A Discourse on Agricultural Intensification in the Mid-Hills of Nepal

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ABSTRACT

Agricultural intensification is not as simple as the Boserupian process of agricultural change; rather it is a complex evolutionary process involving several interacting drivers. This article attempts to identify the gaps in the social, economic, and environmental effects of agricultural intensification in the mid-hills of Nepal by reviewing agricultural intensification, which emerged as a major subject of development discourse in livelihood improvement and environmental degradation in Nepal. Intensification of agriculture has provided improved economy, food security, employment opportunities, decision making, labor division, local institutions, and leaderships. However, with the aim of increasing production, the intensification process has almost overlooked essential environmental factors -- soil acidification, fertility decline, and greenhouse gas emissions have been accelerated. A path towards sustainable intensification would be possible through improvements in agricultural extension programs such as integrated pest management (IPM) and farmers' field schools. Indeed, good institutional systems make sustainable agricultural intensification economically feasible. Thus, such measures will probably encourage farmers and likely ensure economically- and environmentally-sound production, with the promise of sustainable agricultural intensification.

INTRODUCTION

Shifting cultivation, the first stage of agricultural development, was the most widespread agricultural system in South and Southeast Asia until the mid-twentieth century (Spencer 1966). The necessity of increasing food production due to rapid population growth, especially during the twentieth century, brought about the Green Revolution by growing input-responsive and improved varieties with increased application of fertilizers and irrigation (Lal 2011). Of the total fertilizer consumption, nitrogen (N) fertilizer was the most intensively used in South Asia which increased from 0.35 metric tons (t) in 1961 to 14.25 t in 2002 (Lal 2011).

Agricultural intensification is not as simple as the Boserupian process of agricultural change (Boserup 1965), rather it is a complex evolutionary process (Carswell 2000) involving several interacting drivers. The major issues emerging from agricultural intensification are associated with external drivers such as inputs, mechanization, roads, and market access. Boserup has defined agricultural intensification as "the gradual change towards patterns of land use which makes it possible to crop a given area of land more frequently than before." She argued that increasing population pressure provides stimulus for innovation and intensification. However, population growth and density are not the only variables for agricultural intensification as it can take place in response to policy (Lele and Stone 1989) and improved market access (Pingali et al. 1987).

Agricultural intensification has multiple impacts on society as well as the environment and has been viewed from different schools of thought. Some view it from the perspective of food scarcity and insecurity (Dahal et al. 2009; Carswell 1997), whereas, others view it in terms of the soil fertility implications of intensification (Westarp et al. 2004; Shrestha et al. 2004).

Agricultural intensification in Nepal is evidenced by a greater number of crops planted and an increase in the use of chemical fertilizers. Indeed, it seems to be the potential viable option for food security. However, continuous application of chemical fertilizers is a serious problem in intensive agricultural production areas as it leads to significant acidification of the croplands (Brown and Shrestha 2000; Guo et al. 2010) and emission of greenhouse gases such as methane and nitrous oxide. Moreover, the trend of diminishing use of farmyard manure is of concern in soil fertility management.

A question that needs to be answered is, "Are farmers aware of the potential environmental degradation caused by the intensification, or do they allow such environmental degradation as long as the benefits exceed the costs?" When the cost of environmental degradation and climate change is significant and recurring, farmers might be victimized by what is called degradation and marginalization as mentioned by Robbins (2004: 131).

> "Otherwise environmentally innocuous local production systems undergo transition to overexploitation of natural resources on which they depend as a response to state development intervention and/or increasing integration in regional and global markets."

Farmers ultimately adopted coping strategies such as abandoning agricultural land, selling their lands, and migrating to other places. Thus, the process of intensification should be viewed from both socioeconomic and environmental grounds. Therefore, this paper attempts to identify the gaps in the social, economic, and environmental effects of agricultural intensification in the mid-hills

of Nepal. Although the consequences of such a trend have already been recognized by the international scientific community, very little is known about the environmental and climatic consequences among communities in the developing world. In addition, it is very difficult to alter farming practices since many of the farmers still hold the traditional opinion that higher-yielding varieties need more chemical fertilizers in order to realize their production potential.

Agricultural Intensification: Two Sides of a Coin

Agricultural development has emerged as a major subject of development discourse in livelihood improvement and environmental degradation in Nepal since many hill farmers have chosen land intensification as an alternative approach for livelihood (Table 1). The economy of the farmers involved in agricultural intensification has been reported to have improved (Katwal and Sah 1992; Brown and Kennedy 2005). For example, in the Khani Khola area of the Dhading district, farmers have intensified the land by vegetable cultivation. This has contributed to tripling household incomes over the last 15 years (Katwal and Sah 1992). The yield has increased in both cereal-based and vegetable-based cropping systems by 41 percent and 61 percent, respectively. The net income from vegetable production is found to be significantly higher as compared to cereal crop production (Tiwari et al. 2008). Similarly, in Phewatal watershed, an increase in cash crop production has resulted in an increase of household incomes (Dahal et al. 2008; Poudel 2002).

Food security

Food security is an important social determinant of livelihood. The shift from subsistence cereal farming to an intensive vegetable-based farming system has significantly improved food security in the mid-hills of Nepal, mainly among the poor and disadvantaged groups. Vegetable growers have increased their income from farming by selling vegetables in nearby markets, from which they can buy food and other household items. It is reported that only half of the farmers relying on a cereal-based cropping pattern could meet food requirements for half a year. But after intensive vegetable farming, over half of the famers have

Table 1. Examples of positive effects of agricultural Intensification

Indicators	Impacts	Sources
Economic	Increase in yield for both vegetables and cereals	Katwal and Sah 1992; Brown and Kennedy 2005; Tiwari et al. 2008; Poudel 2002; Blaikei et al. 2002
	Increase in the household income	
Social	Food security	Carswell 1997; Tiwari et al. 2008; Dahal et al. 2008
	Employment opportunities	
	Autonomous decision-making process changed to consensus-based decision-making process	
	Division of labor	
Institutional	Increase in local institutions and leaderships	Pretty 1995; Tiwari et al. 2008

increased their household income to avoid food shortage (Tiwari et al. 2008). Thus, agricultural intensification enhanced the quantity of food produced, improved food security (Katwal and Sah 1992; Carswell 1997; Dahal et al. 2008; Tiwari et al. 2008), and allowed farmers to consume more nutritious food in terms of more green vegetables in their diet (Tiwari et al. 2008).

Employment opportunities

Agricultural intensification has increased employment opportunities for local people in the mid-hills. It opened new opportunities for employment in the markets of agricultural products, fertilizers, and pesticides. Farmers with large landholdings hire local farmers who have small landholdings, for cultivation and transport of farm production to the market (Tiwari et al. 2008). Furthermore, labor wages have also been increased which benefited the poor and disadvantaged groups.

Decision-making processes

The decision-making processes at the household level have changed after the intensification process was introduced (Rasul and Thapa 2003). The autonomous decision-making process led by the household head has been changed to a consensus-based decision-making process done together with the family members. Decision making in the selection of crop varieties also changed with the adoption of new technologies and marketing of farm produce (Tiwari et al. 2008).

Division of labor

Traditionally, a clear division of labor and responsibilities existed among the family members in Nepal. Male members are mostly involved in ploughing, digging, threshing, and marketing. Female members are involved in planting, applying farmyard manure, and harvesting of crops. The shift from cereal-based production to vegetable-based production systems has changed the social values at the local level, which somehow replaced the existing division of labor between males and females and among different caste systems (Tiwari et al. 2008). Both males and females are now engaged in land preparation, planting, buying and applying fertilizer, and harvesting of crops. Both males and females are involved in selling farm produce in the market and buying materials for household consumption and vegetable farming inputs. Such marketing activities help them acquire access to price information, give them opportunity to expose themselves to other communities and interact with them, increase the bargaining power of their farm products, and allow them to compete in the market.

In addition, the caste-based division of labor has been changed to some extent. Before, the so called higher caste people *(brahmin* and *chhetri)* did not plough the land and used to hire lower caste people. Because of the adoption of agricultural intensification, however, lower caste people started cultivating vegetables in their own farm land by observing higher caste people getting benefit from it (Tiwari et al. 2008). As lower caste people began to get busy in their own farms, there was a labor shortage for higher caste people. In this way, the shift from the traditional agricultural system to more intensive agriculture system has, to some extent, changed labor division.

Local institutions and leadership

Institutional indicators such as local institutions and leadership are indicators for livelihood improvement. Community-based

local institutions (the self-initiated local level institutions) in the region includes conservation and development groups (CDGs), community forest user groups (FUGs) and women groups (WGs). CDGs focus on integrated farmland and resource management in which all member households participate in a regular meeting regarding experiences related to farming. Such social capital encourage local farmers, women, and disadvantaged groups to participate in decision-making processes (Preety 1995; Tiwari et al. 2008). Some of the FUGs have leaders from the minority groups and women, which show that discrimination based on caste and gender has been decreasing with the adoption of agricultural intensification.

Environment

The excessive and inappropriate use of chemical fertilizers and pesticides to increase production has almost overlooked the essential factor of the environment. Soil degradation implies a decline in soil quality due to anthropogenic activities. It has three principal processes: the physical process, which includes crusting, compaction, and erosion; the chemical process, which includes nutrient depletion, leaching, acidification, and salinization; and the biological process, which includes depletion of soil organic matter and reduction in soil biodiversity. Agricultural intensification raises concerns about soil erosion, nutrient depletion, water quality, and soil organic matter depletion (Gardner and Gerrard 2003; Shrestha et al. 2004; Westarp et al. 2004).

> The issue of accelerated erosion was developed from a number of studies and impressionistic writings, which claimed that Nepal would slide away into the Ganges by the year 2000 and that the Nepalese hill farmer was to blame for this situation (Biot et al. 1995: 96).

Soil loss through surface erosion from hilly agricultural land varies from less than two tons per hectare per year to a high soil loss of 105 tons per hectare per year (Acharya et al. 2007). Soil losses are found to be higher in *bari* [1] land on sloping terraces (32 tons/ha/year) than in *khet* [2] land (less than one ton/ha/year). Soil loss is directly related to the slope gradient and it is cheaper to make sloping terraces than to make level terraces (Shrestha et al. 2004). Thus, the frequent breaking and loosening of soil through regular hoeing and ploughing forces the soil to erode during rainy season.

Soil degradation through nutrient depletion is also a serious issue (Lal 2000). Soils in the mid-hills have very low nutrients, especially nitrogen and phosphorous (Shah and Schreier 1991; Brown 1997; Westarp et al. 2004). In particular, the double and triple annual cropping rotations are more nutrient-demanding and as a consequence of increased fertilizer use during the intensification process, soils in the mid-hills are becoming more acidic (Westarp et al. 2004). Intensification also leads to the deterioration of nearby water bodies such as rivers. During the monsoon season, heavy rainfall takes away tons of nutrient-rich topsoil from the hills to the water bodies. Water bodies near intensification areas, therefore, have higher concentrations of nitrogen, phosphorous, and potassium (Dahal et al. 2007).

Methane (CH_4) and nitrous oxide (N_2O) are the two most significant greenhouse gases that are emitted as a result of agricultural practices.

[1] Rain-fed uplands with maize-based cropping system
[2] Irrigated lowlands with rice-based cropping system

Agricultural intensification contributes directly to emissions through a variety of processes. This paper, however, will focus on emissions from crop intensification, looking into the levels of chemical fertilizer inputs, tillage frequency, number of crops per year, and types of cultivation. The process is accelerated when soils are treated with ammonium or ammonium-yielding chemical fertilizers. Referring to previous established research (Awasthi 2004; Bremner 1997) and the present scenario of chemical fertilizer application, intensified cropping systems in the mid-hills which may have led to severe soil acidification and enhanced emissions of greenhouse gas.

How Agricultural Intensification Links to Marginalization

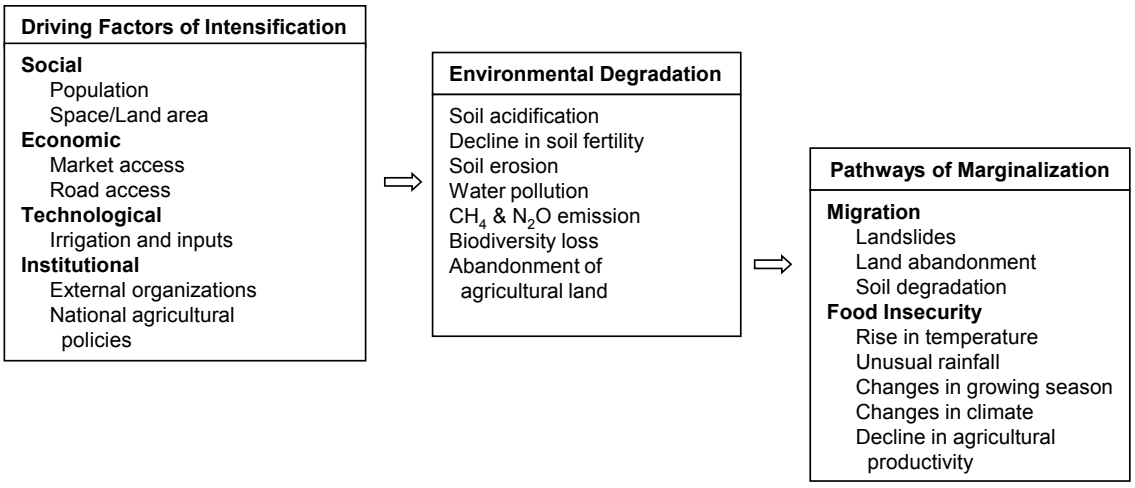
Agricultural intensification has been practiced in areas with access to a market, roads, and the availability of agricultural assets such as irrigation, inputs, and high-yielding varieties. Social, economic, technological, and institutional factors play a great role in driving intensification. Population growth is the main driving factor for intensive agriculture (Ananda and Herath 2003; Boserup 1965). However, complexity between population growth and agricultural change still persists. As the population grows, larger areas are needed to produce more food and since most of the suitable lands in Nepal are already being cultivated (Thapa and Weber 1990), intensification is the only option left for farmers. Similarly, road, market, and profit motives are common driving forces for intensive agriculture in the mid-hills of Nepal (Brown and Shrestha 2000; Sen 1989). Such forces facilitate farmers' access to inputs such as chemical fertilizers and high-yielding varieties. For example, the annual use of chemical fertilizers increased by about 22% over the last forty years (Dahal et al. 2008).

Despite being informed about the negative effects of agricultural intensification, farmers give first priority to livelihood. The consideration of environmental degradation by farmers also depends on the farmers' household size, income source, and social background such as whether they are rich or poor, and the caste they belong to. Farmers who are illiterate and those who have less exposure to society and institutions may not consider management practices as easily compared to literate farmers (Mehta and Killert 1998; Rauniyar 1998). However, the potential risk in the long run, which is very contextual, is also a serious issue and the cost of potential damage caused by environmental degradation might exceed the cost of livelihood improvement. The potential effects will then have a profound influence on who gets to eat and who does not, who is forced to migrate and who is not, and who controls the labor of others and who does not. Although the pathways of marginalization due to intensification might be local, the mechanisms are global (Figure. 1).

Migration issues

There has been evidence of increasing soil erosion, nutrient depletion, and soil acidification in the mid-hills. The soils are deficient in nitrogen, phosphorous, sulphur, and other micronutrients (Blaikie and Sadeque 2000). Marginal households become less able to secure the labor or capital inputs to manage changing soil conditions, thus, people leave the land and move to places where the land is more fertile. According to Dutt (1981), it is easier for farmers to accept a migration situation created by unsustainable practices especially where adults from the mid-hills are frequently moving to other places due to different socio-political reasons.

Figure 1. Establishing the linkages between agricultural intensification potentially leading to marginalization



Food insecurity

It is primarily through changes in temperature, rainfall pattern, and growing season that agriculture is affected. A big concern for developing countries related to changing climate is the possibility of a decrease in agricultural productivity, which may create a scenario of food insecurity. The changing climate may not be favorable for some crop varieties traditionally cultivated in the area. Specific impacts, possibly, will be complex; however, most researches conclude that fauna and flora are very vulnerable to small changes in climate (Gisladottir and Stocking 2005). For example, in Nepal, temperature has increased by 1.8^{o}C during the last 32 years, with the average temperature increase recorded at 0.06^{o}C per year. Likewise, the rainfall pattern would be inconsistent with higher intensities of rain and fewer rainy days (Malla 2008). The plains of Nepal faced a problem of rain deficit in 2005 and 2006 due to an early monsoon season, which reduced national crop production by 12.5 percent. Around 10 percent of the country's arable land was left fallow due to rain deficit, whereas there was flooding in the mid-western plains that decreased production by 30 percent in the same year (Malla 2008). Early maturity of the crops due to increasing temperature helps to increase the number of croppings per year. This, however, leads to an increase in tilling and agro-inputs, which have potential implications for soil degradation and emissions of greenhouse gases in the fragile landscape of the mid-hill region.

The agricultural intensification process leads to the production of food in larger quantities at different levels of diversity, thus increasing food availability at lower prices for farmers. Thus, on the positive side, agricultural intensification potentially reduces food-borne illnesses. On the other hand, productivity might also decline due to unusual temperature and rainfall patterns. The situation might be much worse in the mid-hills where the soil is very fragile. Soil, air, water bodies, and even plants are contaminated by overuse of chemical fertilizers and pesticides through different pathways, and the direct and indirect exposure to fertilizers and pesticides will have direct consequences on human health.

Institutions and Intensification of Agriculture

Past efforts

A number of plans and sector strategy efforts have already been set in place (Table 2). The national agricultural policy of Nepal puts emphasis on agricultural production through the use of agro-inputs, road networks, marketing infrastructure, and rural electrification (National Planning Commission 1995; Dahal et al. 2008). Earlier, the government provided fertilizer subsidies to encourage investments in agriculture from 1973/74 until 1996/97. This policy was brought in to encourage farmers to use fertilizers by providing these at relatively low prices. This directed the government to bear a huge financial burden through its subsidy allocation. Thus, the government decided to deregulate the subsidy policy (1997/98 - 2007/08). One of the objectives of the national fertilizer policy ([NFP] 2002) is to enhance fertilizer consumption through policy and infrastructure management. However, the deregulation policy failed to improve the supply situation and the quality control on fertilizers. Therefore, the government decided once again to provide fertilizers at subsidized rates. One of the features of this later decision is that the fertilizers would be distributed according to the technically required amount for three croppings a year. This clearly shows that the national agricultural policy and the national fertilizer policy have emphasized the intensification process (Ministry of Agriculture and Cooperatives 2009).

Agricultural extension

The agricultural extension service is the oldest of all public services targeted at rural people. Some of the extension models tried so far include: (1) the traditional approach in which a junior technical assistant (JTA) is expected to provide assistance with any problem; (2) the training and visit (T&V) approach applied mostly in Terai; (3) the *tuki* (a Nepali term for kerosene lamp) approach in which the JTA acts both as a source of information and a commission agent for purchased inputs he/

Table 2. Past efforts by the government to prepare plans and sector strategies

Plans and Sector Strategy	Year	Focused Area/Outputs
Perspective Study of Agricultural Development	1970-1990	Emphasized increasing cropping intensities and crop yields
Ten-Year Agricultural Development Plan	1973	Considered organizational structure as a main problem
Nepal Agriculture Sector Strategy Study	1982	A well-defined operational strategy for agricultural development is missing
Perspective Plans	1985-2005	Land use, agriculture, and food grains
The Basic Needs' Programme	1986	Meeting the minimum basic needs of all Nepalese by the year 2000
The Agricultural Perspective Plan	1995	Specifies four priority inputs (fertilizer, irrigation, technology, and roads and power)

Source: International Centre for Integrated Mountain Development (2000)

she supplied; (4) the farming system approach, further concentrating on service delivery in selected sites that have higher potential; and (5) the group approach in which farmers' groups are constituted according to the main commodity they grow such as rice group, vegetable group, etc. (Blaikie and Sadeque 2000). In addition, integrated pest management (IPM) technology has already been launched in view of controlling pests. Extension offices are supposed to educate local farmers about new varieties of crops and vegetables, and to monitor and control the quality of improved seed, fertilizers, and pesticide use. However, their inability to respond to the specific needs of farmers in different socioeconomic conditions and agro-climatic conditions make them ineffective.

Market mechanisms

Agricultural marketing comprises buying, selling, storage, processing, standardization, certification, and distribution of farm products. The process of transferring produce from farmers to consumers has to pass through a channel which causes changes in the products' forms and prices (Pokhrel and Thapa 2007). The farm produce are taken to the nearby markets through a middleman who decides the prices, which are based on the previous day's wholesale market price and also include transport cost, tax, quality of products, and the middleman's profit margin. Since most of the local farmers are unaware of market prices, the middleman benefits from the local farmers in selling the farm produce. Agricultural policymakers in many developing countries perceive middlemen as parasites who take away a large share of the benefit from crop selling (Ellis 1996; Pokhrel and Thapa 2007; Tiwari et al. 2008). Farmers' bargaining power with middlemen further weakens when combined with seasonal shortfalls of cash and lack of storage facilities (Thapa et al. 1995; Banskota and Sharma 1999; Shrestha and Shrestha 2000). Furthermore, the middleman provides agricultural inputs and other household goods on loan to the local farmers. Such situations have obliged farmers to sell their products to the same middleman so that they could repay their credit. In addition, farmers always prefer to get cash for their produce, thus taking limited risks associated with its storage.

TOWARDS SUSTAINABLE AGRICULTURAL INTENSIFICATION

Agriculture being the main occupation of Nepal, the government's developmental plans have focused on increasing agricultural production in order to meet the food demands of the growing population. Farmers in the mid-hills are widely practicing agricultural intensification through intensive use of chemical fertilizers, pesticides, introduction of equipment, and increasing the number of croppings per year. Thus, the concern of feeding a fertile population from infertile soil on fragile and marginal agricultural land in the mid-hills, is a dilemma. The food security and socioeconomic condition could become worse unless agricultural productivity and rural economies get better. Developing an approach to sustainable agricultural intensification that follows a middle path to secure both livelihood and the environment would be useful (Pretty et al. 2011; Royal Society 2009).

As soil is the primary requirement for enhanced agricultural production, approaches towards integrated nutrient and pest management have already been launched. The misconception of farmers that high doses of chemical fertilizer inputs increase productivity

can be corrected through improvements in IPM and farmers' field schools. Policies can be made to enforce environmental taxes on nitrogen fertilizers, promoting better timing of fertilizer and manure application. Indeed, this could be possible through government institutions and market mechanisms. The creation of local institutions that increase the market strength of small farmers and the presence of state policies that allow the powerless to compete in the market, will make sustainable agriculture economically feasible.

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