

# Sustainable Agricultural Intensification for Livelihood and Food Security in Nepal

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**Abstract:** With increased market access and road links to urban centres, settled agriculture in Nepal is becoming transformed into intensified cropping, especially in peri- and semi-urban areas. On a global scale, major driving factors for intensification are: population growth, lack of alternate employment, profit motive, market access, road links, availability of agricultural inputs and organizational cooperation. However, in Nepal the main driving factor is necessity due to lack of other income opportunities. The outcomes of agricultural intensification, namely, improved economic condition of farmers with higher production and good market price are intended to address the developmental challenges of high population growth, food deficit, agricultural trade modalities, fragile ecology, and national policies. In spite of soil fertility loss, erosion, workload and pollution, agricultural intensification is found to be a viable option for better livelihood in developing countries. This review paper discusses the global driving factors of intensification in the local context highlighting their positive and negative impacts.

**Key words:** Cropping intensification, food deficit, Nepal, peri-urban, semi-urban, sustainable development.

## Introduction

Over the centuries subsistence farming has been practiced throughout the country and the well being of people was related to agricultural production in the past. Those farmers who were able to grow enough crops to supply year- round food for their families were considered 'self sufficient' and who could not were regarded as 'deficit' farming households. In recent years cash crops and livestock have gained importance within agricultural system. In urban and peri-urban areas of Nepal, vegetables grown as cash crops dominate agricultural production.

The fragile geological set up and sensitive environmental conditions in Nepal hinder the construction of roads, irrigation facilities, use of modern

tools and technologies as well as other infrastructure development required for increasing growth in the agricultural sector. The distribution and storage of agricultural produce is another major challenge due to transportation and market constraints. For instance, most cereal crops fetch a low price at harvest time due to inadequate storage facilities, while at other times they are imported at higher price. Moreover, the liberalization policy of the government has also led to increased import of food grains from India because of lower prices there as compared to Nepal. These factors are affecting the agricultural production and growth, contributing both to poor economic condition of the farmers and food insecurity.

In spite of government prioritizing the agricultural sector and marginal improvement in irrigation facilities, hybrid seed varieties and a shift towards commercial farming, the Nepalese agriculture is unable to alleviate

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poverty and food insecurity. Intensified production has potential to be a viable option but some authors (Ananda and Herath, 2003; Metz, 1991; UNEP, 2001) argue against it on environmental grounds. The question of 'how to achieve higher agricultural production with minimal negative impacts?' continues to haunt Nepalese agriculture. The 'more people less erosion' hypothesis of Boyd and Slaymaker (2000) offers a possible answer to this question.

The aim of this paper is to review and synthesise literature on agricultural intensification and its impacts on farm production, livelihood, food security, and environment in Nepal. The figures and statistics in this study are associated with Nepal unless otherwise specified. It is argued that intensification of agriculture need not be detrimental to the environment, but in fact, may be beneficial for socioeconomic uplifting of rural communities. As agricultural intensification is still localised and practiced mainly in 'pocket' areas, conclusions drawn on the basis of only a few cases must be interpreted with caution.

### **Agricultural Intensification and Sustainable Development**

The literature contains many definitions of agricultural intensification (see Boserup, 1965; Brookfield, 1984; Carswell, 1997; Turner and Doolittle, 1978). In the Nepalese context, agricultural intensification is best defined as the cultivation of new types and numbers of crops to increase production from same land area. Greater use of chemical fertilisers, pesticides and labour inputs are also characteristics of agricultural intensification in Nepal. The aim in Nepalese agriculture has been to raise the agricultural production; therefore, whatever means are applied to increase production from the same amount of land can be regarded as intensification.

World Commission on Environment and Development in 1987 defined sustainable development as development that 'meets the needs of the present without compromising the ability of future generations to meet their own needs'. Future generations must inherit an improved capital stock and better technology that will equip them to substitute resources and overcome scarcity (Redclift, 1987). If we consider sustainable development as an alternative to unsustainable development, it should imply a break with the linear model of growth and accumulation that ultimately undermines the planet's life support systems (Redclift, 1987).

Sustainable agricultural intensification could be a viable option to meet the food need and minimise the environmental consequences. 'Sustainable agricultural intensification' in this context has similar meaning to that highlighted by FAO (2004) – the agricultural practices that do not degrade the natural resource base while also taking into account the need to improve the livelihoods of the millions of people who till the land, particularly in developing countries. Therefore, sustainable agricultural intensification has two goals: intensive cultivation for enhanced livelihoods and to improve the land and environment. The World Bank (2003) has also emphasised intensive sustainable agriculture by the statement 'intensified and sustainable production systems are environmentally beneficial, technically appropriate, economically viable, and socially sound'. The present agricultural practice in Nepal is not adequate to fulfil the country's food needs and as stated by Gips (1987), intensive production without considering geological conditions and environmental issues will not be sustainable. Therefore, this paper emphasises the balanced approach of 'sustainable agricultural intensification' to improve the livelihoods and economic conditions of farmers as well as food security in Nepal.

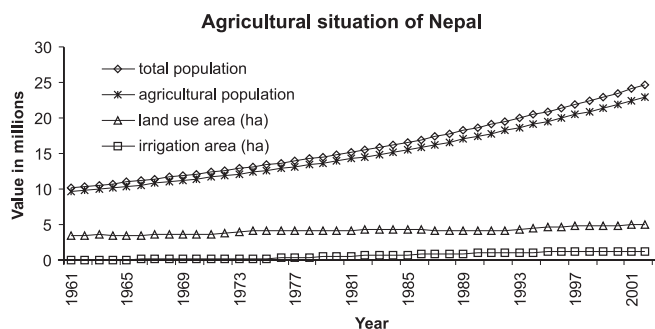
### **Need of Agricultural Intensification to Secure Livelihoods in Nepal**

The meaning of livelihood security is elucidated by Chambers (1988) who points out that livelihoods are secure when households have secure ownership of, or access to, resources and income earning activities, including reserves and assets, to off-set risk, ease shocks, and meet contingencies. Similarly, Adhikari (2002) in Nepalese context defines livelihood security as the capacity of the individual or household to improve their various assets (physical, financial, human, social and political). When the household has adequate and sustainable access to income and resource to meet basic needs, the livelihoods of its members can be considered secure. As a large proportion (>40%) of the people in Nepal are living below the international poverty line and still struggling for basic needs, livelihood insecurity predominates.

Population growth rates, the food deficit situation, imbalance of agricultural trade, land/geological conditions, and national policies are found to be the major factors affecting agricultural intensification in Nepal. The relationships of these factors are discussed individually in the following sections.

## Population Growth

Agricultural productivity is important for livelihood security in Nepal as more than 80% of the people's livelihoods are based upon it. However, despite being an agrarian society, Nepal's agricultural production has always been suppressed (FAO, 2003; World Bank, 1998) by the higher population growth rate (2.3%) (CBS, 2003). See Figure 1 for the trend of population growth in last forty years.



**Figure 1: Unequal growth of population and agricultural land area.**

Data source: FAOSTAT data, 2004.

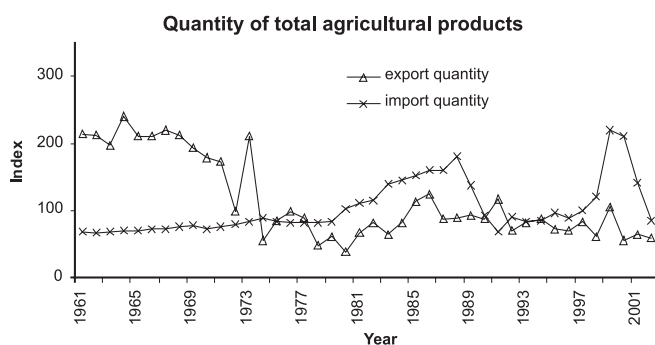
Agricultural intensification is in large part a consequence of increased food demands of a growing population. In Nepal, an imbalance in the growth rate of the population (2.3%) compared to agricultural land (0.8%) indicates that fulfilling the increasing food demand will have to be met by alternate means (Figure 1). People began migrating from villages to towns, especially in Terai, for employment and food production during the 1950s and a food deficit situation began to persist from the 1970s. Food and nutritional security are subsets of livelihood security, and the provision of food is indeed a central issue within society since so much in human life depends on the ability to find enough to eat (Sen, 1989). It is perhaps for this reason that there are many places in Nepal where farmers grow crops according to annual food requirements.

## Food Deficit

Annual food deficit condition is another reason for the need of agricultural intensification. It is estimated that out of the 75 districts, 43 are food deficit in Nepal and most of these districts are in hills and mountains (Bohle and Adhikari, 1998). Here, 54 per cent of households have only sufficient food for less than six months out of the year. The per capita food grain production has decreased and the average food deficit is 47 kg per capita in mountain region and 32 kg in the hills (Pyakuryal et al., 2005). Nepal Living Standard Survey report estimated

that 40 per cent of the people were living below the poverty line (CBS, 1996). This figure is believed to have increased since.

Nepal went from being a net exporter to becoming a net importer during the late 1970s reflecting a problem in agricultural sector of Nepal (see Figure 2). Between 1975 and 1983, paddy and maize yields declined from 2.6 to 2.0 and 1.8 to 1.4 t/ha respectively in Gorkha, Syangja and Tanahun districts (Kumar and Hotchkiss, 1988). At this stage, the food demand was growing faster than the internal food supply; hence Nepal started importing foods (Pyakuryal et al., 2005). Therefore, in order to balance the food import and export situation, crop production needs to be increased.

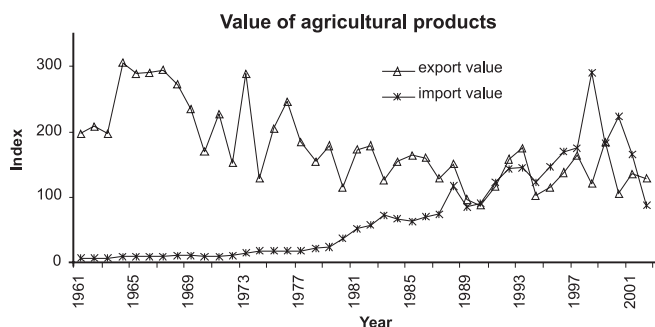


**Figure 2: Index of imported and exported quantities of food.**

Data source: FAOSTAT data, 2004.

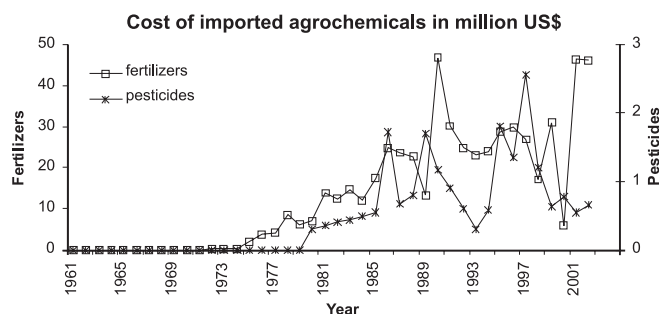
## Agricultural Trade

The total income from exports of agricultural income is not balanced. The import value is increasing whereas export value is decreasing (Figure 3). If this situation persists, the sustainability of agricultural production is doubtful. Furthermore, the cost and import of agro-chemicals is always increasing (see Figure 4). This imbalance also reflects the increase of agricultural inputs



**Figure 3: Imbalance of export and import of agricultural products.**

Data source: FAOSTAT data, 2004.



**Figure 4: Increasing cost of fertilizer and pesticides.**

Data source: FAOSTAT data, 2004.

without increasing the productivity to boost the export value. Under such conditions, farmers are becoming poorer; hence, the need of intensive farm production.

### Geology

The dramatic increase in farm production through agricultural modernization (mechanization, chemical fertilisers, hybrid varieties and pest control) marking the green revolution in advanced nations is a lesson for the development of poor countries (Redclift, 1987). Intensified agriculture had been a key development strategy to enhance food security and economic growth (Lee et al., 2001). But Nepal has less suitable agricultural land due to geologic and natural conditions. The agricultural land area increased from about 24% of total land area in 1961 to 34% in 2002 and has since essentially stabilized (FAOSTAT data, 2004). In fact, some of the previously prime agricultural land is being lost to urban expansion. Furthermore, the landholdings are small and fragmented (40 percent of landholdings are less than 0.5 hectare and 70 percent are less than one hectare), fertiliser use is low, agricultural road networks are inadequate and, in spite of extensive river systems, irrigation does not reach all arable land (UN, 1999). Only about 22 percent of the total cultivated areas receive year-round irrigation. Without improving the irrigation facility and modern inputs, it will be difficult to increase production. Distribution and transportation of agricultural products are also major hurdles to progress resulting from a lack of infrastructure development in the country.

### National Policies

Nepalese agriculture focusses on intensive production to overcome the food deficit situation and to improve socio-economic condition. The national agricultural policy has also stressed the need of agricultural intensification i.e., to increase per capita food production

from 277 kg to 426 kg by 2017 (NPC, 1995). It is possible to achieve this goal through inputs and supports to farmers. Here, the statement of Boserup (1965) on intensification is very relevant – ‘previously the regions under forest fallow could support only a couple of families per square kilometre; however at present, supports hundreds of families in the same area by means of intensive cultivation’. She has further highlighted that intensification is needed in every part of the world. Therefore, to support a growing population, meet the national target, overcome the food deficit problem, balance the economy of the country, and improve the living standard of people, despite the extreme geological and natural conditions, intensification is needed.

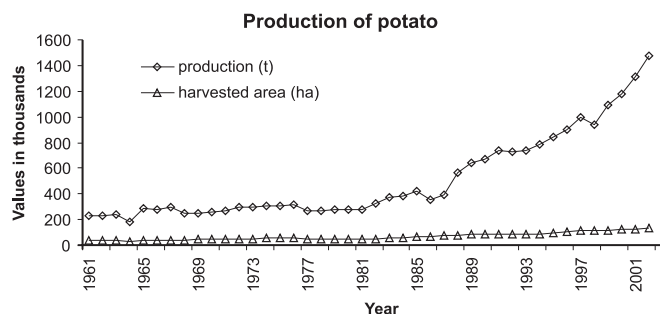
### Signs of Intensification Practices in Nepal

Agricultural intensification is now practiced in some areas of Nepal having access to roads and markets, irrigation facilities, and input/support from external organizations. Though intensification exists in a few pocket areas of Nepal (Carswell, 1997; Schreier et al., 1997), they supply a large proportion of the agricultural produce to nearby urban centres. GIS analysis between 1976 and 2000 (Gautam et al., 2003) also indicates that intensification exists in Nepalese agriculture. However, the farmers have only been able to capitalize upon a few products to intensify farming, namely, high value crops (in terms of market value and production), fertilisers, and cropping pattern. These parameters are considered as the main indicators of intensification in Nepal.

### High Value Crops

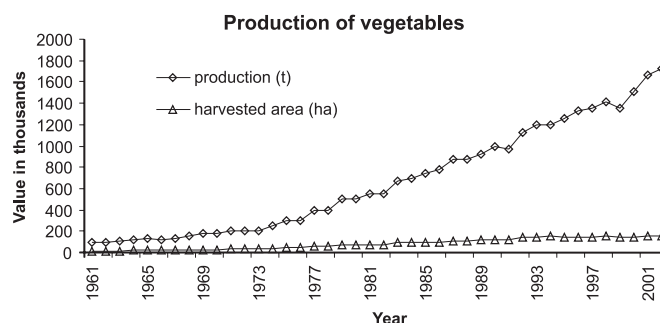
The most common crops used as high value crops are out-of-season vegetables, potatoes, and tomatoes in hilly areas. The recent trend of cultivating these cash crops instead of cereal crops is an indication of agricultural intensification in Nepal. The main reason for cultivating these crops is due not only to the higher price, but also because of higher yields. For example, on an average, the price of paddy, potato and tomato per kg is nearly the same; however, the yields of the latter are higher than that of rice. See Figures 5 and 6 where production has increased from nearly the same harvested area for the last four decades.

Over the past forty years, the rate of cereal production has remained nearly constant at 3%, while total fruit and vegetable production increased to 19%. Similarly, the production of cash crops like tea, coffee, tobacco and



**Figure 5: Increase of production from approximately same harvested area of potato.**

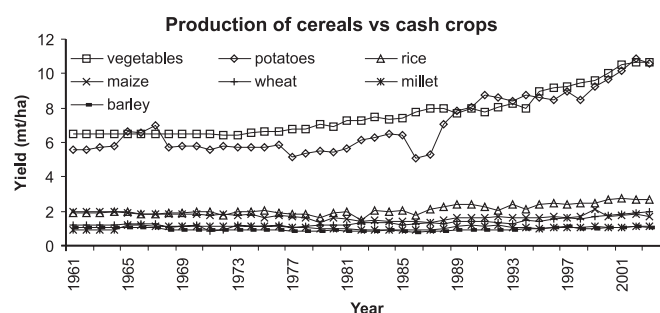
Data source: FAOSTAT data, 2004.



**Figure 6: Increase of production from approximately same harvested area of vegetables.**

Data source: FAOSTAT data, 2004.

sugarcane also increased to about 35% during the same period. Considering potatoes alone, the production rate was 14%. The overall amount of food production is increasing, but the production rate of cash crops is much higher than cereal crops (Figure 7). Clearly, the low average yields of cereal crops (maximum of 5 t/ha, Saleem, 1994) cannot support the ever-increasing population of Nepal. Hence farmers are attracted to and intensifying farming by growing higher yielding vegetables, which yield up to 40 t/ha (Saleem, 1994).

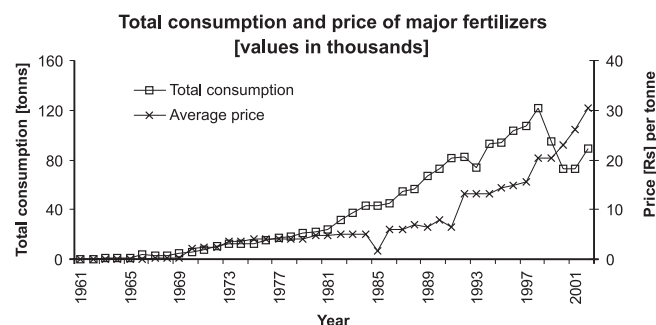


**Figure 7: Yield of cereal crops as compared to cash crops.**

Data source: FAOSTAT data, 2004.

## Fertilisers

Cropping intensification has been practiced with farmers applying more fertilisers as necessitated by the changing cropping pattern. The rapid increase in the use of chemical fertilisers (Figure 8) after the 1970s reflects the intensification process. On an average, the annual chemical fertiliser use increased by about 22% over the last forty years (calculated from FAOSTAT data, 2004). However, after 1998, fluctuations in the fertiliser use may be attributed to price and subsidy policies, as well as political unrest in the nation. Nevertheless, considerable amounts of fertiliser use have become indispensable for enhancing crop yields.



**Figure 8: Trend of total consumption and average price of urea and muriate fertilizers.**

Data source: FAOSTAT data, 2004.

## Land Use and Cropping Pattern

Intensification is being practiced in Nepal by changing land use and cropping pattern. Irrigation availability is one of the contributors to land use change. As a result of irrigation facilities, farmers have increased crop rotations from an average of 1.3 crops to 2.6 crops per year (Shrestha and Brown, 1995). However, year-round irrigation is available on only 22% of the agricultural land (calculated from FAOSTAT data, 2004). As pointed out earlier, most of the potential arable land is already cultivated and there has been no significant land use change for major cereal crops over the past 10 years, while there is an increasing trend of potato and vegetable cultivation. Hence change of cropping pattern i.e., vegetable, tomato and potato, in the hill region of Nepal is a part of the intensification process.

## Global Driving Factors of Intensification in Context with Nepal

Globally, agricultural intensification has been driven by population growth, food demand, labour etc., particularly in the advanced countries of the world. Agricultural assets

like improved and high-yielding crop varieties, irrigation facilities and chemical fertiliser have contributed to intensification of production in Nepal (World Bank, 1998). External organizations also play a positive role in intensifying agriculture through awareness, education and empowerment. This, along with population, cultivable land area and agricultural GDP of farmers are driving them to shift towards cropping intensification. Such factors have individual and/or combined effects on intensification and play an important role in the policy making process for sustainable agricultural development in the Nepalese context.

### **Population**

Population growth is the main driving factor for intensive agriculture throughout the world (Ananda and Herath, 2003; Boserup, 1965; Carswell, 1997; Metz, 1991; Ojha and Morin, 2001; Shrestha et al., 2004; Templeton and Scherr, 1999). Sometimes the compulsion to acquire enough food may force vulnerable people to engage in unsustainable practices (Sen, 1989) and that may lead to land degradation. However, the relationship between population growth, agricultural change and environmental degradation is highly complex and no single explanation is entirely satisfactory (Holden and Sankhayan, 1998).

### **Space/Land Area**

With increasing demand for food, larger areas are needed to produce more food. In the past, farmers have encroached upon forests and public lands to increase crop production (Thapa and Paudel, 2000). However, most of the suitable lands in Nepal are already under cultivation (Bajracharya, 1983; Thapa and Weber, 1990). Hence, farmers are left with no option but to intensify production from their existing parcels of land. Boserup (1965) clearly highlighted that slowing of agricultural development and land scarcity drives intensification. In this respect, Nepal is no exception.

### **Market Access**

Production for own household consumption and for sale are the two types of crop production systems operating in the country. Market-based production has led to cropping intensification in hills of Nepal (Brown and Shrestha, 2000). Intensification is evident in farms with market access, such as in the northeast of Kathmandu, where fresh vegetable production has expanded (Dixon et al., 2001). Intensive vegetable cultivation in the Jhikhu khola watershed is also due to markets in Banepa and

Kathmandu (Brown and Shrestha, 2000). The economic reform in China after 1979 can be attributed to the rapid expansion of agricultural output after freeing of markets and the unleashing of productive opportunities connected with profit incentives (Sen, 1989). Therefore market and profit motives are also driving Nepalese farmers towards intensification to raise household income. Market access to agrochemicals is another important driving factor for intensification.

### **Road Access**

Road access helps in commercial production, agribusiness and distribution of agricultural products (World Bank, 1998). The main highway, Mahendra highway, running east to west in the Terai region, has facilitated distribution of agricultural products throughout the southern part of the country and the capital. However, the absence of link roads between this highway and hill districts has created distribution problem in hill districts and could be a cause for food deficit in the hills. For example, in the absence of road access, apples from Marpha are used for compost manure or liquor, while city markets are flooded with apples imported from abroad.

### **Irrigation and Inputs**

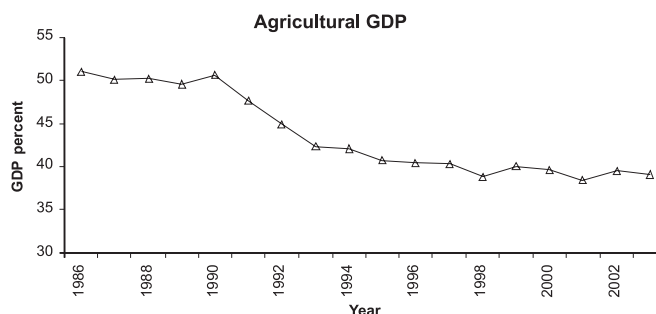
The introduction of multi- and annual cropping often depends upon the creation of irrigation facilities, which help in raising crop yields per hectare (Boserup, 1965). Food deficit situation occurs in absence of irrigation facilities, droughts, and/or heavy rainfall conditions (Pandey, 1997). Annual gross income per hectare has increased by more than 100% after the introduction of irrigation facilities in three districts of Nepal (Angood et al., 2002). Therefore, Nepal has a potential for higher production by increasing irrigation facilities.

Earlier, the practice of grazing and collection of forage and litter from the forest helped in sustaining nutrients in croplands. These practices have been curtailed in recent years due to labour shortage, restriction of access to forests, less production of compost and higher nutrient demand by hybrid crops. Thus, average crop yields declined 5 to 30% during the past few decades in a number of mountain watersheds in Nepal, along with the Indian Himalayas, and the Tibet (Partap and Waston, 1994). Farmers have started using chemical fertilisers to replenish soil nutrients. Along with the practice of intensification, use of chemical fertiliser in Nepal is increasing but still inadequate (see Figure 8). Cost is the reason for inadequate fertiliser use (Figure 4), thus affecting overall agricultural production.



## Agricultural GDP

Nepal remains heavily dependent on its agricultural economy and there is still a tendency to equate food security with food self-sufficiency (CBS, 2004). Although the agricultural GDP has declined from 75 per cent during 1950s and 1960s (CBS, 2004) to below 40 per cent at present (Figure 9), it continues to influence the overall GDP. The declining trend of the national GDP reflects, to a large extent, a decline in agricultural productivity. This decline in productivity is partly due to inefficient utilization of land resources (UN, 1999).



**Figure 9: Declining trend of agricultural GDP.**

Data source: FAOSTAT data, 2004.

## External Organizations

External assistance in small-scale hill irrigation schemes have made a significant impact on agricultural productivity and cropping intensity in parts of Nepal (Banskota and Lohani, 1999). Without the assistance and cooperation of different organizations, farmers, on their own, would have difficulty in using improved seeds, chemical fertilisers, and large-scale irrigation facilities. Thus evidently, there is a major role of external organizations in the process of agricultural intensification. However, the majority of farmers lack access to new agricultural practices due to geographical, economical, financial, risk-avoidance and socio-cultural factors (Bajracharya, 2001).

## National Agricultural Policies

The national agricultural policy of Nepal emphasises boosting agricultural production through the use of agricultural inputs, road network, marketing infrastructure and rural electrification (NPC, 1995). Earlier, the government had provided capital, interest and fertiliser subsidies to encourage investments in agriculture, especially in irrigation, cash crops and livestock. The subsidy policy has promoted the use of chemical fertilisers but production was limited by the

absence of irrigation facilities. Because of the same, small farmers were unable to overcome food insecurity (Timsina and Upreti, 2002). Hence, intensification has been stressed again in the ninth and tenth five-year plans.

## Analysis of the Effects of Agricultural Intensification

Intensification of agriculture has effects on both the socio-economic conditions of farmers and on the environment. More often than not, intensive production has increased crop yield, progress in farm income, and better management practices of cultivated land (Carswell, 1997; Katwal and Sah, 1992). This is a positive trend to overcome food security by increasing yield per hectare in intensively cropped areas. Yet, in the absence of adequate infrastructure like roads and irrigation facilities, markets of agro-chemicals and agricultural products, initial inputs like hybrid seeds, capital, trainings and awareness, the impacts are limited to semi- and peri-urban areas of Nepal. Therefore, the overall contribution of agricultural intensification at the country scale is hard to quantify. Nonetheless, several cases of food security and economic improvement of farmers involved in agricultural intensification have been reported.

A case from Kavre district showed that vegetable farming had a higher gross margin of US\$137 compared to US\$12 per year for farmers growing only staple crops (Brown and Kennedy, 2005). Other cases from Dhading, Tanahu and Parsa districts indicated irrigation-promoted agricultural intensification. Cropping of higher value crops like potato, tomato and other vegetable improved the household food security and household incomes (Angood et al., 2002). Paudel (2002), in Phewatal watershed, reported an increase of cash-crop cultivation from 37% in 1975 to 59% in 1998 which resulted in a tripling of household incomes for vegetable growing farmers. Similarly in Palpa district, women involved in vegetable production were noted to have better financial and food security conditions (Upadhyay, 2004).

Along with the positive effects on production and income, some authors have reported negative impacts of agriculture in Nepal. Most of the studies related land degradation, environmental pollution and pesticide pollution with agricultural intensification, which needs further verification. The overall impact of agricultural intensification is difficult to pinpoint through the available literature. However, a number of literatures have highlighted both positive and negative impacts of agricultural intensification (see Table 1).

**Table 1: Comparison of positive and negative impacts of agricultural intensification**

<i>Positive impacts</i>		<i>Negative impacts</i>	
<i>Field of impact</i>	<i>Literatures</i>	<i>Field of impact</i>	<i>Literatures</i>
Increased crop yield and income	Blaikie et al. (2002), Katwal and Sah (1992), Matson et al. (1997), Timsina and Upreti (2002)	Soil erosion and land degradation	Ananda and Herath (2003), Carswell (1997), Metz (1991), Shrestha et al. (2004), UNEP (2001)
Higher productivity and environmental quality	Boserup (1981)	Environmental pollution	Collins and Jenkins (1996), Lee, et al. (2001), Matson et al. (1997), Schreier et al. (1997)
Improved air quality and water quality	Bunch (1988)	Fertility loss	Thapa and Weber (1990)
Year round ground cover by crops check run-off and soil loss hence maintains soil fertility	Gardner and Gerrard (2003), Matson et al. (1997)		
Overall increased quantity and quality of livelihood	Carswell (1997)		

From Table 1, there are apparent contradictions among positive and negative impacts of intensification. For example, Bunch (1988) claims positive impact on environment (improves air and water qualities); however other studies (Matson et al., 1997; Schreier et al., 1997; Lee et al., 2001; Collins and Jenkins, 1996) emphasized negative impacts on environment. Overall, Table 1 shows positive effects towards crop yield and farm income. But soil loss, nutrient loss and environmental—pollution mainly by chemicals—are regarded as negatives. Conversion of land use and other negative impacts to positive ones is achievable through soil conservation and fertility management practices with intensification.

### **Sustainable Agriculture for Poverty Alleviation and Food Security**

Poverty alleviation and food security in Nepal is only possible through increased agricultural productivity and overall agricultural development. Here, the term development is equated to economic growth, i.e., when the country experiences increased growth, its productive capacity expands and it develops. In Nepal, policy research prioritizing poverty reduction needs to be undertaken in agriculture and rural development (Pyakuryal et al., 2005). Conway (1985) has linked productivity, stability, sustainability and equitability as four vital properties of agro-ecosystems. These four properties must be balanced to achieve sustainable agricultural development. This review indicates that intensive agriculture has the capacity for higher productivity to alleviate poverty and food insecurity,

although it may have some drawbacks for the environment. Therefore, a balanced approach, namely, sustainable agricultural intensification (as described earlier), is proposed to overcome the problem of poverty and food security in Nepal.

### **Why Sustainable Agricultural Intensification in Nepal?**

Food insecurity is both a cause and a consequence of poverty. Furthermore, poverty and household food insecurity are more prevalent and severe in rural compared to urban areas of all regions (Dixon et al., 2001). Nepal has a food deficit problem that is most acute in the mountain and hill districts with annual food shortage for six months or more (Bohle and Adhikari, 1998; FAO, 2003). The situation could become worse unless agricultural productivity and rural economies are transformed. Adoption of intensive farming throughout the country along with appropriate technological innovation offers promise for such a transformation. But such intensification must be done in an ecologically friendly manner due to the fragile mountain environment of Nepal.

Poverty tends to drive people to practice short-term benefit-oriented production that leads to land and environmental degradation imposing externalities on future generations (Holden and Shiferaw, 2002). However, poverty reduction is occurring in countries that are experiencing rapid growth in agriculture (Mellor, 1999), and livelihood security is achievable through agricultural intensification (Carswell, 1997). Agricultural



growth also reduces urban poverty due to consequent reduction in food costs and lower rates of migration from rural areas (Datt and Ravallion, 1998). Thus, sustainable intensification and agricultural growth offer a means to break the vicious cycle of poverty and resource depletion.

### **How to Achieve Sustainable Agricultural Intensification?**

The misconception that high doses of chemical fertiliser and pesticides increases productivity still persists in some areas. Decline in use of farmyard manure and soil nutrient insufficiency eventually threatens livelihood of farmers due to reduced production (Dougill et al., 2001; Schreier et al., 2001; Thapa and Weber, 1990). But it is well established that injudicious use of chemicals deteriorates soil quality, increases pest insurgency, and raises production cost. Thus, while improvement of soil fertility is a prerequisite for enhanced agricultural production, dependence upon chemical means alone is unsustainable (Schreier et al., 1997; Carswell, 1997). Integrated approaches to nutrient and pest management using combinations of chemical and organic fertilisers as well as biological/natural pest control measures are appropriate and sustainable for maintaining soil fertility and increasing productivity (Brown and Shrestha, 2000; Thorne and Tanner, 2002).

As yet governmental and non-governmental agencies endeavour to implement appropriate management approaches to improve production in Nepal (Gautam et al., 2003). The available literature and experiences of other developing nations indicate that sustainable agricultural intensification could be achieved through improved agricultural technologies. These include adoption of high yielding varieties, sloping agricultural land technology, terracing, legume intercropping, contour hedgerows, alley cropping, cover crops, agro-forestry, residue management, minimum tillage, rotational grazing, integrated pest management, organic and inorganic fertiliser etc., along with construction of irrigation and road networks. Clearly, the selection of appropriate crops, balanced application of nutrients, judicious use of pesticides, and adoption of appropriate conservation practices could enhance production while minimising environmental and human health impacts.

### **Limitations of Sustainable Agricultural Intensification**

The design and implementation of sustainable agricultural systems continue to be elusive due to socio-cultural and

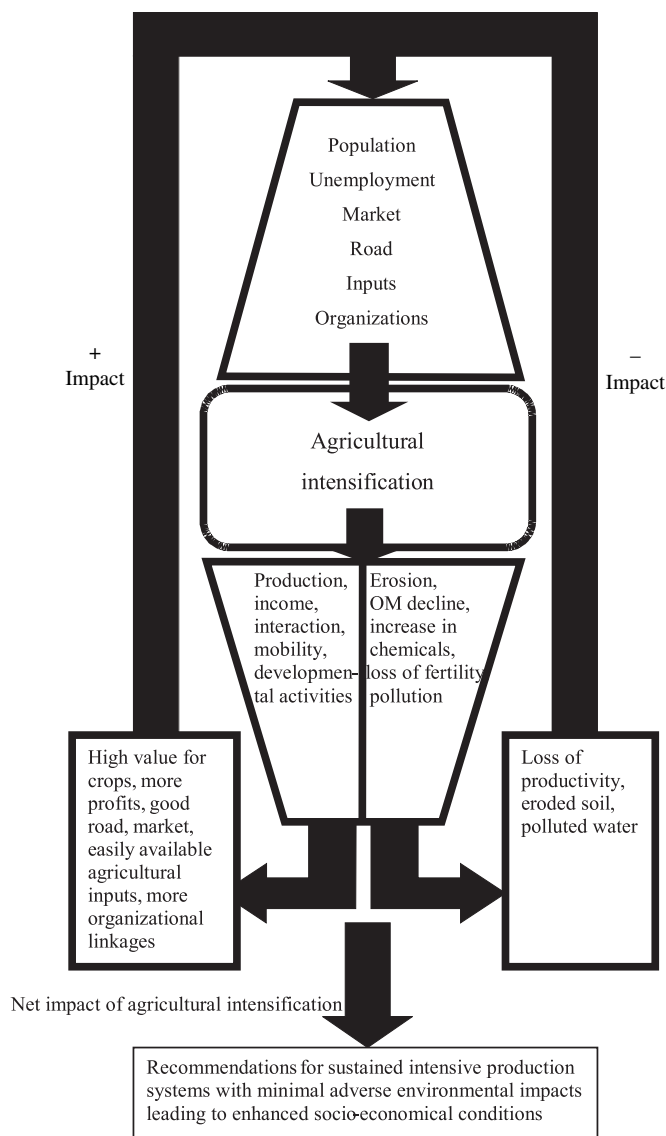
political instability in Nepal. Shortage and high price of agricultural inputs (Pandey, 1997) pose significant barriers for Nepalese farmers to replenish plant nutrients, without which it would be impossible to intensify production. Sustainable agricultural intensification must address socioeconomic, technological, managerial and environmental issues. Initially government intervention is unavoidable for construction of roads, irrigation canals, adoption of biophysical erosion control, etc., which involves capital investment. Unless these aspects are addressed at local and national levels, farmers would be unable to practice sustainable agricultural intensification. However, if these limitations are overcome through local and national policies, farmers will achieve higher production while avoiding environmental degradation, which will ultimately uplift their livelihood and increase food security in the country.

### **Conclusions**

At present, intensified cropping in Nepal is limited to peri- and semi-urban areas that have good road and market access. This review found that fragile ecological condition, irrigation availability, access to roads, markets and agricultural inputs, and national policies are the main factors limiting agricultural intensification in Nepal. Other factors for intensification that are in line with global driving factors include population growth, food deficit, low agricultural GDP, and external organization intervention. Previous studies revealed both positive and negative impacts of intensification on farmer's livelihood and the environment and stressed the need of sustainable intensive production.

Agricultural production may be increased either by expansion of agricultural land or through intensive cultivation. The former is no longer possible in Nepal, so intensified cropping is the only option. In view of the potential adverse environmental impacts, however, sustainable approaches need to be emphasised. Redclift (1987) states—'for sustainable development to become a reality it is necessary for the livelihoods of the poor to be given priority'. Hence, sustainable agricultural intensification with minimal negative environmental consequences may be achieved only if the economic and livelihood needs of the poor rural communities are met.

At present, a majority of farmers are unable to afford the capital investment or risk of changing or intensifying their farming practices. Therefore, at the outset government policies and practices should encourage



**Figure 10: Cyclic process of agricultural intensification based on existing literatures.**

sustainable intensive farming system throughout the country through subsidies for improved varieties, fertilisers, agricultural implements and small agro-industries. Further the government must invest in infrastructure development like roads, irrigation, credit and market facilities. The overall theoretical and empirical analysis of agricultural intensification in Nepal concludes with the model presented in Figure 10. The intensification model bifurcates in its impact, yet overall effect is on the socio-economic condition of people. Thus, the middle path of sustainable intensification is proposed to address livelihood and food security issues of Nepal.

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