indigenous fallow management strategies, *Agroforestry Systems*, 47(1): 37-48.

Coomes, O. T., Grimard, F and Burt, G. J (2000). Tropical forests and shifting cultivation: secondary forest fallow dynamics among traditional farmers of the Peruvian Amazon. *Ecological Economics*, 32: 109-124.

Culas, R. J (2006). Debt and deforestation: A review of causes and empirical evidence, *Journal of Developing Societies*, 22 (4): 347-358.

Culas, R. J and Hanjra, M. A (2011). Some Explorations into Zambia's Post-Independence Policies for Food Security and Poverty Reduction - *Chapter 4*, In: Contreras, L, M (eds.) *Agricultural Policies: New Developments*, Nova Science Publishers, Inc. Hauppauge, NY, USA. p. 117-142.

Daly, H. E and Farley, J (2004). Ecological Economics: Principles and Applications. Island Press, Washington.

Dorward, A (2009). Rethinking agricultural input subsidy programs in a changing world, Paper prepared for the Trade and Markets Division - FAO, Centre for Development, Environment and Policy, University of London, April 2009.

Dove, M. R (1996). So far from power, so near to the forest: a structural analysis of gain and blame in tropical forest development, In: Padoch, C., Peluso, N. L (eds.) Borneo in Transition: People, Forests, Conservation, and development, Oxford University press, Kuala Lumpur, p. 41-58.

FAO, UNDP, UNEP 2008. UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD). Framework Document. 20 June 2008.

Fox, J (2000). How blaming 'slash and burn' farmers is deforesting mainland Southeast

Asia, *Asia Pacific Issues*, 47: 1-8.

Fox, J., Truong, D. M., Rambo, A. T., Tuyen, N. P., Cuc, L. T., Leisz, S (2000). Shifting cultivation: A new old paradigm for managing tropical forests. *Bioscience*, 50(6): 521-528.

Hanjra, M. A and Culas, R. J (2011). The Political economy of maize production and poverty reduction in Zambia: Analysis of the last 50 years. *Journal of Asian and African Studies*, 46(6): 546-566.

Holden, S. T (1993). Peasant household modelling: Farming systems evolution and sustainability in northern Zambia, *Agricultural Economics*, 9: 241-267.

Holden, S. T and Shanmugaratnam, N (1995). Structural adjustment, production subsidies and sustainable land use, *Forum for Development Studies*, 2: 247-266.

Holden, S. T., Taylor, E. J. and Hampton, H (1998). Structural adjustment and market imperfections: A stylised village economy-wide model with non-separable farm households, *Environmental and Development Economics*, 4: 69-87.

Ickowitz, A (2006). Shifting cultivation and deforestation in tropical Africa: Critical reflections, *Development Change*, 37(3): 599-626.

Jakobsen, J., Rasmussen, K., Leisz, S., Folving, R and Quang, N. V (2007). The effects of land tenure policy on rural livelihoods and food sufficiency in the upland village of Que, North Central Vietnam, *Agricultural Systems*, 94 (2): 309-319.

Jyotishi, A (2008). Efficiency of the small farm swidden system: case from Orissa, *The ICFAI Journal of Agricultural Economics*, V(3): 72-86.

Kafle, G (2011). An overview of shifting cultivation with reference to Nepal, *International Journal of Biodiversity and Conservation*, 3(5): 147-154.

Kakeya, M., Sugiyama, Y. and Oyama, S (2006). The c*itemene* system, social levelling mechanism, and agrarian changes in the Bemba villages of northern Zambia: An overview of 23 years of fixed-point research, *African Study Monographs*, 27: 27-38.

Kanninen, M., Murdiyarso, D., Seymour, F., Angelsen, A., Wunder, S., German, L., 2007, Do Trees Grow on Money? the implications of deforestation research for policies to promote REDD. Centre for International Forestry Research (CIFOR), Bogor, Indonesia.

Kapekele, E. M (2006). Determinants of slash and burn: The case of c*hitemene* farming system in Zambia, MSc Thesis, University or Pretoria.

Karsenty, A (2008). The architecture of proposed REDD schemes after Bali: Facing critical choices, *International Forestry Review*, 10(3): 443-457.

Kleinman, P. J. A., D. Pimentel, R. B. Bryant (1995). The ecological sustainability of slash-and-burn agriculture. *Agriculture, Ecosystems and Environment*, 52(2-3), 235-249.

Klooster, D (2003). Forest transitions in Mexico: Institutions and forests in a globalized countryside, *Professional Geographer*, 55: 227-237.

Liang, L., Shen, L., Yang, W., Yang, X., Zhang, Y (2009). Building on traditional shifting cultivation for rotational agroforestry: Experiences from Yunnan, China. *Forest Ecology and Management*, 257(10): 1989-1994.

Mertz, O (2009). Trends in shifting cultivation and the REDD mechanism, *Current Opinion in Environmental Sustainability,* 1: 156-160.

Olander, L., Boyd, W., Lawlor, K., Madeira, E. M and Niles, J. O (2009). International forest carbon: Issues and options, Nicholas Institute for Environmental Policy Solutions, Duke University, Durham, NC, USA.

Rasmussen, K and Jensen, L. M (1999). A generic model of shifting cultivation, *Danish Journal of Geography*, 1: 157-164

Reed, D (1996). Structural Adjustment, the Environment and Sustainable Development, Earthscan Publication Limited.

Sankhayan, P. L., Mwanawina, I. and Oygard, R (1993). Stabilisation and structural adjustment programs in Zambia, Ecology and Development Paper No. 8, Agricultural University of Norway.

Scatena, F. N., Walker, R. T., Homma, A. K. O., de Conto, A., Ferreira, C. A. P., Carvalho, R. D. A., de Rocha, A. C. P. N., dos Santos, A. I. M and de Oliverira, P. M (1996). Cropping and fallowing sequences of small farmers in the "terra firme" landscape of the Brazilian Amazon: A case study from Santarem, Para. *Ecological Economics,* 18, 29-40.

Taylor, T. G., Evan, D. H and Aloisio, T. G (1986). Agricultural credit programs and production efficiency: An analysis of traditional farming in Southern Minas Gerais, Brazil, *American Journal of Agricultural Economics*, 68 (1): 110-119.

UNFCCC (United Nations Framework for Conference on Climate Change) (2007). Initial analysis of the mitigation potential in the forestry sector, August 2007.

Wise, M., Calvin, K., Thomson, A., Clarke, L., Bon-Lamberty, B., Sands, R., Smith, S, J., Janetos, A and Edmonds, J (2009). Implications of limiting CO_2 concentrations for land use and energy, *Science*, 324: 1183-1186.

WRI (World Resources Institute) (2009). The Climate Analysis Indicators Tool.