

# **Factors Affecting Agricultural Productivity in Nepal:**

## **Macro and Micro Perspectives**

(ネパールにおける農業生産性の規定要因：マクロとミクロの視点)

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ピアスジャン

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# **Summary**

Due to an ever increasing population growth, use of food crops for bio-fuel and scarcity of land and water resources, the pressure on increasing agricultural productivity is getting more and more intense. Recently, many developing countries have faced food shortage in domestic market that has disturbed the socio-economic harmony in these countries. These facts provide an important ground to carry out research on the agricultural productivity in developing country. In this context, this study is focused on assessing the factors affecting agricultural productivity in developing countries with special reference to Nepal. The whole study can be divided into three parts. The first part deals about the issues related to modern input use and total factor productivity. The analysis was done to assess the sources of land productivity as well as the trend in total factor productivity in developing countries including Nepal. The second part of the study is focused on analyzing the factors affecting input intensification, technical change and efficiency. The study was based on the grass-root level survey in Nepal. The last part deals about the responsiveness of Nepalese agriculture to policy variables like price, technology and agricultural export. The study was based on the aggregate national data.

The second chapter deals about the sources of agricultural growth in South and Southeast Asian countries. The result showed that the contribution of land expansion to the production growth was almost zero in South Asia while it was around 24% in Southeast Asia. This indicates that the productivity growth is the

main source of agricultural growth. There was a wide difference in land productivity between Nepal and other South and Southeast Asian countries. The difference in modern input use was the main reason for difference in land productivity. The result showed that the modern inputs like chemical fertilizer and tractor explained around 74 percent of growth in land productivity in Southeast Asia while it explained 61 percent in South Asia. This indicates a gradual transformation of agriculture from its dependency on conventional inputs to modern inputs to augment the land productivity. However, the case of Nepal is not encouraging as the level of modern input use is comparatively the lowest among all.

Agricultural growth based on input intensification has an upper limit. It is not possible to promote the input based growth after reaching a certain level. To expedite the rate of productivity growth, the input intensification should be accompanied with the technological advancement. In this regard, the third chapter is focused on measuring the trend of total factor productivity of Nepal compare to other low and lower middle income countries. Some of the past studies have embarked on this issue considering a group of developed and developing countries but Nepal was not included in such study and most of the data series was before 1980. This study considered the post-green revolution period (1980 to 2000) and 31 low and lower middle income countries from Asia and Sub-Saharan Africa. The focus was given on comparing the case of Nepal with that of other low and lower middle income countries. Past studies have concluded that the total factor productivity is negative in developing and least developed country. Contrary to the

past studies, this study found a positive factor productivity growth in both low and lower middle income countries. Nepal also showed a positive factor productivity growth. Positive factor productivity might be due to a shift in macro policy from a closed to a liberal economy in most of the developing countries after 1980. Findings showed an evidence of factor productivity convergence between Nepal and other countries. This supports the fact that the open economic policy in many developing countries help to converge factor productivity in the long run. When all countries are regrouped into three geographic regions, namely, South Asia, Southeast Asia and Sub-Saharan Africa, the total factor productivity was positive only in case of South and Southeast Asia while Sub-Saharan Africa indicated a negative growth in factor productivity. This explains the reason for the stagnant agricultural growth in many Sub-Saharan African countries. When the factor productivity was deconvoluted into technical change and technical efficiency change, the contribution of technical change was found higher compare to the contribution of technical efficiency change. However, in case of Nepal, the contribution of efficiency change was found higher.

The fourth chapter is focused on the factors affecting technical efficiency of rice farms in Nepal. A micro level survey, considering 120 rice growers, was carried out to collect the necessary data. The result showed that the productivity of rice in the surveyed areas could be increased by 30 percent by increasing the technical efficiency in a given technological state. In the second stage of the analysis, assessment was done to explore the factors affecting technical efficiency. The result

showed that the level of commercialization of rice had a positive impact on technical efficiency. Other household characteristics like age of household head, share of agriculture income in total household income also showed a positive impact on technical efficiency while sharecropping had negative impact on technical efficiency.

In chapter five, an assessment was done to study the factors affecting input and output market orientations and its impact on productivity. The result showed that the factors like land size, family size and market distance had a significant effect on the integration of farm to the output market. Land size had positive effects while market distance and family size had a negative effect on the output market orientation. Input market orientation was found to be affected by the level of output, output market orientation, contact to service providers, and share of agriculture income. Productivity was found to be affected by both input and output market orientations.

After analyzing the source of agricultural productivity and factors affecting it, the sixth and seventh chapters are focused on analyzing the response of production to different policy variables like price, technology and export. Chapter six is about the response of agricultural production to price and technological variables while chapter seven deals about the agricultural export policy and its effect on productivity. The result showed that the response of production to price and technology varied across crops. Commercial crop like vegetable was found more responsive to price and technological variables compare to other cereals and industrial crops. This suggests that the government policy on price and technology

may be more effective in the areas that have more commercial farms. The analysis of aggregate production response to terms of trade and technological variables showed that the aggregate production was responsive to technological variable but not to the terms of trade in the long run. Thus, the government price policy should not be general but should be targeted to specific commercial crops.

In chapter seven, analysis is carried out to see the effect of agricultural export and its diversification on agricultural productivity. The OLS result showed that the effect of export volume and product concentration was insignificant while the effect of geographic concentration was positive. The assessment of short-run dynamics using vector auto regression (VAR) method showed that both geographic concentration and product concentration had a positive impact on agricultural productivity. The positive impact of export concentration could be due to a small volume of exportable surplus and excessive dominance of big Indian market.

# **Chapter 1:**

## **Introduction**

### **1.1 Background of the Study**

#### **1.1.1 Role of Agriculture in Economic Development**

Before the green revolution, agriculture was perceived as a stagnant sector. The low productivity in agriculture has led many economists to advocate the transfer of labor and capital from agriculture to industry to ensure a higher economic growth. The traditional belief was changed with the advent of green-revolution in the early 70s. The green-revolution has made possible to subside many constraints that were caused by the fixed natural resource endowments. As a result, the agricultural productivity in many developing countries increased remarkably. This has led to reaffirm agricultural sector as a growth augmenting sector that could generate more food and raw materials at lower price; provide growing amounts of capital and labor for industrial growth; reduce poverty by increasing labor productivity and employment in rural areas and provide a growing domestic market for nascent national industries (Hazell and Diao, 2005).

The contribution of agriculture to the national gross domestic product (GDP) of many developing countries is still higher. Mass still depends on agriculture for their daily livelihood. A higher level of population growth in these countries has left no

option other than to increase production. Moreover, the fledgling industrial sector in these countries also demands a higher rate of agricultural growth. Generally, a higher demand from industrial worker increases the food price which ultimately put pressure on wage rate and dampens the industrial growth process (Ricardian Trap). Thus, the agricultural growth is a prerequisite condition in developing countries for its overall economic growth. To support this fact, Tiffin and Irz (2006) showed that the causality runs from agricultural value added per worker to gross domestic product per capita. Apart from this, the agriculture growth could work as a stabilizing factor to reduce economic inequalities across people and regions. The globalization has accelerated the pace of economic development in many developing countries but it has also increased the inequalities of different forms and dimensions within and across countries. This demands a broader development framework that would be more pro-poor. In this context, the World Bank (2008) has emphasized that the growth in agriculture is more responsive to poverty alleviation in developing countries. Thus, the role of agriculture in developing countries is just not to foster economic growth but also to promote a balanced growth.

Some of the past studies have dealt about the mechanism through which the agricultural growth translates into the economic growth. Johnston and Mellor (1961) mentioned that agricultural growth generates a forward-linkage effect when production is supplied as the inputs for nonagricultural production and generates a backward-linkage effect when it demands intermediate inputs such as seed and fertilizer. Apart from this, the increase in agricultural production generates extra

income that increases the demand for non-agricultural products. Increased income may also be saved and can be used for the investment in both urban and rural areas (Hart 1998). The strong linkage effect of agricultural growth to other sectors of the economy demands a balanced growth strategy that emphasizes the development of agriculture as the primary sector and developing industries with a strong emphasis on agriculture-industries linkages and interactions (Singer, 1979 cited by Diao, 2007).

### **1.1.2 Comparative Feature of Agriculture in Asian Countries**

Agriculture occupies an important place in the economy of many developing Asian countries. Table 1.1 presents a comparison of different agricultural indicators in the South and Southeast Asian countries. The figure indicates that the contribution of agriculture to the national GDP ranged from the lowest 18% in Thailand to the highest 59% in Nepal during 1981-1985. The share of agricultural value added to the national GDP declined in every country by a substantial margin during 2001-2005 compare to that of during 1981-1985. However, the rate of decrease of agricultural contribution to the national GDP did not commensurate with the rate of decrease in agricultural population. The percentage of rural population ranged from the minimum (59 percent) in Philippines to the maximum (93 percent) in Nepal during 1981-85. Every country witnessed a decrease of rural population during 2001-2005. But the rate of decrease was not so substantial. This could be due to the inability of manufacturing sector to absorb the labor from

agricultural sector. This is the main cause to increase the income disparity between urban and rural areas. This sort of imbalance in economic development has caused mass dissatisfaction and social unrest in many developing Asian countries. In this context, the challenge is to bring the rural mass into the main stream of development. This is possible only through a higher growth in agriculture and its strong linkage with non-agricultural sector. Many past studies also supports the importance of agricultural sector as an engine of growth during the early stage of development (Nguyen, 2000; Foster and Rosenzweig, 2008; Hazell and Diao, 2005, The World Bank, 2008).

There is a markedly difference in the proportion of arable land to the total land area across the countries. India, Pakistan, Bangladesh and Thailand have a higher proportion of arable land while rest of the countries has less than 17 percent arable land. The percentage of arable land has slightly decreased in India, Bangladesh, Philippines, and Thailand while in other countries it has slightly increased from 1981-1985 to 2001-2005. This indicates that there is an upper limit for land extension. With a fixed land resource accompanied with a higher rate of population growth, the food demand has been surging remarkably over time. Moreover, the gradual betterment of living standard in these regions has also instigated the demand for food. Thus, agriculture has two important agendas in these regions; first is to meet the food demand of growing population and second is to create a multiplier effect on the fledgling economy through its linkage to the other sectors of the economy. So, the issue is obviously to increase production and productivity

through technologically driven farming that will overcome different constraints emanating from resource endowments, socio-economic features, and climatic constraints.

Table 1.1 Cross country agricultural GDP, Arable land and Employment in agriculture

Country	Year	Agricultural Value added (% of GDP)	GDP per capita ppp	Arable land (% of total land)	% of rural population	Rural population growth
Nepal	1981-85	58.98	608.94	15.99	93.86	2.10
	2001-05	37.83	931.67	16.44	85.16	1.6
India	1981-85	33.00	950.02	54.84	76.18	1.83
	2001-05	20.66	1968.18	53.73	71.7	1.21
Bangladesh	1981-85	31.72	620.37	68.10	83.54	1.98
	2001-05	21.95	989.19	61.37	75.14	1.12
Pakistan	1981-85	29.82	1342.2	25.98	71.18	2.38
	2001-05	22.89	2021.14	27.82	65.78	1.89
Srilanka	1981-85	27.73	1701.75	13.53	81.86	1.58
	2001-05	14.38	3255.66	14.55	84.66	1.13
Thailand	1981-85	18.66	2462.97	33.83	72.42	1.75
	2001-05	9.90	6192	29.97	68.18	0.77
Indonesia	1981-85	23.22	1518.53	10.10	75.5	0.98
	2001-05	14.67	2987.15	12.06	54.34	-0.90
Philippines	1981-85	23.98	2490.52	17.67	59.2	0.84
	2001-05	14.84	2743.08	16.64	38.98	-0.21
Vietnam	1981-85	40.17	796.51	17.86	80.56	1.73
	2001-05	22.31	1898	21.04	74.44	0.79
Lao	1981-85	-	863.80	3.4	86.76	2.1
	2001-05	46.57	1505.56	4.16	74.76	0.25

Source: Based on data from the World Bank, 2010

### 1.1.3 Features of agricultural development in Nepal

#### 1.1.3.1 Geographic and socio-economic feature of Nepal

Nepal is one of the South Asian countries. It is a land-locked country and bordered with the People's Republic of China in the north and by the Republic of India in the south, east and west.



Figure 1.1: Map of Nepal

The total land area of Nepal is 147,181 square kilometers with the population of approximately 30 million. Nepal ranks 93<sup>rd</sup> in the list of world's largest country by land mass and ranks 41<sup>st</sup> in terms of the most populous country. Nepal is divided into three physiographic areas: the Mountain, Hill and Terai. Administratively, Nepal is divided into 14 zones and 75 districts which are grouped into five development regions. Development indicators show that Nepal remains below the

average of its South Asian counterparts. The per capita income, PPP is 1560\$; life expectancy at birth is 62.65; literacy rate is about 48.59%; 84.2% of people lives in rural area and 30.9% people are below the absolute poverty line (The World Bank, 2010). Nepal's gross domestic product (GDP) for 2008 was at over \$12 billion (at official exchange rate) with GDP real growth rate was 4.7%. Agriculture accounts for about 35% of Nepal's GDP, service comprise 49% and industry 16%. Agriculture employs 76% of the workforce, services 18% and manufacturing/craft based industry 6%. According to the 2008 estimate, the unemployment rate is 46%. Nepal ranked at 34<sup>th</sup> position for inequality in income distribution with Gini coefficient of 47.2. (The World Bank, 2010).

#### **1.1.3.2 Climatic feature of Nepal**

Nepal has five climatic zones, broadly corresponding to the altitude. The tropical and subtropical zones lie below 1200 meters, the temperate zone 1200 to 2400, the cold zone 2400 to 3600 meter, the subarctic zone 3600 to 4400 meter and the arctic zone above 4400 meters. Starting south, the terai and bordering *Churia* (Siwalik) hills have a climate much like the north Indian plains - subtropical monsoonal. In this region, the summer temperature can pass the 40 degree Celsius, while in winter they can hover around freezing. In the central part of Nepal, temperature can cross 35 degree in the summer and in the winter it is regularly below zero, with snow at higher altitudes. The high Himalayas have alpine climate and is very cold and snowy in the winter. All of these high areas are in the rain-shadow, which means that while they get some precipitation throughout the year,

they are predominantly dry. Nepal gets over 75% of its precipitation in the monsoon, from mid-June through end-September. The south gets more rain than the north, and the east more than the west.

#### **1.1.3.3 Nepal's agricultural structure and performance**

Agriculture is the main backbone of Nepalese economy with its contribution around 37% to the national GDP, 20% to merchandise exports (The World Bank, 2010). Of the total land area (14,855,042 ha) in Nepal, only 15 percent is arable. There are already 30 million people and this population is growing at the rate of 2.1 percent a year (HMG, 1995). Because the possible arable land is already brought under cultivation and the non-agricultural sector, with a sluggish growth rate, only absorbs 20 percent of labor force, the pressure on limited land has been increasing due to the rapid population growth. If this situation continues in the offing, this will jeopardize the already downtrodden society of Nepal. In this context, augmenting agricultural growth is a prime concern.

Nepalese agriculture is mainly dominated by cereal crops. But, it is gradually diversifying to high value crops. The share of high value sub-sectors (fruits and vegetables, spices and condiments and livestock) has increased from 54% to 59% from 1981 to 2005. The increase of share of high value crop is mainly attributed to the fruit and vegetable sub-sectors which has jumped from 14% to 25% (Figure 1.2 and 1.3). Rice accounts around 36% of total cropped area of Nepal; other cereal crops like maize and wheat cover around 36% of total cropped area; sugarcane, potato, tobacco and mustard are considered cash crop in Nepal and covers around

8% of the total cropped area (Piya, 2009). On the other hand, fruits and vegetables covers only 7% of the total cultivated area but contributes a much larger proportion of the overall value of agricultural output.

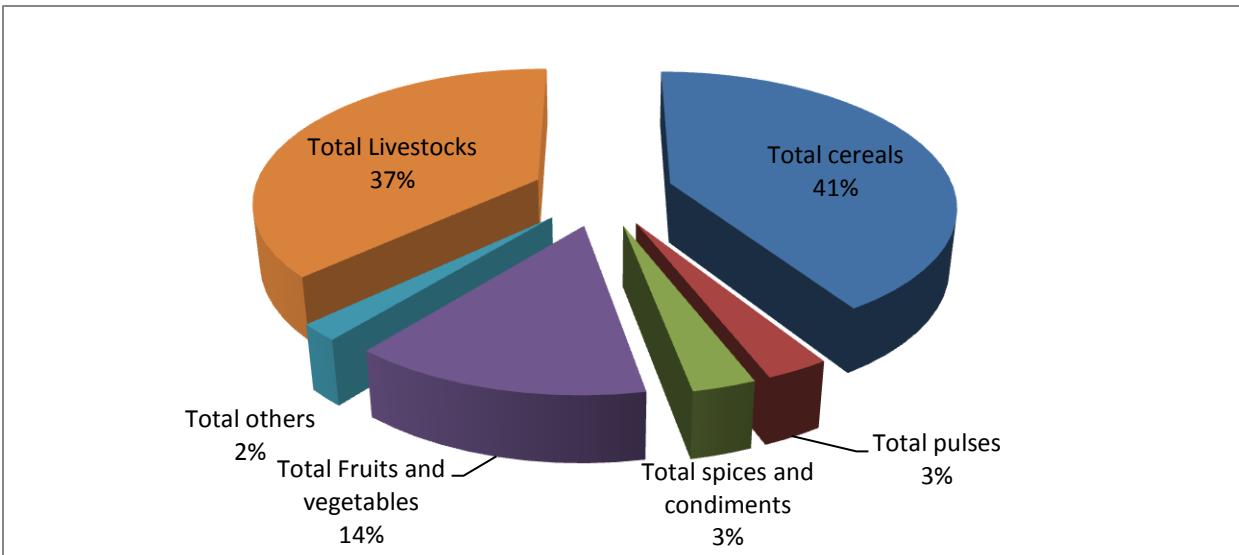


Figure 1.2: Value of output from different agricultural sub-sectors, 1981

*Source:* FAO, 2010

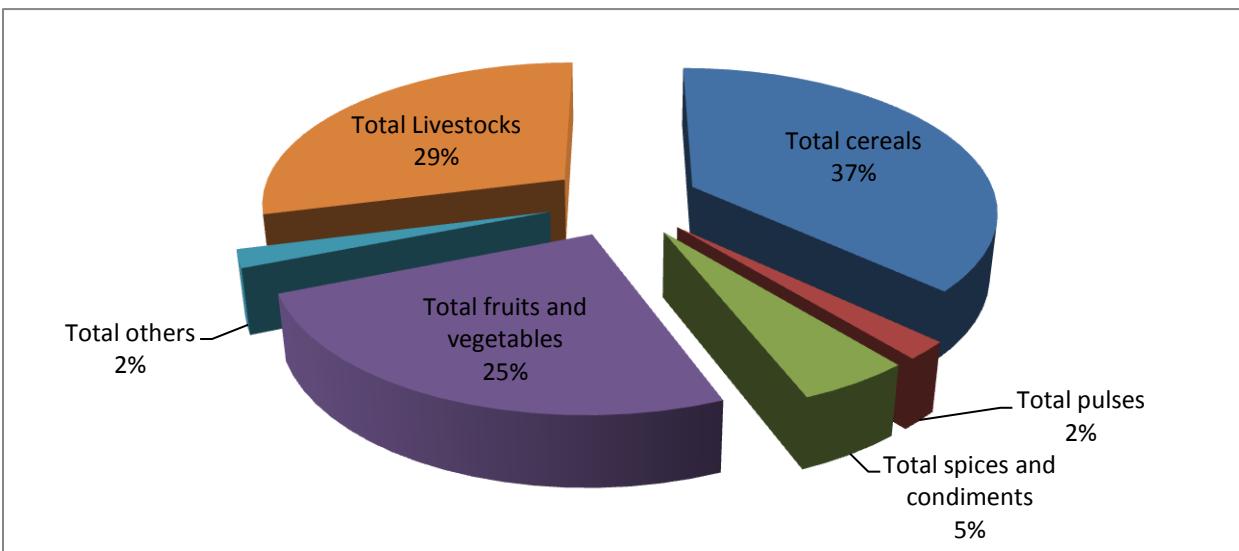


Figure 1.3: Value of output from different agricultural sub-sectors, 2005

*Source:* FAO, 2010

The performance of major cereal crops (rice, maize and wheat) substantially affects the overall performance of agriculture in Nepal. The recent past trend shows that Nepal has accomplished a marginal increase in paddy yield growth rate in the 20s compare to the 90s, going up from 1.3% per annum on average during 1991/92-1999/00 to 1.4% during the period 2000/01-2008/09. The rate of growth in wheat yields has however declined from 2.9% in the 90s to only about 1.2% in the 20s. Alternatively, maize is the only cereal whose production growth rate (3.1%) exceeds the population growth rate of 2.1% of Nepal. The production growth in maize has been driven largely by yield enhancement rather than an increase in area (IFPRI, 2010). The performance of high value sector has been remarkable. Vegetable production growth rate is by far the highest with production increasing from 1.65 million tons in 2000/01 to nearly 2.3 million tons in 2008/09 at an average rate of 7% per annum. The growth rate of fruit production is 4.2% per annum in 2008/09. Livestock products- milk and meat have been growing at 3.1 and 2.8 % respectively (MoAC, 2009)

Nepal has started giving emphasis on agricultural development since its inception of first five-year plan in 1956 and the emphasis has been continued in the later period of development plan. To bring a substantial impact on agricultural sector, a long-term agricultural perspective plan (APP) is also designed and implemented. The main aim of the plan is to expedite the pace of agricultural commercialization in Nepal. It has put emphasis on input intensification and technological advancement to expedite the growth of agricultural production and

productivity. As market is an important factor in the commercialization process, the plan has also emphasized the investment on rural agricultural road to connect the production pockets to the market centers. APP recognized production areas as commercial, semi commercial and subsistence pockets. Input intensification is given a top priority in the commercial pockets while road link up and input intensification program are implemented in the semi commercial pockets and focus is given to maintain the food security in subsistence production pockets.

#### **1.1.4 Research Issues**

There is a little option to increase production through expansion of agricultural land as almost all land has already been brought under cultivation. Thus, productivity increment is the only option to realize a higher growth rate in agriculture. In developing countries, the use of modern inputs like chemical fertilizer, modern seed is very low compare to other developed countries. Similarly, the effort to upgrade the technology in agriculture has not been remarkable so far. As a result, the growth in agricultural sector has been stagnant that has affected the overall economic growth of developing countries. This has raised some queries like why farmers are not using the modern input in an optimal amount; why is there a general apathy in adopting a new technology. These issues are not only specific to one country but applicable to developing countries in Asia. Thus, this study is conducted both at macro and micro perspectives. At macro level, a group of

countries from South and Southeast Asia and Sub-Saharan Africa including Nepal are considered while at micro level the case of Nepal is taken as a reference country.

The first issue is related to the sources of productivity growth in developing countries. There is no clear understanding that whether the modern inputs or traditional one or technological change is responsible for the current growth in agricultural productivity. To make a pragmatic policy reform in agricultural sector, it is worthwhile to understand the major source that has led the current productivity growth in agriculture. The analysis of this issue in an individual country may give a very narrow and biased outlook. Thus, many developing countries with similar resource endowments were considered.

After analyzing the role of modern input in production growth, the second issue considered in this study is the analysis of total factor productivity in agriculture. Total factor productivity deals about the changes in production technology and efficiency. Past studies have shown that the total factor productivity growth in many developing countries is negative contrary to the positive growth rate in developed country. This indicates that the contribution of total factor productivity in explaining the production growth is negative. However, most of the developing countries have witnessed a major policy shift from closed to more open and liberal economy in the early 80s. Such policy transformation also occurred in Nepal. There is a general belief that the total factor productivity in developing countries might be positive and converging across the countries after 1980. Thus, the issue to be explored is whether or not the total factor productivity in developing countries

including Nepal is positive and converging after 1980. This shades light on the role of total factor productivity in the production growth in the post-green revolution era.

The first and second issues are analyzed at cross-country level. This explains the role of modern inputs and factor productivity in the production growth of developing Asian countries including Nepal. However, for a policy maker, it is imperative to understand the factors affecting these sources of production growth. Many micro level intricacies might affect the level of input and technology use in farming. Thus, in the second stage of the study, a micro level analysis is carried out to assess various factors that affect technical change, efficiency change and input intensification. Micro analysis is carried out in Nepalese context, which can be referred for the case of other developing countries.

Past studies showed that the level of technical inefficiency in Nepal is very high (Dhungana et al., 2004). This means, the farmers in Nepal are not only poor in using new technology but they are also inefficient in capitalizing the existing technology. In general, the past results showed that the productivity can be increased by around 30 percent in a given technological condition. Various factors related to farm socio-economics are considered to explain the difference in technical efficiency across farmers. However, the past study did not conceptualize the factors related to market orientation and its effect on various farm decisions that may ultimately affect the technical efficiency of a farm. Generally, it is perceived that if a farm transforms from subsistence to commercial state, its ability to utilize the technology will be enhanced. Thus, the issue to be explored is the role of market

orientation on enhancing the technical efficiency in farming. Another issue that is to be explored is the factors affecting the level of modern input intensification. Most of the developing countries including Nepal seem to depend on the market instruments to expedite the level of input use in agriculture. However, there are other non-market factors like farm internal characteristics that may affect the level of input intensification. Thus, it is necessary to explain the role of both internal and external factors in input intensification.

Another issue in agricultural development is the selection of appropriate policy to expedite the production and productivity. The government policy affects various micro and macro factors that ultimately affect the production and productivity. There is always a policy dilemma to select an appropriate policy framework in developing countries. The socio-economic environment in developing country like Nepal is quite different compare to that of developed country. Thus, it needs a specific policy and development strategy to tackle with the problems. The government mainly uses price and non-price policy instruments to bring changes in the economy that ultimately affects the production and productivity trend. However, the effectiveness of government policy depends on the appropriateness of government policy itself and the responsiveness of production to economic incentives brought about by the policy shifts. There is a general belief that the responsiveness of agricultural production to policy variables in developing countries may be low due to the higher level of subsistence farming. In this context, it is worthwhile to investigate into the magnitude and nature of responsiveness of

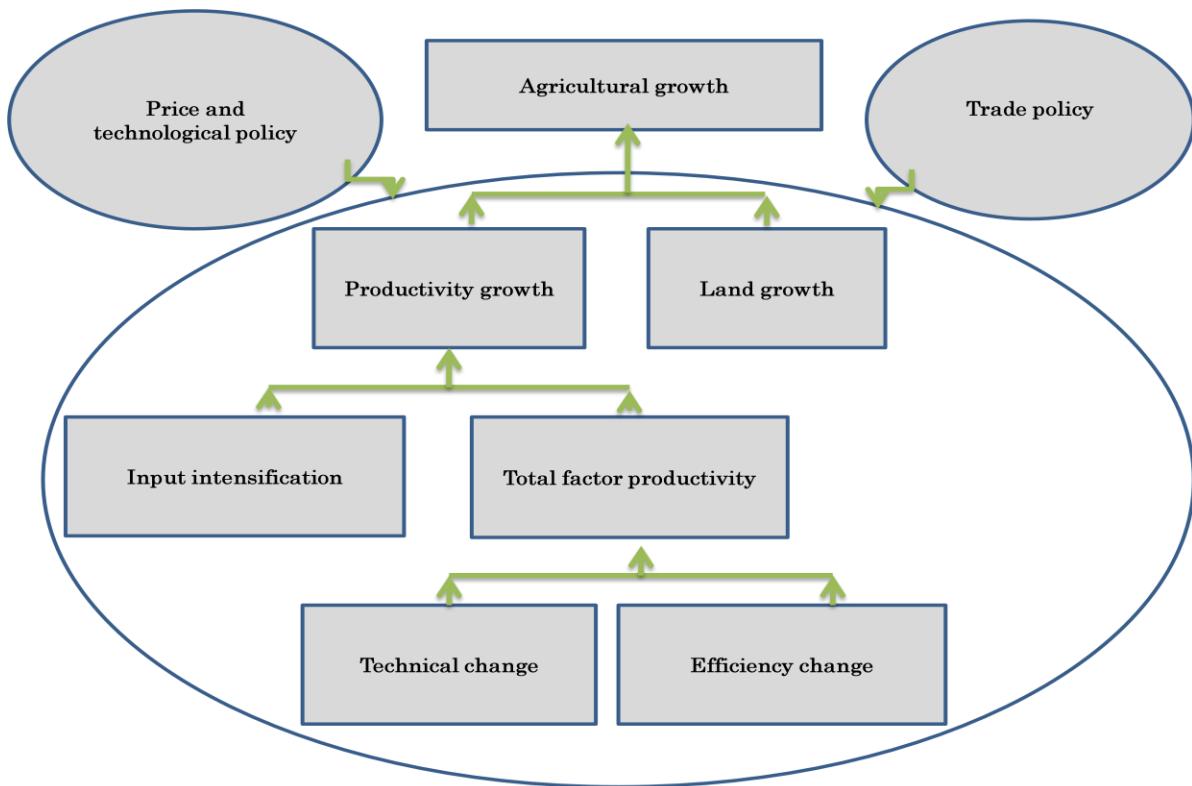
individual crop and aggregate production to the price and technological variables so that it provides an opportunity to scrutinize the appropriate policies..

Another important policy that affects agricultural production and productivity is the agricultural export policy. In the context of globalization, the domestic production is not only affected by the domestic factors, but it is more importantly affected by the trade related factors. The evidence shows that due to the low competitiveness and structural constraints in rural agriculture, many poor farmers in developing countries are out of the mainstream of globalization. But, the important issue is how the benefit of globalization can be reaped for a developing country. In this context, the issue is to select the appropriate export strategies that will have a profound effect on the agricultural productivity.

## **1.2 Objective of the study**

This study was attempted to examine the factor affecting agricultural production and productivity. More specifically this study aimed to:

1. assess the sources of agricultural productivity growth
2. assess the total factor productivity trend in developing countries
3. assess the factors affecting technical efficiency
4. assess the effect of input and output market orientations on productivity
5. assess the responsiveness of production to price and technological variables
6. assess the effect of export diversification on agricultural productivity



**Figure 1.4: Conceptual framework of research**

### 1.3 Limitation of the study

This study tried to analyze the factors affecting agricultural production and productivity from macro and micro perspectives. The result of macro perspective was based on the inference drawn from the Southern Asian context. Thus, the result should be generalized only for the regional context. At country level, the analysis was done to see the effect of different variables on agricultural production considering the national aggregate data. Here, the emphasis was only on price, technological and export variables. To analyze the issue in micro perspectives, only two districts were selected out of 75 districts in Nepal. The analysis was based on

the household survey in the selected village development committee (VDCs) of two districts. Thus, the conclusion of micro study should be generalized with a caution.

#### **1.4 Structure of dissertation**

This dissertation is divided into eight chapters. The introductory section is in chapter one. Source of agricultural productivity is presented in chapter 2. Chapter 3 and 4 present the factor productivity and technical efficiency in agriculture respectively. Chapter 5 describes the input and output market orientation and its effect on productivity. Chapter 6 analyzes the production response to price and technological variable and chapter 7 describes the agricultural export diversification and its effect on productivity and lastly, chapter 8 concludes the overall findings. Methodology and conceptual framework is presented in the respective chapter.

# CHAPTER 2:

## Sources of Agricultural Productivity Growth

### 2.1 Agricultural Productivity growth in developing countries

During the 19<sup>th</sup> century, almost all increase in crop production occurred as a result of increase in cultivated area. Due to the fixed land resource with an increasing demand for food, during the later period of the 20<sup>th</sup> century, the contribution of land productivity became more prominent. The shift from area expansion to land productivity indicates that there is a change from natural resource based to a science-based system of agricultural production. However, the rate of transformation is not parallel across countries and across regions. In many developed countries, the shift from area expansion to land productivity begun during the middle of 19<sup>th</sup> century. In some developing countries it begun at the later stage of 20<sup>th</sup> century while in many underdeveloped countries transformation is just beginning (Ruttan, 2002). This indicates that there is a wide gap in agricultural productivity across developed and developing countries with different level of technology and input intensification.

The recent period has witnessed many changes in agriculture such as increase use of food crops for bio-fuel, erratic weather conditions, and increasing scarcity of land and water. These changes have affected the supply pattern of agricultural products both in domestic as well as in international markets. Recently, many parts of the world have experienced a shortage of staple foods like rice, maize, and wheat. The consequences are seen in the form of global food price hike and its ailing effect on the poverty stricken people of developing countries (Lustig, 2009 and Mitchell, 2008). The problem of shortage is further aggravated by the raise in average income of mass in some of the highly populated countries in Asia and Latin America that has escalated the global food demand. This has incited debate regarding the possible options for increasing agricultural production in developing countries. As land is a scarce resource in many developing countries, production growth primarily depends on the growth of productivity. In the past, some studies have been carried out to examine the productivity difference between developed and developing countries (Hayami and Ruttan, 1985; Lau and Yotopolous, 1989; Craig et al., 1994; Frisvold and Ingram, 1995). These studies showed that there is a big gap in agricultural productivity between developed and developing countries. Kawagoe et al. (1985) reported large variations in land and labor productivity across 43 countries, for the years 1960 and 1980. Similarly, Fulginiti and Perrin (1998) focused on 18 developing countries (mixed from many regions) and reported that agricultural mechanization explained most of the difference in agricultural production. Due to the low level of existing productivity, the opportunity for

increasing agricultural production through productivity growth is higher in developing and underdeveloped countries (Rutan, 2002; Sharma et al., 1990). This possibility is quite higher in Nepal as the current level of productivity is quite below than that of other developed and developing countries.

In Nepal, due to inadequate infrastructure, poor rural-urban linkage and inadequate resource endowments, majority of farm households are engaged in subsistence farming. Thus, the productivity is quite below compare to the potential level. This has a set-back effect on the agricultural growth that has affected the pace of overall economic growth. The role of agriculture to balance the overall economic growth during the preliminary and transforming stage is highlighted by many scholars (Diao et al., 2007; Tiffin and Irz, 2006). Empirical study also supports the fact that there is a significant correlation between agricultural and overall economic growth in developing countries (Singer, 1984). Thus, increasing agricultural productivity is indispensable in Nepal not only to meet the demand of growing population but also to promote a balanced growth. In this context, this study compared the level of different agricultural input use in Nepal against other South and Southeast Asian countries and estimated the average contribution of modern inputs in the productivity growth.

The rest of the chapter is organized as follows. Section 2 deals about the comparison of AGDP, GDP and population growth of Nepal with other South and Southeast Asia. Section 3 illustrates the methodology used in the analysis. Section 4 presents the result and lastly, section 5 concludes the result.

## **2.2 Comparison of AGDP, Per Capita Income and Agricultural Population of Nepal with Other South and Southeast Asian Countries**

Figures 2.1 and 2.2 present a comparison of agricultural population, AGDP and per capital income of 10 South and Southeast Asian countries. In 1980, agricultural based population was more than 60 per cent in Nepal, Bangladesh, Thailand, Pakistan and India. While, other countries like Indonesia, Srilanka, Philippines and Malaysia had less than 60 percent of agricultural based population. In the same period, the percentage of agricultural contribution to the total GDP was more than 60 percent in Nepal, while in the rest of the countries this percentage was less than 40 percent. The lowest is represented by Malaysia. Compare to 1980, in 2007, all countries witnessed a decrease of agricultural population, however, the rate of decrease was not proportional across the countries. The share of agriculture in the total GDP also decreased in all countries in 2007. Only Nepal and Vietnam had more than 20 % share of agriculture in GDP while other countries had less than 20% share in total GDP in 2007. Per capita income more than doubled in all countries from 1980 to 2007. Malaysia represented the highest per capita income while Nepal represented the lowest per capita income in both periods. Individually, Srilanka, Thailand and Indonesia were better off in the ranking while Philippines performance was worse off in the ranking in term of per capita income in 2007 compare to 1980.

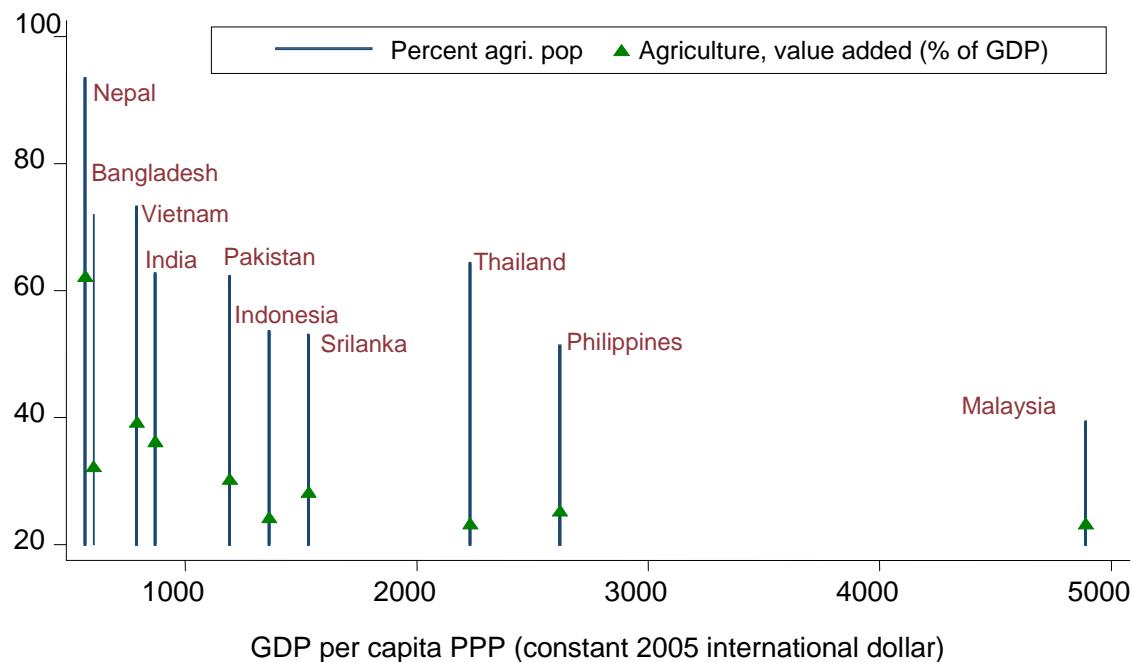


Figure 2.1: Comparison of AGDP, Agricultural Population and Per Capita GDP, 1980  
*Source:* Based on data from the World Bank, 2010

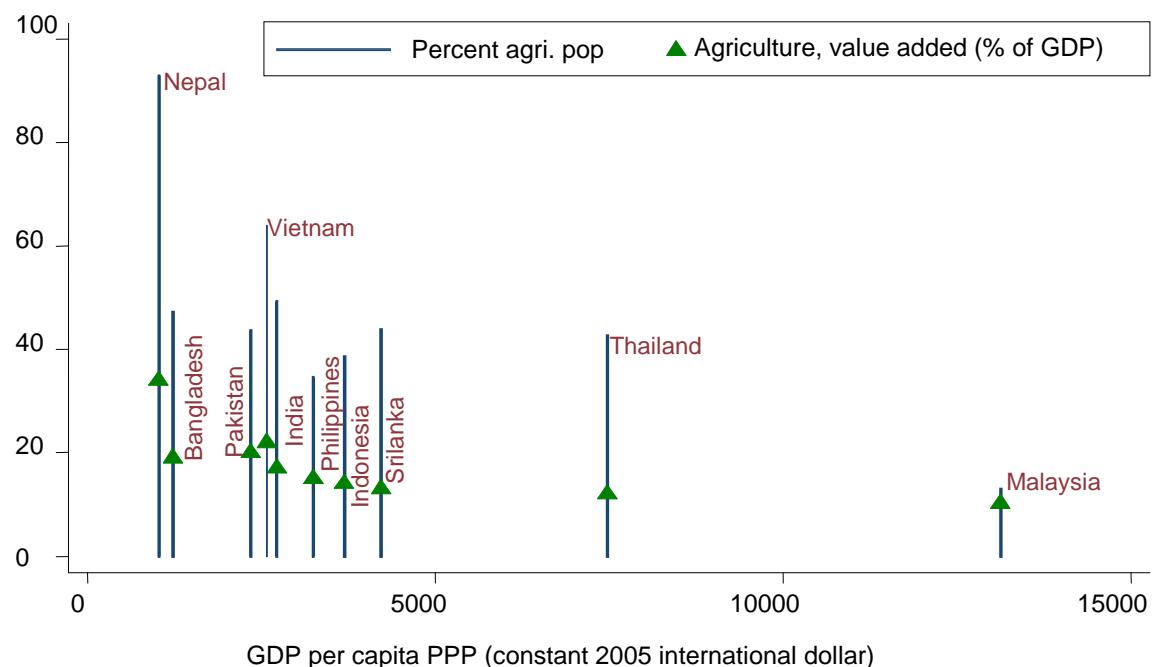


Figure 2.2: Comparison of AGDP, Agricultural Population and Per Capita GDP, 2007  
*Source:* Based on data from the World Bank, 2010

## **2.3 Comparison of trend of average productivity of major staple crops of Nepal with different regional aggregates**

Figure 2.3, 2.4 and 2.5 present a comparative trend of average productivity of rice, wheat and maize respectively. Nepal's average productivity is compared with the South and Southeast Asian average, world average and developed country average (Japan and USA). Every country and regions witnessed an increase of average productivity in all three crops. However, there was not a proportionate increase in productivity. Rice productivity in Nepal was equal to world's average and higher than that of South and Southeast Asian average during the 60s, however, during the later period its productivity ranked the lowest among all.

In case of wheat also, Nepal's average productivity was equal to the average world productivity during the 60s and was higher than South Asian average. However, in the later period, wheat productivity in Nepal ranked at the lowest among all. So the productivity growth did not commensurate with the average growth trend of South Asia. Among developed countries, Japan represented the highest productivity in wheat while the USA went along with the world average.

In case of maize, Nepal did not gain much in productivity increment. During the 60s maize productivity was as par the world average and greater than South and Southeast Asian averages but in the later period, maize productivity was below the world and South and Southeast Asian averages. USA represented the highest maize productivity. Maize productivity in Japan was more and less equal to South and Southeast Asian averages.

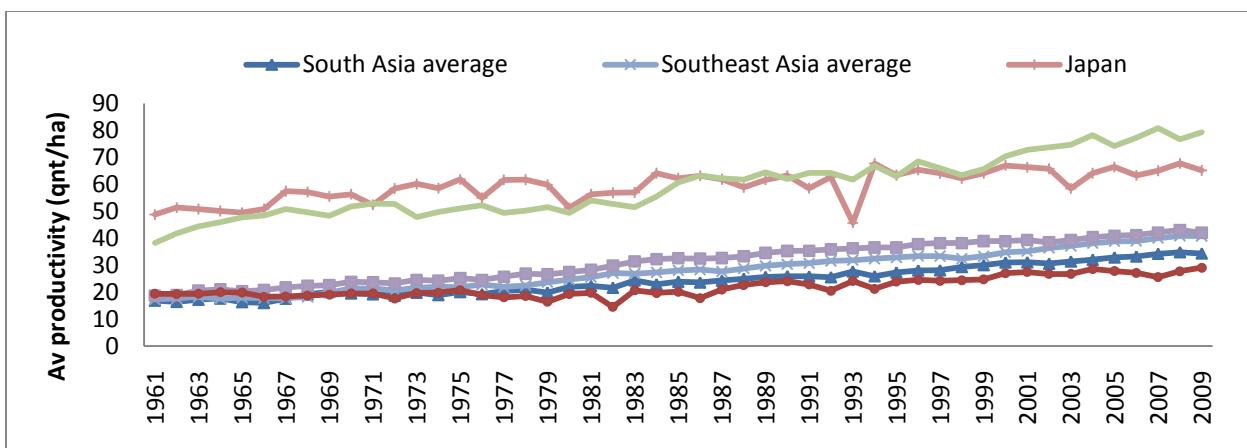


Figure 2.3: Average productivity trend of rice (1961-2009)

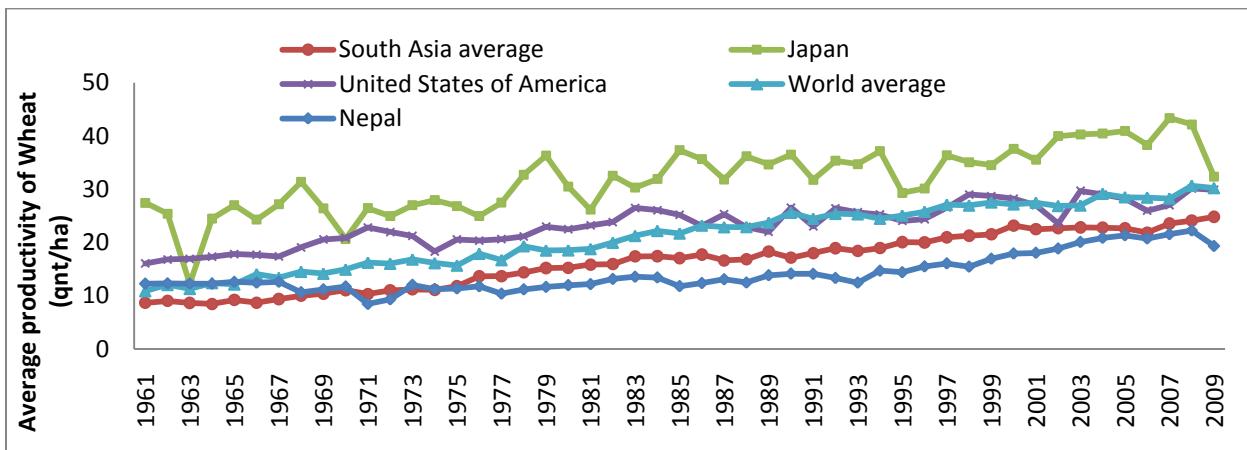


Figure 2.4: Average productivity trend of wheat (1961-2009)

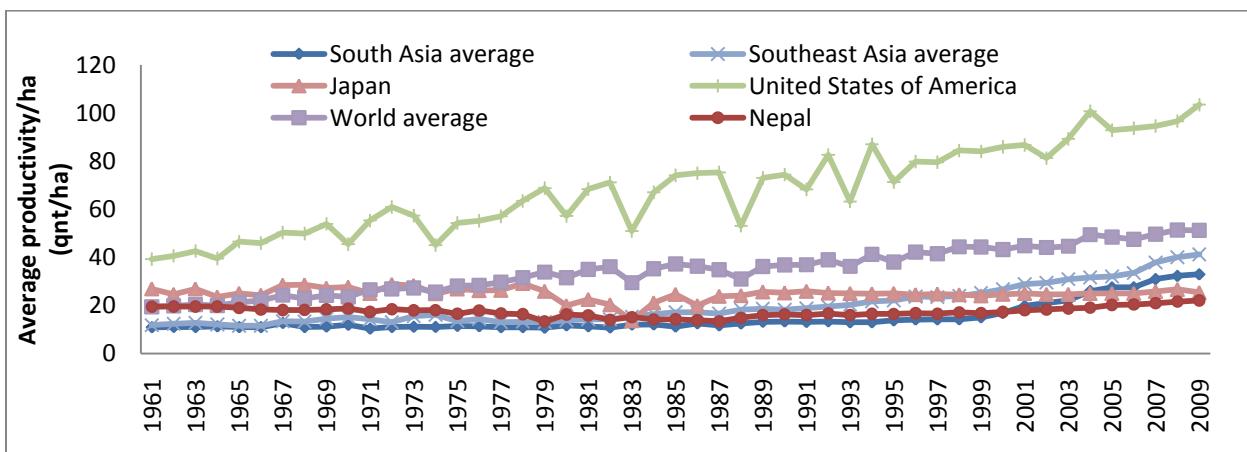


Figure 2.5: Average productivity trend of maize (1961-2009)

Source: Based on data from FAOSTAT

## 2.4 Materials and Methods

First, land productivity and input use per unit land was calculated to compare the trend of agricultural productivity and input use in agriculture in Nepal compare to other South and Southeast Asian countries. Second, an aggregate agricultural production function was estimated from cross-section, time-series data of 10 South and Southeast Asian countries including Nepal for the year 1980-2007. In this study, four major agricultural inputs- fertilizer, labor, livestock and tractor were considered. Some previous studies also considered the non-conventional inputs like exports, nutrition, and literacy rate as the source of variation (Frisvold and Ingram, 1995; Fulginiti and Perrin, 1998). However, in this study the effect of these non-conventional variables on productivity was assumed not direct but indirect through its effect on input use. The production function was specified as follows.

$$Y_{it} = \beta_0 + \sum_{j=1}^4 \beta_j X_{j it} + u_{it} \quad (1)$$

where  $Y_{it}$  is the log of aggregate agricultural output per hectare of agricultural land for the  $i$ th country in year  $t$ . The variables  $X_{j it}$  represents input  $j$  for the  $i$ th country in year  $t$ . Four types of inputs namely labor, fertilizer, tractor and livestock inputs per unit land were considered. The  $\beta_j$  term is the parameter to be estimated and  $u_{it}$  is an error term.

In the third part of the analysis, average annual growth in production was deconvoluted into growth in land area and land productivity. The following

accounting framework was used in this study: Q is log of output, Y is log of productivity and A is log of agricultural land area.

$$(Q_{it} - Q_{i0}) = (Y_{it} - Y_{i0}) + (A_{it} - A_{i0}) \quad (2)$$

Output growth is the sum of land productivity growth and the rate of land expansion. The regression results obtained from estimation of equation 1 was used to express land productivity growth as a function in changes in inputs.

$$Y_{it} - Y_{i0} = \sum_{j=1}^4 \hat{\beta}_j (X_{j�} - X_{j�0}) + (\hat{u}_{it} - \hat{u}_{i0}) \quad (3)$$

where  $Y_{it} - Y_{i0}$  is the continuous growth rate of land productivity.  $\hat{\beta}_j (X_{j�} - X_{j�0})$  is a weighted aggregation of input intensities.

Time series data were collected from 1980 to 2007 and included 10 countries; 5 from South Asia (India, Bangladesh, Sri Lanka, Nepal and Pakistan) and 5 from Southeast Asia (Thailand, Malaysia, Vietnam, Indonesia and Philippines). This study used FAOSTAT data on crop and livestock production. FAO uses the international dollar to estimate crop and livestock production values. To obtain comparable data from different countries, previous studies measured aggregate production in wheat-equivalent units (Hayami and Ruttan, 1971, 1985). This method avoids the use of exchange rates but introduces unpredictable biases in the measure of total output (Rao et. al., 1991). Thus, production data from FAOSTAT, which is measured in international dollars, was used in this study. Output was measured on a per hectare basis to avoid problems of heteroscedasticity. Data on

agricultural inputs including agricultural land, tractor usage, fertilizer, agricultural labor and livestock were obtained from FAOSTAT. Land measure was represented by the total hectares of agricultural land. Agricultural labor was represented by the economically active agricultural population. The number of livestock was considered fixed capital. To compile different types of livestock into an aggregate unit, a weighted total was used, where weights values were referenced from Hayami and Ruttan (1971). Variables including fertilizer and tractor usage were considered working capital.

## **2.5 Results and Discussion**

### **2.5.1 Comparison of land productivity and input intensification of Nepal with other South and Southeast Asian countries.**

Table 2.1 illustrates the average figure of land productivity and input use across the South and Southeast Asian countries during 1980-1990 and 1991-2007. Every country witnessed an increase in land productivity from 1980-1990 to 1991-2007. However, the increase was not proportionate across the countries. Vietnam and Bangladesh secured the highest increase while Srilanka got the lowest increase in land productivity from 1980-1990 to 1991-2007. Comparatively, land productivity was lower in Nepal and Indonesia in both periods. To illustrate the comparative position of countries in terms of land and labor productivity, two-way scatter plot was drawn and presented in figure 2.6. Malaysia had the highest labor productivity while Vietnam had the highest land productivity. Indonesia represented the lowest

land productivity. Nepal is placed at the point that represents lower land and labor productivity. In general, results revealed that an increase in agricultural inputs per unit of land was observed in all countries from 1991 to 2007, compared to that of 1980 to 1990. Input intensification is an important source of growth in land productivity. Thus, the variation in land productivity among nations may be attributed to the differences in input intensification. Fertilizer and tractor are considered as modern inputs in agriculture. Fertilizer use increased in all countries during 1991-2007. However, the increase in fertilizer use was not uniform across all countries and regions. Many country specific agricultural policies might have affected the difference in the growth rate of fertilizer use. Malaysia used the highest amount of fertilizer per unit land during 1980-1990; however, Vietnam topped the list during 1991-2007. Specifically, fertilizer usage in Vietnam and Thailand increased more than three-fold from 1980-1990 to 1991-2007. Vietnam remarkable progress on modern input use may be attributed to various policy shifts after 1990s and institutional innovation that has created an environment for widespread use of modern inputs. In other Southeast Asian countries, fertilizer use increased by approximately 50 – 90%. In South Asia, Srilanka used the highest amount of fertilizer per hectare during 1980-1990, while Bangladesh topped the list during 1991-2007. Alternatively, Nepal used the lowest amount of fertilizer in both periods. Specifically, fertilizer usage in Bangladesh increased by more than two-fold while other South Asian countries witnessed an increase of 40-100% from 1980-1990 to 1991-2007. The average regional value of fertilizer usage indicated that the level of

fertilizer applied in Southeast Asia was higher than that of South Asia. Tractor is another important agricultural input. In many parts of South and Southeast Asia, tractor is also used as a mean of transportation for agricultural products. The fifth column of table 2.2 shows tractor usage per 1000 hectares of agricultural land. A comparison of data from 1980-1990 and 1991-2007 revealed that tractor usage increased in all countries. Comparatively, Vietnam, Thailand, Malaysia, India and Pakistan increased tractor usage at higher rates. During 1980-1990, Pakistan had the highest tractor usage per unit of land; however, during 1991-2007, Vietnam displayed the highest tractor usage. The tractor use in Nepal is comparatively lower. Only Bangladesh and Philippines have lower tractor use than Nepal.

Livestocks and labor are considered as traditional inputs in agriculture. In this study, the economically active population was considered as a proxy for agricultural labor. Labor per hectare of agricultural land increased in almost all countries except Malaysia, where labor decreased during 1991-2007 relative to 1980-1990. In all countries, an increase in the number of livestock per unit of land was observed, except in Srilanka, where the number of livestock decreased. The number of livestock per unit of agricultural land was highest in Bangladesh in both periods. With the exception of Sri Lanka, all South Asian countries had more livestock per unit of agricultural land than Southeast Asian countries. In summary, investment in fertilizer and tractors per unit of land was higher in the Southeast Asian countries, while labor and livestock were higher in the South Asian countries. The average level of fertilizer and tractor use in Nepal is below the South and Southeast

Asian average. The correlation between livestock and fertilizer was -0.21, indicating that a higher use of fertilizer may suppress the number of livestock and vice versa. In rural areas, farm yard manure from livestocks is an important source of fertilizer. In general, countries with a higher number of livestock also had a lower number of tractors. The correlation between tractor usage and livestock input was -0.40. Thus, livestock power may be a substitute for machinery in some countries, especially in South Asia. Varying input levels and patterns might have caused differences in land productivity in South and Southeast Asian countries.

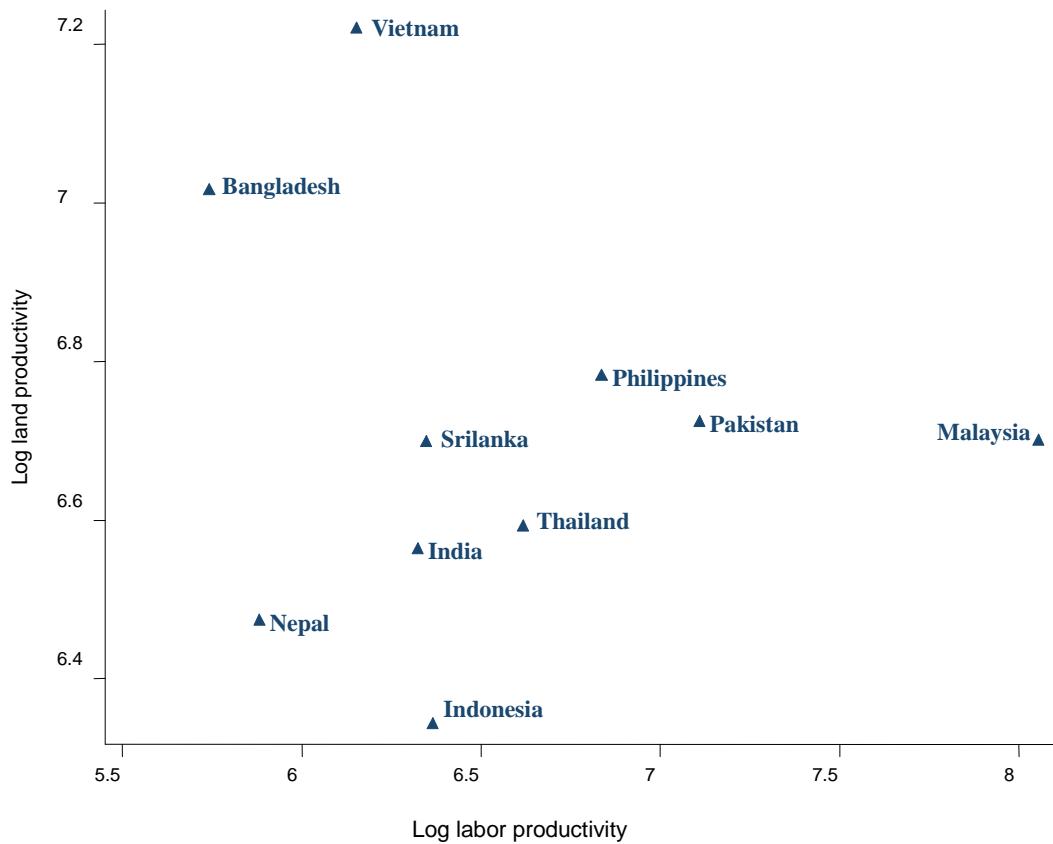


Figure 2.6: Two-way scatter plot of land and labor productivity (1980-2007)

*Source:* Based on FAOSTAT data source

Table 2.1: Average land productivity and input use

Country	Year	Land	Fertilizer/l	Tractor/	Livestock/	Labor/
		productivity Int \$/ ha	and Kg/ha	land No./1000 ha	land No./1000 ha	land No./1000 ha
Indonesia	1980-90	440	44.19	0.35	380.79	818.64
	1991-07	650.34	63.78	1.73	576.91	1017.93
Malaysia	1980-90	652.35	97.92	2.12	278.22	295.62
	1991-07	881.72	161.30	5.21	353.76	231.52
Philippines	1980-90	684.27	33.84	0.74	594.39	849.72
	1991-07	961.11	60.99	1.02	796.36	1099.57
Thailand	1980-90	557.52	25.52	1.57	522.13	861.57
	1991-07	787.74	80.51	9.11	538.72	989.74
Vietnam	1980-90	981.89	58.50	3.45	1089.58	2720.78
	1991-07	1569.51	203.00	14.13	1450.85	3082.75
Bangladesh	1980-90	793.70	59.50	0.45	1937.02	2871.69
	1991-07	1239.45	141.11	0.60	2824.02	3845.16
India	1980-90	508	43.84	3.39	1280.90	970.78
	1991-07	771.56	91.20	10.98	1515.49	1300.81
Nepal	1980-90	451.06	10.25	0.72	1886.32	1315.02
	1991-07	731.42	19.13	1.34	2408.56	2058.60
Pakistan	1980-90	583.62	53.99	6.25	1338.67	537.37
	1991-07	953.48	103.41	12.64	1961.36	705.64
Sri Lanka	1980-90	742.97	72.01	3.40	979.25	1271.90
	1991-07	805.42	101.80	3.55	751.44	1542.90

Source: Based on FAOSTAT database

## 2.5.2 Contribution of land productivity to the overall production growth

After accounting input use and land productivity, the overall production growth was estimated and was divided into growth in land area and land productivity using equation 2. Sample countries were classified into two groups- South Asia and Southeast Asia. Result is presented in Figure 2.7. The result

indicated that an increase in land productivity was the main cause of production growth. Comparatively, the contribution of land expansion to the increase in production was higher in Southeast Asia (24%) while it was zero in case of South Asia and slightly negative in case of Nepal. This indicates that South Asian countries have limited land resources compared to Southeast Asia. The negative growth of land expansion in Nepal could be due to the use of agricultural land for urban purpose. Thus, Nepal has to increase agricultural productivity if it has to sustain the production growth in the long run. The result indicates that there is a huge potential to increase productivity through input intensification as the current level of input use is quite below than the average of developing and developed countries.



Figure 2.7: Production growth divided into land area and land productivity growth

*Source:* Estimation based on FAOSTAT data

Table 2.2 presents the contribution of land expansion and productivity to the overall production growth at individual country level. The result indicated that average annual production growth was the highest in Vietnam and the lowest in Srilanka. Malaysia, Vietnam and Pakistan had the annual production growth rate higher than 3% while rest of the countries had annual production growth rate less than 3%. In South Asia, Pakistan had the highest production growth. Nepal represented little bit lower than Pakistan but higher than other South Asian countries. The contribution of land expansion to the production growth was higher in Malaysia (41.19%), Vietnam (33%), and Indonesia (30.3%). All countries in South Asia except Pakistan and Srilanka had negative contribution of land expansion on production growth. The result indicates that the production growth in South Asia is primarily generated through the growth in land productivity. Most of the South Asian countries, which productivity level was below than that of the Southeast Asian level, exhibited a higher growth in land productivity. Thus, the result has supported the view that underdeveloped country working below the frontier has higher potential to increase productivity compare to those that are near to the frontier. Individually, Pakistan represented the highest growth in land productivity while Srilanka represented the lowest growth. Land productivity growth in Nepal was 2.82, just little below than Pakistan but greater than all other South Asian countries. Among Southeast Asian countries, Vietnam represented the highest land productivity growth.

Table 2.2: Land productivity and growth accounting

Country	Growth in		
	Production	Land area	Productivity
Indonesia	2.93	0.89	2.04
Malaysia	3.35	1.38	1.97
Philippines	2.11	0.21	1.9
Thailand	1.884	0.006	1.878
Vietnam	3.94	1.3	2.64
Bangladesh	2.19	-0.27	2.45
India	2.37	-0.01	2.38
Nepal	2.79	-0.03	2.82
Pakistan	3.1	0.24	2.86
Srilanka	0.5	0.07	0.43

### 2.5.3 Production function and growth accounting

In the second part of the analysis, the aggregate production function was estimated. In this analysis, the relationship between land productivity and agricultural inputs per hectare was estimated. Cobb Douglas functional form was used. Hausman test was carried out to determine whether the fixed or random effect model is appropriate for the estimation. In the test, chi-square value came significant. Thus, the estimation was conducted in the fixed effect model. Equation 4 displays the result of panel regression, which explains the percentage change in land productivity due to one percentage change in fertilizer, tractor, livestock and labor per hectare of land. All estimates were positive and statistically significant. The greatest increase in land productivity was caused by labor (0.4) and then by livestock (0.36). This result concurs with those of previous studies. For instance, Kawagoe et al. (1985) estimated the response in land productivity of least developed countries as 0.6 for labor and 0.27 for livestock. Frisvold and Ingram (1995)

estimated that the response of production in Sub-Saharan African countries were 0.97 for labor and 0.31 for livestock. Additionally, Fulginiti and Perrin (1998) estimated a response of 0.33 for labor and 0.4 for livestock in 18 developing countries. The production elasticities of fertilizer and tractor were 0.21 and 0.12 respectively. The estimates of fertilizer and tractor usage were also similar to previous studies. To observe an interaction effect between livestock and fertilizer, and tractor and labor, interaction terms were included in regression analysis. However, interaction terms were not statistically significant and were subsequently removed from the analysis.

$$Y = .25 + 0.21^{***} F + 0.12^{***} T + 0.36^{***} LV + 0.40^{***} L \quad (4)$$

(R<sup>2</sup> within = 0.85, between = 0.38 and overall= 0.44)

F = 394.28\*\*\* Hausman test: Chi<sup>2</sup> 66.97\*\*\*

Where, Y= land productivity, F = fertilizer per hectare, T= tractor per ha, LV= livestock per hectare, and L = Labor per hectare

The regression coefficient was used for growth accounting using equation 3. A summary of growth accounting by region is presented in figures 2.8 and 2.9. Results suggested that an increase in fertilizer usage per hectare explained a majority of growth in land productivity in South and Southeast Asian countries. Fertilizer usage accounted for 34% of growth in land productivity of South Asia. While in case of Southeast Asia, fertilizer usage accounted for 40% of growth in land productivity. Tractor usage per unit of land explained around 27% of land productivity growth in

South Asia while in case of Southeast Asia, it accounted for 34% of growth in land productivity. The contribution of labor was comparatively higher in South Asia. Only 5% of growth in land productivity was attributed to labor in Southeast Asia. Alternatively, the contribution of labor in South Asia was 19%. The contribution of livestock growth in the growth of land productivity was 10% and 16% in South Asia and Southeast Asia respectively. It indicates that the modern inputs related to green revolution technology accounts for more than 60 percent growth in land productivity in these regions. Past studies have also got similar results. Study by Fulginti and Perrin, 1998 estimated the total contribution of fertilizer and tractor to the production growth in 18 least developed countries and showed that the contribution of fertilizer and tractor inputs was around 80 percent. However, the result of Solow residual in this study contradicts the previous result obtained in developing countries. The result of positive technical change in this study could be due to considering recent data and only including developing countries from Asia. Many previous studies on total factor productivity considering a mix of developed and underdeveloped countries indicated that developing countries have experienced technological regression (Trueblood and Coggins, 2003; Nin et al. 2002). If estimation is done including developed countries, the magnitude of the result could be different. The contribution of technical change to the growth in land productivity was found higher in South Asia compare to Southeast Asia as indicated by Solow residual. This could be due to land scarcity in the South Asian countries. Induced growth model proposed by Hayami and Rutan (1971), advocated that the technical

change in agriculture depends on the relative scarcity of resource endowment and factor prices. The relative scarcity of land resource in the South Asian region could be the cause of higher contribution of technical change in the overall land productivity growth.

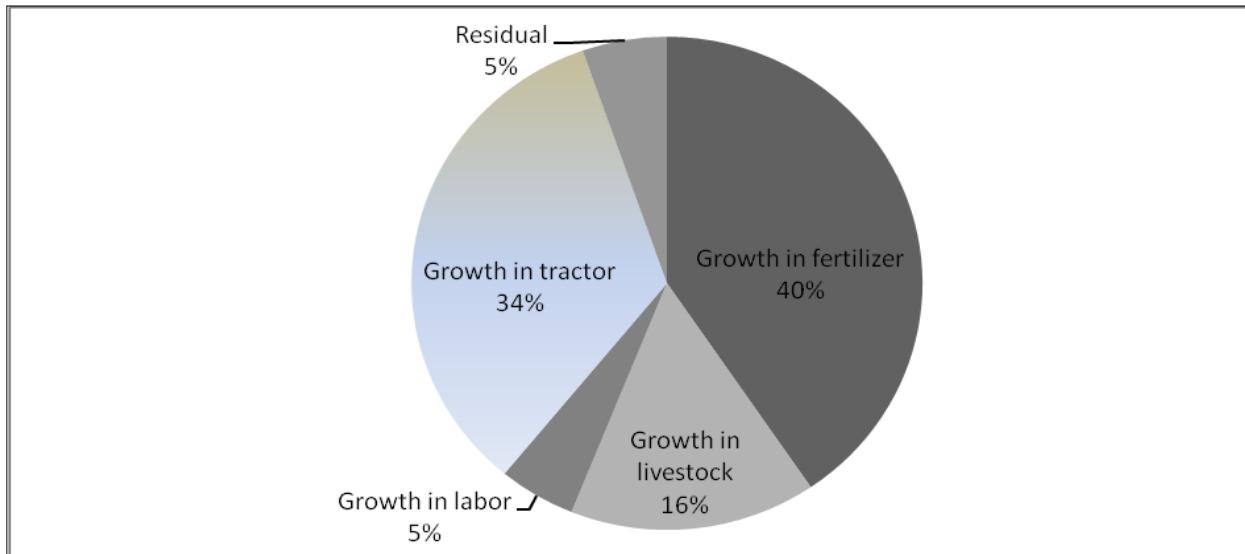


Figure 2.8: Contribution of inputs in the growth of land productivity in Southeast Asia

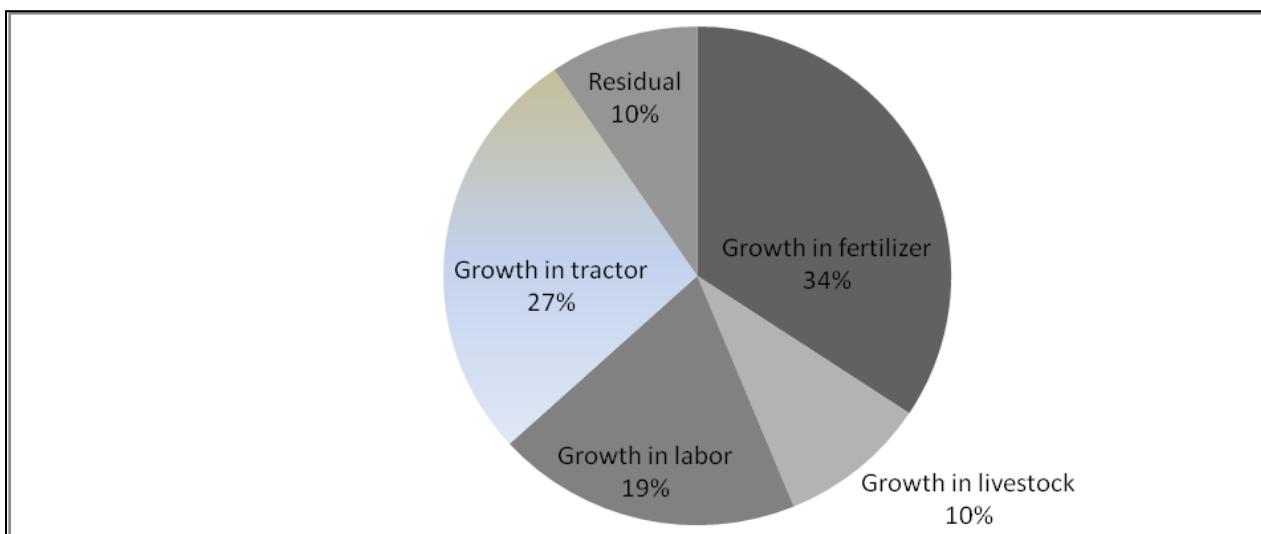


Figure 2.9: Contribution of inputs in the growth of land productivity in South Asia  
*Source:* Estimation based on FAOSTAT data

## **2.6 Conclusions and Policy Recommendations**

Only land productivity growth explained the growth in agricultural production in Nepal and other South Asian countries while land productivity as well as land expansion explained the production growth in Southeast Asian countries. This indicates that cultivable land is very scarce in Nepal and almost all cultivable land is already brought under cultivation. Thus, the increasing land productivity is the only option for production growth in Nepal.

Input intensification of Nepal and other South and Southeast Asian countries were different and led to a large disparity in land productivity. Every country has experienced an increase in land productivity from 1980-1990 to 1991-2007. Comparatively, Vietnam and Bangladesh had higher land productivity while Indonesia and Nepal had lower land productivity. Fertilizer use per unit land was higher in case of Malaysia, Vietnam, Bangladesh, Pakistan and Srilanka. Tractor use per unit land was comparatively higher in Thailand, Vietnam, India and Pakistan. All South Asian countries except Srilanka had higher livestock intensification compare to the Southeast Asian countries. Labor intensity was higher in Nepal, Bangladesh, Vietnam and Srilanka. Different level of input intensification across the countries could be due to difference in resource endowments, government policy, and level of economic development.

Fertilizer appeared to be the most important input that explained around 34% growth in land productivity in South Asia and 40% growth in land productivity in Southeast Asia. After fertilizer, tractor usage was found to be important variable for

explaining growth in land productivity. The contribution of tractor usage was higher in Southeast Asia compare to South Asia. Tractor input is relatively more important in Southeast Asia compare to South Asia due to relatively scarce labor resource. The contribution of labor was higher in South Asia, while the contribution of livestock was higher in Southeast Asia. This indicates that, in South Asia, a higher proportion of population depends on agriculture for daily livelihood and growth in non-agricultural sector could not absorb the agricultural labor. On the basis of the result, it can be concluded that there is a need to increase the level of fertilizer in south Asian Countries particularly in Nepal. The respective country report shows that a direct subsidy is used as a tool to promote fertilizer in many of these countries while Nepal has totally liberalized the fertilizer marketing. There is a debate on whether the withdrawal of fertilizer subsidy increases or decreases the rate of fertilizer application. Obviously, liberalization increases the cost of fertilizer and ultimately cost of production. Many small farmers may find it difficult to bear the increased cost. But, the increased productivity may offset the increased cost. Further research is needed to see how these countries can augment the rate of fertilizer use.

# CHAPTER 3:

## Total Factor Productivity Growth in Nepal- A Comparison to Asian and African Developing Countries

### 3.1 Concept of Total Factor Productivity

Total factor productivity (TFP) is another important source of productivity growth. TFP represents the rate of transformation of total input into total output. The rate of transformation depends on the level of technology and technical efficiency. Technical change represents the expansion of production frontier while efficiency change represents the better capitalization of a given technology. In the absence of TFP growth, the agricultural growth primarily depends on input intensification. However, the input led growth may not be sustainable in the long run due to fixed land resource and diminishing marginal productivity. Thus, for the sustainable growth, increasing total factor productivity is indispensable.

### 3.2 Past findings and Purpose of the Study

Some of the previous studies have analyzed the issue of agricultural productivity in developing countries (Fulginiti and Perin, 1998; Kawagoe and

Hayami, 1983; Kawagoe et al., 1985; Lau and Yotopoulos, 1989; Luh et al., 2008; NKamleu, 2004, Sharma et al., 1990; Suhariyanto and Thirtle, 2001). The conclusion of these studies supports the fact that total factor productivity has been declining in low-income countries. Schultz (1964) emphasized the shortage of modern agricultural technologies as the main reason for low agricultural productivity in the low-income countries. However, the study by Arnade (1998) and Lau and Yotopoulos (1989) indicated that the factor productivity was declining in developing countries during the Green Revolution era. If this is the case, the picture is disappointing for the people who advocate technology-based agricultural development. Alternatively, Fulginti and Perrin (1998) argued that the distorted price policies and other interferences are the reasons for low factor productivity growth even in the green revolution era. Some researchers like Murgai (2001) and Nin *et. al.* (2002) argued that the definition of technical change used in these studies was biased and led to the biased result. Another important aspect of previous studies was the selection of the period. Generally, most studies focused on the time span from 1960 to 1980. This is the period known for massive restrictive policy on agriculture with an inward looking economy in many developing countries. Thus, the declining factor productivity during that period should be interpreted under the context of such economic policies. A shift in government policy from a closed to a liberal economy after the mid 1980s in many developing countries might have caused a different pattern in agricultural productivity. The proponent of neo-classical growth model believes on the spillover of technology and convergence of

factor productivity in the long run. In this context, this study was focused on estimating the total factor productivity in developing countries in the post green revolution period that coincides with the liberal economic policy in many developing countries. The main purpose of the study was to compare the case of Nepal with other developing nations.

This study considered the data series (1981-2000) of 31 low and lower middle income countries from the African and Asian continents. With some exception, most of these countries are at the initial stage of development with a dominant agricultural share in the national economy. Thus, the comparison of factor productivity among these nations provides insight about the relative performance of agriculture in these nations.

### **3.3 Material and Methods**

This study analyzed the total factor productivity using a non parametric-Malmquist Productivity Index (MPI) technique. The Malmquist index was first proposed by Caves, Christensen and Diewert (1982). It is based on the distance function that describes a multi-input and multi-output production technology. This approach uses data envelopment analysis (DEA) method. DEA is a linear programming (LP) technique to construct a piece-wise linear surface over the data inputs. Given data for  $N$  countries in a particular time period, the linear programming problem that is solved for the  $i$ th country in an output-oriented DEA is as follows:

$$\begin{aligned}
& \max_{\theta, \lambda} \theta \\
\text{st} \quad & -\theta y_i + Y \lambda \geq 0, \\
& x_i - X \lambda \geq 0, \\
& \lambda \geq 0,
\end{aligned} \tag{1}$$

where

$y_i$  is a  $M \times 1$  vector of output quantities for the  $i$ th country;

$x_i$  is a  $K \times 1$  vector of input quantities for the  $i$ th country;

$Y$  is a  $M \times N$  matrix of output quantities for all  $N$  countries

$X$  is a  $K \times N$  matrix of input quantities for all  $N$  countries;

$\lambda$  is a  $N \times 1$  vector of weights; and

$\theta$  is a scalar

$\theta$  will take a value greater than or equal to 1.  $\theta - 1$  is the proportional increase in outputs that could be achieved by the  $i$ th country, with input quantities held constant.  $1/\theta$  represents a technical efficiency (TE) that varies between 0 and 1. The above LP is solved  $N$  times- once for each country. Each LP produces a  $\theta$  and a  $\lambda$  vector. The  $\theta$  provides information on the technical efficiency for the  $i$ th country and the  $\lambda$  provides information on the peers of  $i$ th country. The peers of the  $i$ th country are those efficient countries that define the facet of the frontier against which the inefficient country projected.

The Malmquist index is defined using distance functions. An output distance function considers a maximal proportional expansion of the output vector given an input vector. We define an output distance function in terms of the production technology set  $T$  as follows:

$$D_0(x, y) = \inf_{\theta} \left( \theta > 0 : \left( x, \frac{y}{\theta} \right) \in T \right) \quad (2)$$

where  $T = \{(x, y) : x \in L(y), y \in P(x), x \text{ can produce } y\}$

The output distance function can be defined with respect to the output set as follows:

$$D_0(x, y) = \inf_{\theta} \left( \theta > 0 : \frac{y}{\theta} \in P(x) \right) \text{ for all } x \in L(y) \quad (3)$$

where the output set  $P(x)$  associated with a specific input vector  $x$  is the set of all output vectors  $y$  which can be produced using  $x$ .

$$P(x) = \{y : (x, y) \in T, \text{ for each } x \in \mathbb{R}_+^N\} \quad (4)$$

Using the distance function, the Malmquist productivity index (MPI) can be defined as the productivity change from period  $t$  to  $t+1$ , where period  $t$  is considered as the reference period technology.

$$MPI_t = \frac{D_t(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)}. \quad (5)$$

MPI with period  $t+1$  technology as the reference period technology can also be defined as

$$MPI_{t+1} = \frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_{t+1}(x_t, y_t)} \quad (6)$$

As it is difficult to choose between reference technology in time period  $t$  and  $t+1$ , Fare *et al.* (1994) proposed the geometric mean of these indices for the year  $t$  and  $t+1$ .

$$M_{t,t+1}(x_t, y_t, x_{t+1}, y_{t+1}) = \left[ \frac{D_t(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)} \times \frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_{t+1}(x_t, y_t)} \right]^{1/2} \quad (7)$$

This can be further rearranged into technical efficiency change ( $TEC_{t, t+1}$ ) and technical change ( $TC_{t, t+1}$ )

$$M_{t,t+1}(x_t, y_t, x_{t+1}, y_{t+1}) = \underbrace{\frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)}}_{TEC_{t,t+1}} \underbrace{\left[ \frac{D_t(x_{t+1}, y_{t+1})}{D_{t+1}(x_{t+1}, y_{t+1})} \times \frac{D_t(x_t, y_t)}{D_{t+1}(x_t, y_t)} \right]}_{TC_{t,t+1}}^{1/2} \quad (8)$$

Thus, MPI can be led itself to a decomposition into technical efficiency change and technical change. A Malmquist index, with the value greater than 1, represents an improvement in the productivity and vice versa.

The sample includes agricultural production and input data for 31 developing countries over the period 1981 to 2000. Out of 43 low income countries (LIC) listed by World Bank, 22 LICs and out of 55 lower middle income countries (LMIC) only 9 LMICs are considered in this study\*. The output measure used in most of the past studies is total wheat equivalent units (following the work of Hayami and Ruttan, 1971, 1985). While this method avoids the use of problematic exchange rates but introduces some unpredictable biases in the measure of total output (Rao *et al.*, 1991). Thus, this study used the data on crop and livestock production taken from FAOSTAT. FAO uses the comparable international dollar to estimate the value of crop and livestock production. The agriculture land measure is a stock of total hectares of arable land in agriculture taken from FAOSTAT. The number of agricultural workers, represented by the economically active population in agriculture, was also taken from FAOSTAT. Unlike in the past studies, both male

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\*World Bank divided Economies according to 2008 GNI per capita, calculated using World Bank Atlas method. The groups are: Low income, \$ 975 or less; Lower middle income, \$ 976-\$3855, Upper middle income, \$3856-\$11905 and High income, \$ 11906 or more.

and female population was considered as agricultural labor. Female workers are the integral part of the agricultural labor in developing countries. The number of livestock, taken from FAOSTAT, was considered as a fixed capital endowment in agriculture. To compile different livestocks into one aggregate comparable unit, the weights used in the summation were referenced from Hayami and Ruttan (1971). Variables like use of fertilizer and tractor power were considered as working capital and taken from the World Bank, 2010.

### 3.4 Result and Discussion

#### 3.4.1 Total factor productivity, technical change and technical efficiency change

A non parametric-Data Envelopment Analysis (DEA) was carried out to calculate the country-wise annual total factor productivity change. Four distance functions necessary for estimation of Malmquist Productivity Index (MPI) were evaluated by using linear programming method. Annual Malmquist productivity change, efficiency change and technical change indices of all 31 countries were estimated. The result is presented in table 3.1. The result showed that the performance of average productivity (Malmquist index in the last row) was positive (1.2%) for all set of countries for the period 1981 to 2000. At the individual country level, all LMIC countries had positive factor productivity while in case of LIC, all except Senegal, Burkino Faso, Mali, Gambia, and Uganda had positive factor productivity. This result is contradictory to the result of the previous studies by Fulginti and Perrin (1998), Kumar *et al.* (2008), Luh *et al.* (2008), Nkamleu (2004).

They found negative factor productivity in developing country. The result in this study can be justifiable on the basis of its choice of the period which is the post green revolution era contrary to the previous studies conducted on the data series of 60s- 80s and choice of the countries. Total factor productivity growth was highest in Ghana with 4.2% growth. Nepal has got only 2.4% average total factor productivity growth, which is mostly contributed by technical efficiency change rather than technical change. All countries except Uganda had positive technical change. However, in case of efficiency change, out of 22 LMI countries, only 11 countries showed positive efficiency change while 2 of them showed status quo and rest of them showed negative efficiency change. Contrary to this, all countries in LMI group showed positive efficiency change. Comparing the contribution of technical change and efficiency change to the total factor productivity, on an average, the contribution of technical change was found higher. However, in case of individual country case, the result differs with each other. Countries like Malawi, Mozambique, Uganda, Ghana, Nepal, Lao, China and Sudan had slightly greater contribution of efficiency change in total factor productivity growth.

All LIC and LMIC countries were regrouped according to geographic region and comparison was done against the case of Nepal. Table 3.2 presents the result. Total factor productivity was found positive both in South and Southeast Asia while it was found negative in Sub-Saharan Africa. The result of Sub-Saharan African concurs with the previous result of Frisvold and Ingram, 1998. Comparatively, South Asia had higher factor productivity growth (2.3%) compare to Southeast Asia

(1.1%) and Sub-Saharan Africa (-3.6%). Comparatively, total factor productivity growth in Nepal was little bit higher than average of South Asia.

Table 3.1: TFP, Efficiency and Technical change indices: Average of 1981-2000

Country	Malmquist total factor productivity change	Efficiency change	Technical change
<b>Low Income Country</b>			
Niger	1.021	0.997	1.025
Chad	1.006	0.993	1.013
Benin	1.027	1.008	1.019
Senegal	0.984	0.972	1.012
Malawi	1.026	1.02	1.005
Burkina Faso	0.996	0.994	1.002
Mali	0.981	0.973	1.008
Zambia	1.02	1.009	1.01
Zimbabwe	1.002	0.987	1.015
Guinea-Bissau	1.005	1.001	1.004
Central African Republic	1.037	1.005	1.031
Gambia	0.994	0.99	1.004
Togo	1.005	0.993	1.012
Mozambique	1.014	1.013	1.001
Uganda	0.987	1	0.987
Rwanda	1.011	1	1.011
Burundi	1.01	1.005	1.005
Ghana	1.043	1.027	1.015
Kenya	1.007	0.994	1.013
Nepal	1.026	1.022	1.004
Viet Nam	1.011	1	1.011
Lao	1.026	1.015	1.011
<i>Av of LIC</i>	<i>1.011</i>	<i>1.001</i>	<i>1.010</i>
<b>Lower Middle Income Country</b>			
Philippines	1.005	1	1.005
Indonesia	1.004	0.997	1.007
Pakistan	1.023	1.005	1.018
India	1.023	1.008	1.015
Bangladesh	1.02	1	1.02
Thailand	1.013	1	1.012
China	1.028	1.02	1.007
Côte d'Ivoire	1.014	1	1.014
Sudan	1.018	1.009	1.008
<i>Av of LMIC</i>	<i>1.016</i>	<i>1.004</i>	<i>1.012</i>
<i>Geometric Mean of all countries</i>	<i>1.012</i>	<i>1.002</i>	<i>1.011</i>

Table 3.2: Region wise summary of total factor productivity, technical and efficiency change

Regions	Average Total Factor Productivity Index	Average Technical Change Index	Average Efficiency Change Index
South Asia	1.023	1.014	1.008
Southeast Asia	1.011	1.009	1.002
Sub-Saharan Africa	0.964	0.964	0.954
Nepal	1.026	1.004	1.022

Figure 3.1 and 3.2 and 3.3 shows the trend of total factor productivity from 1982 to 2000 in LMIC and LIC and Nepal respectively. The general trend of factor productivity seemed similar in both economic groups. However, the trend in LMIC was steeper than that of LIC. In the short run, total factor productivity trend seemed quite fluctuating with a cyclical peak and trough in both cases. In case of Nepal, total factor productivity was not steady but fluctuating over time.

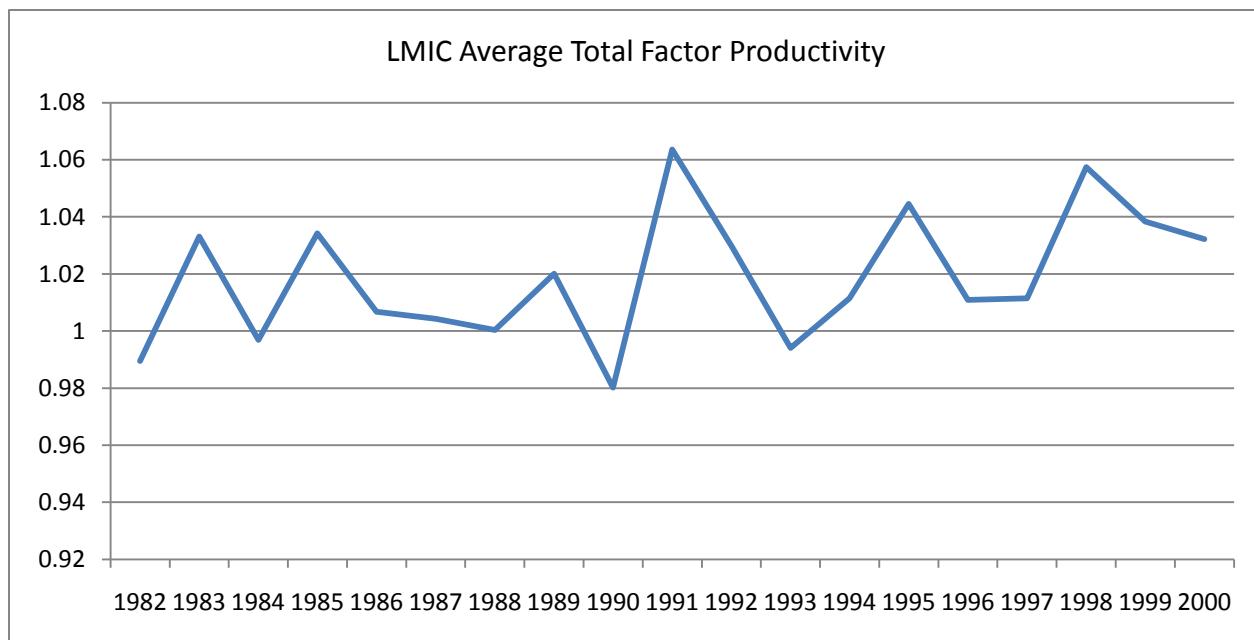


Figure 3.1: Average annual total factor productivity in lower middle income countries



Figure 3.2: Average annual total factor productivity in low income countries

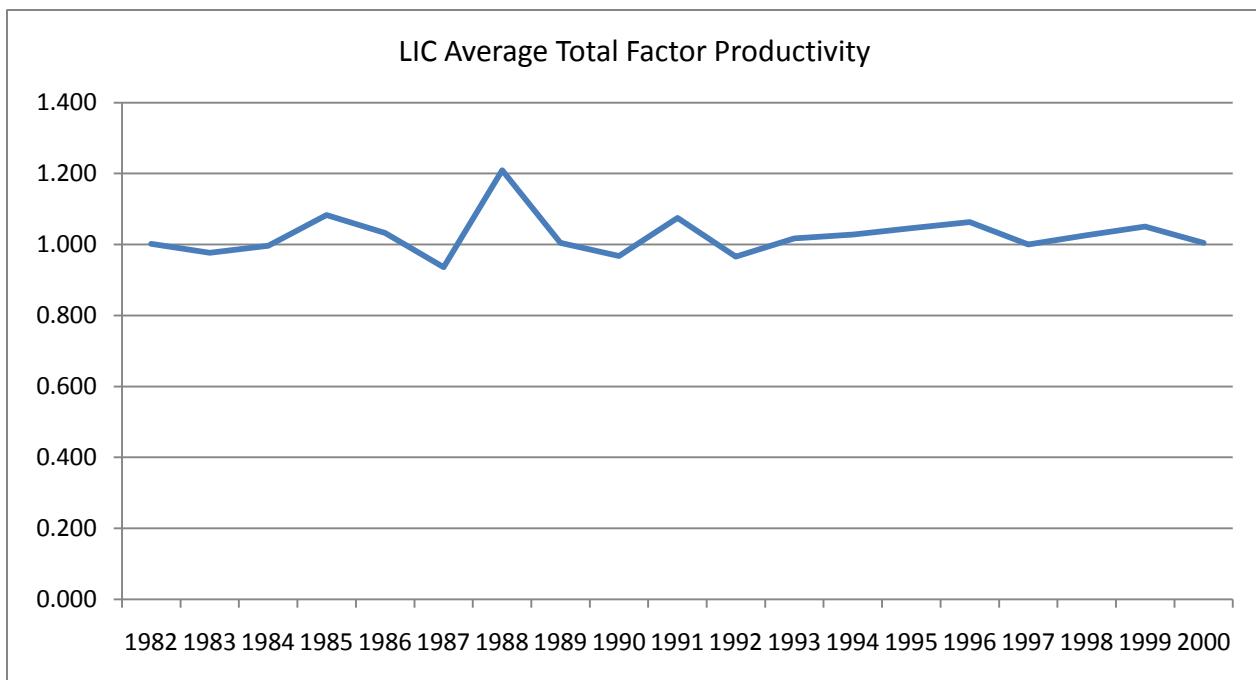


Figure 3.3: Average annual total factor productivity in Nepal

### 3.4.2 Behavioral trend of factor productivity in LIC and LMIC

After estimating total factor productivity, analysis was done to assess the behavioral trend of factor productivity across the countries. The results are presented as Fig 3.4 and Fig 3.5. The figure 3.4 shows the cross-sectional standard deviation of log of total factor productivity of LIC, LMIC and all 31 countries from 1982-1989. The result indicated that initially, from 1982 to 1984, the dispersion steadily increased in all cases. From 1984 to 1986, the dispersion decreased but it again increased after 1986 in LIC, while in case of LMIC, the dispersion gradually decreased after 1986. Thus, the trend of dispersion was very much random with periodic increase and decrease. So, we can say that there was neither productivity convergence nor divergence. It was simply cyclical over time. This result is similar to the result found by Suhariyanot and Thirtle (2001).

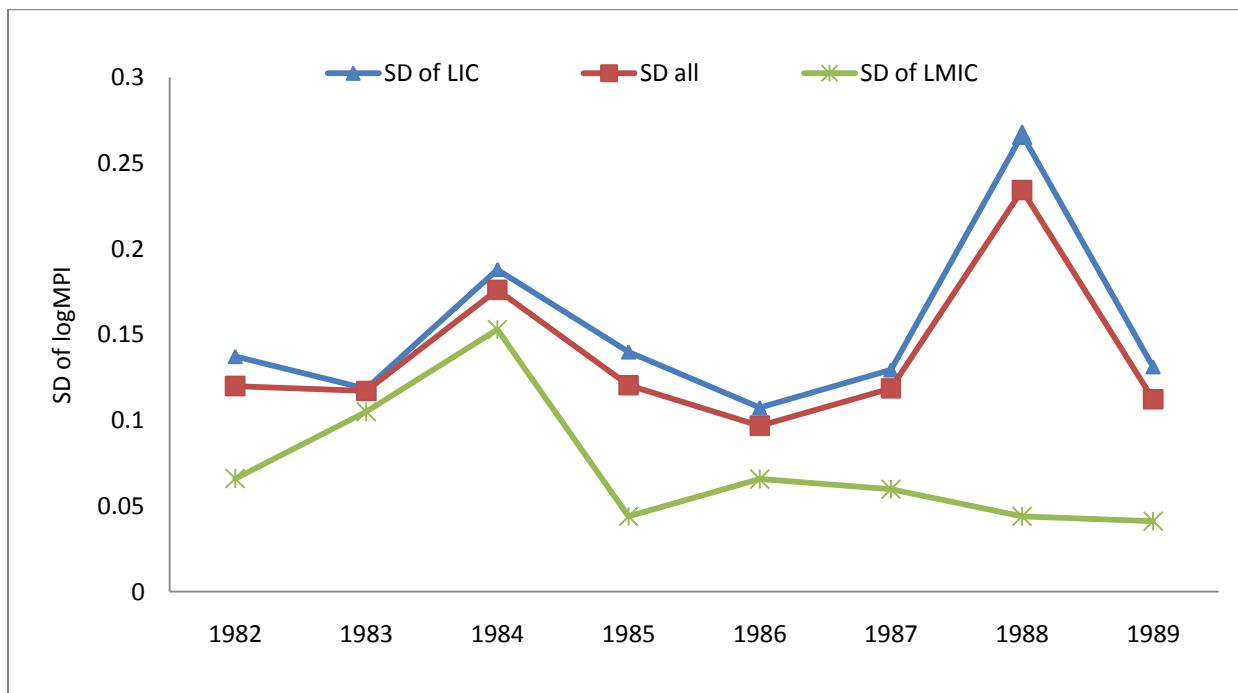


Figure 3.4: Standard Deviation of log of total factor productivity, 1982-1989

When analyzed the factor productivity trend over the period 1991-2000, the result was different than that of the previous period. The result indicated that the standard deviation gradually decreased in all cases. This indicates the convergence of factor productivity between and within two income groups. This result is similar to Martin and Mitra (1999) and Coelli and Rao (2005). The reason for convergence in factor productivity could be the dissemination of technology across the countries. The major policy shift from closed to the open economy in developing countries in the early 1980s might be responsible for convergence of factor productivity in developing countries. However, its effect only appeared after 1990.

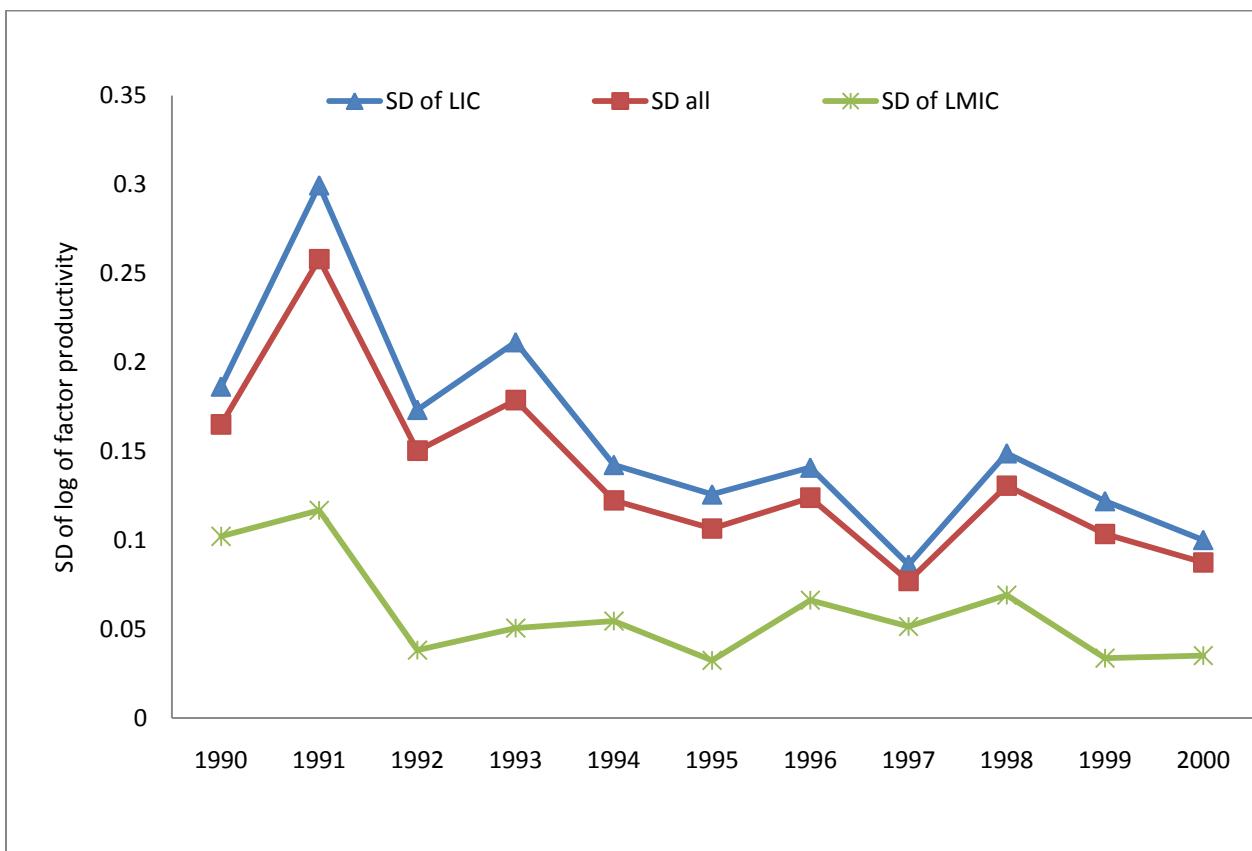


Figure 3.5: Standard Deviation of log of total factor productivity, 1990-2000

### **3.5 Conclusion and Policy Recommendations**

The average annual factor productivity of Nepal was positive during the study period. The contribution of efficiency change was higher compare to technical change. This indicates that Nepal has to give more emphasis on technical change in agriculture. Both LIC and LMIC had positive factor productivity with a greater contribution by technical change. However, when result analyzed geographically rather than economic group, the total factor productivity was positive only in case of South and Southeast Asian regions but not in Sub-Saharan Africa. After 1990, factor productivity across and within developing countries was found converging. Many past studies showed that there is a technological regression in developing country even in the so called green revolution period. The result in this study found a different pattern in the post-green revolution period. The post-green revolution era is marked by more open and liberal economy in developing world leading to relatively minimum market distortion. This could be the reason for positive and converging factor productivity in the post-green revolution period.

The result and its explanation lead certain policy recommendation. Developing countries should focus equally on increasing the production efficiency. Many previous studies at micro and macro level have shown that the production efficiency in developing country is very low. This study also found a little contribution of efficiency change in the overall factor productivity growth. This suggests that developing countries still need to work out on efficiency part. However, there are many endogenous factors like price as well as exogenous factors like government

policy that may affect the technological advancement and production efficiency in developing countries. Further research is needed to assess the factors governing technological and efficiency change in developing countries. The policy of cross-country economic cooperation could be the best way to share and disseminate new innovations across the countries for the overall benefit.

# **Chapter 4:**

## **Factors Affecting Technical Efficiency of Rice Farms in Nepal**

### **4.1 Background of the Study**

In the past, the role of agriculture in economic development has been recognized by many authors (Johnston and Mellor, 1961; Hayami and Ruttan, 1985). In this regard, the adoption of new technology has received more attention in developing countries. However, agricultural growth is not only determined by the level of technology but also by the level of efficiency that is associated with the utilization of given technology. The potential contribution of efficiency to the overall output growth has yielded a number of past studies on production efficiency<sup>†</sup>. Several hypotheses were tested to analyze the low production efficiency in developing countries. One of the celebrated hypotheses proposed by T. W. Schultz (1964) says that the poor farmers in developing countries are efficient under the circumstances they operate the farming business. This hypothesis had a strong influence in shaping the agricultural development policy in developing countries.

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<sup>†</sup> For the compilation and summary of past studies on production efficiency, see Bravo-Ureta and Pinheiro, 1993

Policy makers overlooked the inexpensive way of increasing agricultural production through increasing efficiency and focused only on the expensive option such as investment on new technology. The “poor but efficient hypothesis” assumes that the external conditions are steady and farmers are in a continuous equilibrium. In reality, farmers find themselves in disequilibrium because of continuously generated new technology and variation in input and output prices (Ali and Chaudhry, 1990). Farmers’ cope-up strategy to these disequilibria differs with each other that may result into different levels of efficiency. Thus, against Schultz’s hypothesis, many past studies proposed that farmers in developing countries failed to exploit the existing technology no matter whether it’s traditional or modern. For example, the study by Ali and Flinn (1989) concluded that the profit of rice farmers in Pakistan’s Punjab could be increased by 28% through enhancing efficiency in the existing state of technology. Similarly, many other studies carried out in developing countries found similar results (Jamison and Peter, 1984; Squires and Tabor, 1991; Tadesse and Krishnamoorthy, 1997; Dhungana *et. al.*, 2004; Idiong, 2007; Rahman, et al., 2008; Rahman, 2010). Thus, the technological advancement may not bring the expected impact if inefficiency is pervasive in farming business.

In general, past studies have explained the difference in technical efficiency mainly by socio-economic characteristics of farm households. For example, Rahman (2010) concluded that infrastructure, soil fertility, experience, extension service, tenancy and share of non-agricultural income were the main factors to affect the efficiency of rice farms in Bangladesh. Similarly, Brazdik (2006) found a rapid land

fragmentation as the important factor affecting the technical efficiency of rice farms in West Java, Indonesia during the Green Revolution. The literature abounds on such studies. However, past studies have paid a little attention to the level of commercialization and its effect on technical efficiency. Under a given set of socio-economic characteristics, production decisions may vary if the level of commercialization varies. If farming is more commercially oriented, farm decisions tend to be affected by market phenomena. If it is for family consumption, farm decisions are mainly motivated to maintain household's food security. Due to difference in farm decisions under subsistence and commercial farming, the effect of farm characteristics on efficiency will be different. Market demand hypothesis advocates that commercialization leads higher level of productivity through its strong backward-linkage effect while alternatively, Boserup's hypothesis advocates that in a subsistence farming, the pressure due to population growth tends to make a farm more efficient as there is a need to produce more for growing population (Boserup, 1981). Thus, the incentive for being more productive differs according to the objective of farming. The interest in this study was to compare and analyze the technical efficiencies and investigate the behavior of farm characteristics under these two different scenarios. This study assumed that the incentives for being more efficient would be higher as the level of commercialization increases and thus, the capitalization of existing technology would be relatively higher in a commercial farm.

The study was carried out in two districts of Nepal. In Nepal, farming is mainly carried out in rural environment. However, most of the development efforts have been focused in urban areas. Generally, high-hill and mid-hill areas have less physical infrastructure and poor market access while, *terai*, plain areas of Nepal, is relatively more benefited with physical infrastructures and market access. This has provided different economic opportunities to the farmers residing in different geographic regions. Economic opportunity, defined by external market access, always interacts with the ability of farm household to harness the economic opportunity. This affects various aspects of farming business like technology use, input intensification, and technical efficiency. In this study focus is only given to the analysis of technical efficiency and factors affecting it considering the level of commercialization and household characteristics.

## **4.2 Theoretical Discussions**

### **4.2.1 Technical efficiency**

Technical efficiency refers to a firm's ability to achieve maximum output from a given bundle of inputs. Battese and Coelli (1995) defined the technical efficiency of a given firm (at a given time period) as the ratio of its mean production (conditional on its levels of factor inputs and firm effects) to the corresponding mean production if the firm utilized inputs most efficiently. In microeconomic theory of firm, production efficiency is decomposed into technical and allocative efficiencies. Farrell (1957) distinguished technical and allocative efficiencies through frontier

production function. Production is technically efficient, if production occurs on the boundary of a production possibility curve and is allocatively efficient if production occur in a region of production possibilities set that satisfies the producer's behavioral objective i.s. using inputs in optimal proportions for the given factor prices. Thus, economic efficiency is the product of technical and allocative efficiency. An economically efficient input-output combination would be on the frontier function as well as on the expansion path. Efficiency analysis depends on certain assumptions to be made about the behavior of firm. The behavior of production entity can be described either by production function, cost function, profit function, or demand and supply functions. A producer always tries to either maximize profit or minimize cost. There are different alternative economic theories of peasant household behavior, which assume that peasant households maximize one or more household objectives<sup>‡</sup>. In this study, we analyzed the behavior of producer in terms of production function.

#### **4.2.2 Technical efficiency and the level of commercialization**

In developing countries, agricultural farms are very heterogeneous. Some are commercialized but many are subsistence. Commercialization of farms is mainly affected by the volume of production, family demand and market access. Market opportunity is the external factor to the farm household while family food demand and production volume are internal factors to the farm household. These internal

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<sup>‡</sup> see Mendola, 2007 for the review of theoretical and empirical research on farm household production choices in developing countries.

and external factors interact to define the level of commercialization. Once farm households integrate into the mainstream of commercialization process, it affects various production decisions. Figure 4.1 presents the way farm household characteristics affect production decisions.

In a commercial farming, farm decisions are based on market signals while in a subsistence farming, decisions are based on the institutional arrangements that act as a surrogate for what market do not provide (Binswanger and McIntire, 1987; Rosenzweig, 1988). Due to imperfect information in the subsistence farming, the informal institutional arrangements have high efficiency costs (De Janvery *et al.*, 1991). Figure 4.2 presents the reason for difference in efficiency in commercial and subsistence farming. In commercial farming, due to competition in the market, farmers' decisions tend to be more effective to utilize the given technology to its maximum extent. However, in subsistence farming, the objective of farm household is to maintain food security rather than profit making. Thus, production decisions tend to be based on the local informal institutions. Such a system lacks competitive environment and increases inefficiency in production. This means, same household characteristics in two different locations may have different kinds of impact on efficiency if the level of commercialization varies substantially.

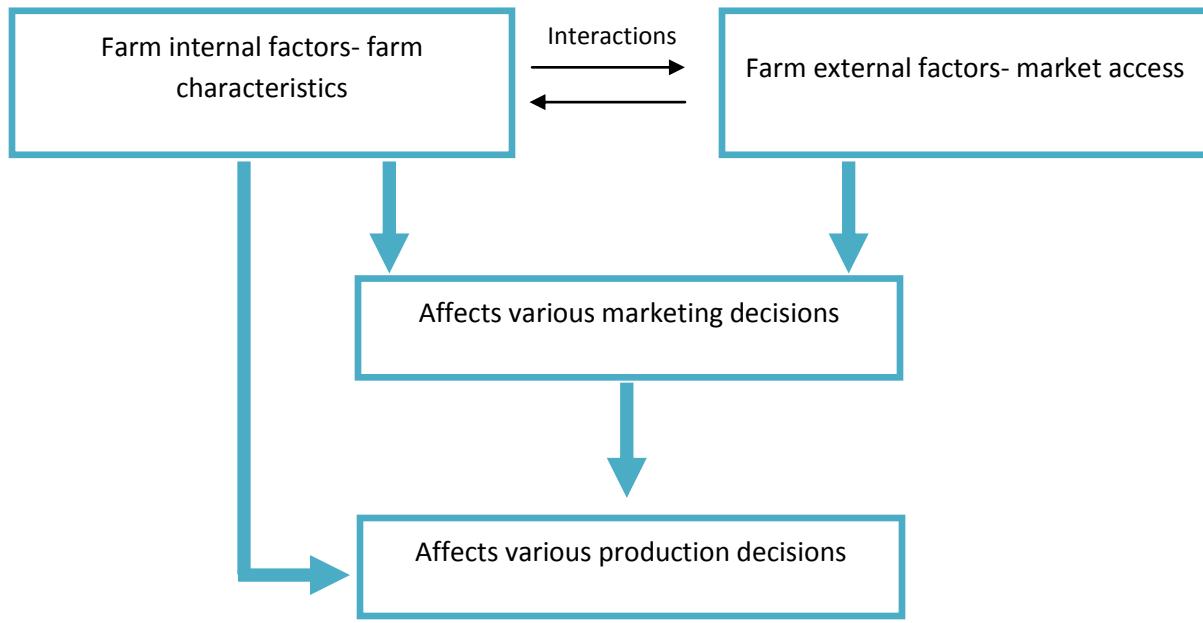


Figure 4.1: Production and marketing decisions

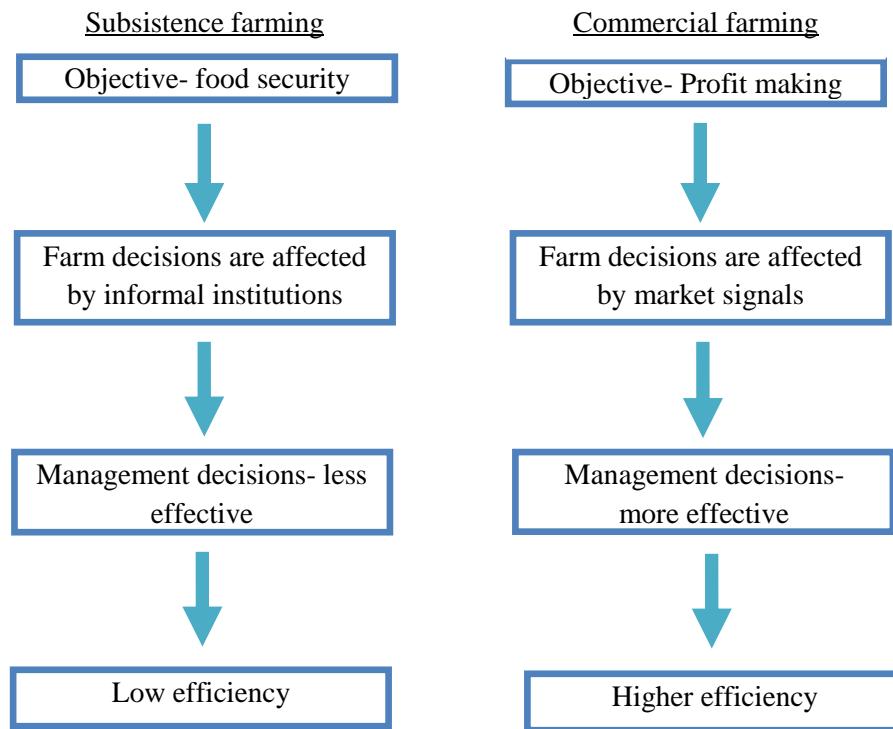


Figure 4.2: Causal link between efficiency and the objective of farming

## **4.3 Material and Methods**

### **4.3.1 Study Area, Sampling and Data Collection**

The study area comprises Dhading and Chitwan districts of Nepal. Both districts are bordered and located near to the capital city. Chitwan district is located at the center of Nepal and is one of the most potential districts in terms of agricultural production. Dhading district is located at the middle of Kathmandu (capital of Nepal) and Chitwan. Chitwan is more urbanized and has better infrastructure compare to Dhading. Production zones in Dhading district are farther from the main urban centers. Apart from this, many production zones at the northern part of the district have poor rural infrastructure. In contrast to this, all production zones of Chitwan are well connected with the motorable road and located near to the urban centers.

The information for this study was obtained through a household survey conducted in the selected village development committee (VDC) from December, 2009 to January, 2010. A village development committee (VDC) represents the lowest administrative unit of the government. Five VDCs from each district are selected for the study. Each VDC is divided into nine small wards. Due to resource and time constraints, only two wards from each VDC were selected purposively. Households within the wards were selected on the basis of random sampling. However, the sample size from each selected ward was drawn so as to make sample size proportional to the population size of the wards. The total household covered in this study was 120, 60 from Dhading and 60 from Chitwan. A structured

questionnaire was administered at farmers' level after pre-testing and the detailed information on farm socioeconomics, cropping pattern, cost of cultivation, marketed volume, consumption volume, gross income, market distance, and linkage to input and output service providers was collected.

Table 4.1 presents the descriptive statistics of inputs and output of the sample farms studied. The quantity of variable inputs use is converted into its value terms. The average land size of farms in Chitwan was 16.18 *katha*<sup>§</sup> while it was 10.06 *katha* in Dhading. Thus, the farm size in Chitwan district was almost 1.6 times of the farm size in Dhading district. The investment on seed, fertilizer and pesticide/fungicide was higher in Chitwan compare to the rice farms in Dhading. This shows that the intensity of modern input use is higher in Chitwan. The use of livestock and labor is higher in Dhading compare to that of Chitwan. This indicates that conventional input use is higher in Dhading. Input prices were similar in both districts. As Dhading and Chitwan districts are bordered districts and are not far away from the capital, the local input suppliers working at production pockets have same channels for purchasing and selling inputs and farm products. Apart from this, government funded input-corporation and farmers' cooperatives play a substantial role to stabilize the input price.

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<sup>§</sup> Katha is a measurement unit of land in Nepal, 1 katha = 2880sq ft (267.56 m<sup>2</sup>)

Table 4.1: Descriptive statistics of the input and output for the sample farms

District	Description	Unit	Mean	Standard deviation	Min	Max
Chitwan	Rice cultivated area	Katha	16.18	9.10	2	45
	Seed	Rs/katha	93.86	35.27	31.25	200
	Labor	Rs/katha	1054.52	331.35	260	2121.4
	Fertilizer	Rs/katha	161.81	62.17	60	356
	Pesticide + fungicide	Rs/katha	34.92	42.32	0	262.5
	Livestock	No/katha	0.23	0.16	0.01	0.82
Dhading	Productivity	Kg/katha	139.66	38.03	65	214.28
	Land	Katha	10.06	6.44	1.5	37.56
	Seed	Rs/farm	72.32	36.69	16.63	190.11
	Labor	Rs/farm	1363.64	671.92	133.03	4660.4
	Fertilizer	Rs/farm	155.01	112.29	0	466.66
	Pesticide + fungicide	Rs/farm	28.12	58.83	0	283.33
	Livestock	Rs/farm	0.60	0.55	0.08	3.05
	Productivity	Kg/katha	108.39	44.89	31.94	228.13

Source: Household survey, 2010

#### 4.3.2 Measurement of efficiency and degree of commercialization

In this study, Stochastic Frontier Analysis (SFA) method was used to calculate the production efficiency. Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) independently proposed the stochastic frontier production function of the form:

$$\ln q_i = \mathbf{x}_i \boldsymbol{\beta} + v_i - u_i \quad (1)$$

where  $q_i$  represents the output of the  $i$ -th firm;  $\mathbf{x}_i$  is a  $K \times 1$  vector containing the logarithms of inputs;  $\boldsymbol{\beta}$  is a vector of unknown parameters;  $v_i$  represents a

symmetric random error (noise effect) and  $u_i$  is an asymmetric non-negative random variable associated with technical inefficiency.

$$q_i = \exp(\beta_0 + \beta_1 \ln x_i + v_i - u_i) \quad (2)$$

$$q_i = \frac{\exp(\beta_0 + \beta_1 \ln x_i)}{\text{deterministic component}} \times \frac{\exp(v_i)}{\text{noise}} \times \frac{\exp(-u_i)}{\text{inefficiency}} \quad (3)$$

Frontier outputs tend to be evenly distributed above and below the deterministic part of the frontier. However, observed outputs tend to lie below the deterministic part of the frontier. They can only lie above the deterministic part of the frontier when the noise effect is positive and larger than the inefficiency effect ( $q_i > \exp(\beta_0 + \beta_1 \ln x_i)$  iff  $v_i - u_i > 0$ ). The most common output-oriented measure of technical efficiency is the ratio of observed output to the corresponding stochastic frontier output:

$$TE_i = \frac{q_i}{\exp(x_i \beta + v_i)} = \frac{\exp(x_i \beta + v_i - u_i)}{\exp(x_i \beta + v_i)} = \exp(-u_i) \quad (4)$$

This measure of technical efficiency takes a value between zero and one. It measures the output of the  $i$ -th firm relative to the output that could be produced by a fully-efficiency farm using the same input vector. Thus, to estimate the technical efficiency, first, we estimated stochastic production function.  $v_i$  is assumed to be distributed independently of each  $u_i$  and both errors are supposed to be uncorrelated with the explanatory variables in  $x_i$ . The noise component  $v_i$  is assumed to have zero mean and constant variance as assumed in the classical linear regression model while the inefficiency component ( $u_i$ ) is assumed to have

similar properties except it has a non zero mean. Under these assumptions, OLS estimator of the *intercept* coefficient is biased downwards. Thus, assumptions are made about the distribution of error terms. Aigner, Lovell and Schmidt (1977) obtained ML estimates under the assumptions

$$v_i \sim \text{iidN}(0, \sigma_v^2) \quad (5)$$

$$u_i \sim \text{iidN}^+(0, \sigma_u^2) \quad (6)$$

The  $v_i$ s are independently and identically distributed normal random variables with zero means and variance  $\sigma_v^2$ . The  $u_i$ s are independently and identically distributed half-normal random variables with scale parameter  $\sigma_u^2$ . That is, the probability density function (pdf) of each  $u_i$  is a truncated version of a normal random variable having zero mean and variance  $\sigma_u^2$ . This study followed the same distributional assumptions as proposed by Aigner, Lovell and Schmidt (1977). The log-likelihood function for the half-normal model in terms of  $\sigma^2$ \* and  $\lambda^2$ \* is given by equation 7. If  $\lambda = 0$  there are no technical inefficiency effects and all deviations from the frontier are due to noise.

$$\ln L(y | \beta, \alpha, \lambda) = -\frac{I}{2} \ln \left( \frac{\pi \sigma^2}{2} \right) + \sum_{i=1}^I \ln \Phi \left( -\frac{\varepsilon_i \lambda}{\sigma} \right) - \frac{1}{2\sigma^2} \sum_{i=1}^I \varepsilon_i^2 \quad (7)$$

where  $y$  is a vector of log-outputs;  $\varepsilon_i \equiv v_i \cdot u_i = \ln q_i \cdot x_i \beta$  is a composite error term; and  $\Phi(x)$  is the cumulative distribution function (cdf) of the standard normal random variable evaluated at  $x$ .

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\*  $\sigma^2 = \sigma_v^2 + \sigma_u^2$

\*  $\lambda^2 = \frac{\sigma_u^2}{\sigma_v^2} \geq 0$

Another important variable considered in this study was the household commercialization index. It was measured by following indexing method.

$$HCI = (Y_s / Y_p) * 100 \quad (8)$$

Where HCI = Household commercialization index,  $Y_s$  = Total sales of a crop per year, and  $Y_p$  = Total production of the crop per year.

This index measures the extent to which the crop production is commercialized. A value of zero would indicate a totally subsistence-oriented household; the closer the index is to 100, the higher the degree of commercialization.

#### 4.3.3 Empirical model

Many studies used a second stage regression method to determine the farm specific attributes in explaining inefficiency (Kalirajan 1991; Sharma *et al.* 1999; Shafiq and Rehman 2000). However, Battese *et al.* (1996) and Battese and Coelli (1995) incorporated farm specific attributes in the efficiency model directly. This study followed the first approach. Many past studies used Data Envelopment Analysis method (DEA) to calculate the efficiency score and used the Tobit regression to analyze the factor affecting efficiency due to score bounded at lower and upper level. In this study, almost all technical efficiency scores calculated were above zero and below 100, so we avoided the use of Tobit regression and just stuck to the ordinary least square technique. The model considered in the study is presented in equation 9. Following was the model used in the study. Seven types of

explanatory variables were considered in the study. Farm household characteristics like education, share of agricultural income, cropping intensity, age of household head, land tenancy system and degree of commercialization were considered. Age of household head represents a proxy variable to the farming experience of household head. Education was measured by the years of schooling; share of agricultural income to the total household income was measured by the percentage share of agricultural income to the total household income, cropping intensity was measured by the ratio of total area of cropped land in a year to the total land area; land tenancy was measured by the total land area under share cropping; degree of commercialization was measured as mentioned in equation 8. Variables like degree of commercialization, education, age, cropping intensity, agricultural income were expected to have a positive impact on technical efficiency while share cropping was expected to have a negative impact on efficiency.

$$E = \beta_0 + \beta_1 E_d + \beta_2 E_m + \beta_3 I_n + \beta_4 R_{mf} + \beta_5 C_i + \beta_6 A_{hh} + \beta_7 S_c + \beta_8 HCI + e \quad (9)$$

where E= observed efficiency,  $E_d$  = Education of household head,  $E_m$ = maximum education of household members,  $I_n$ = share of agricultural income in total household income,  $C_i$ = cropping intensity,  $A_{hh}$ = Age of household head,  $S_c$ = area under sharecropping and  $HCI$ = commercialization index

In equation 9, the level of efficiency and the level of commercialization could be simultaneously determined variables (endogenous variables). In such condition, the least-squares estimators would not only be biased but also be inconsistent. In such

case the estimators do not converge to their true (population) values as sample size increases indefinitely (Gujrati, 2004). Hausman specification test was carried out to see whether efficiency and degree commercialization are endogenous to the model. At 10% level of significance, these two variables appeared to be endogenous to the model. Thus, instrumental variables were used to represent the degree commercialization to avoid the endogeneity bias. Market distance and per capita rice production were used as instrumental variables. As two instrumental variables were used, equation 9 was over identified. Thus, the two-stage regression instead of indirect least square regression was used.

## 4.4 Results and Discussions

### 4.4.1 Production function estimation

Cobb Douglas production function was estimated using the maximum likelihood method (MLE). Table 4.2 presents the result of MLE estimates for Chitwan, Dhading and combination of both. The result showed that rice production was comparatively more responsive to land size in all three cases. Land is a scarce resource in Nepal. Around 18 per cent of land is arable. Due to population pressure on limited land, land fragmentation has been a common trend in Nepal that has caused a smaller per capita cultivable land. Thus, the marginal productivity of land is quite higher in Nepal. The production response to the investment on the modern inputs (chemical fertilizer, pesticide, fungicide) was also positive and statistically significant in all three cases. The response was found higher in Chitwan compare to

Dhading. The elasticity of production to improved seed was also positive and statistically significant in all cases. The impact of labor and livestock was statistically not significant in case of cross-district and Dhading while, the impact of livestock was positive and statistically significant in case of Chitwan. Nepal is a labor surplus country. More than 70 per cent labor force is engaged in agriculture. Thus, the disguised unemployment is quite higher in Nepal. This could be the reason for insignificant to negative response of labor on production. Similarly, Nepal has got very high livestock density per unit land compare to other south and Southeast Asian countries, thus, its impact on production was also very low. So, in conclusion, the investment on the fixed capital like land and variable capital like fertilizer, pesticide, fungicide and improved seed have a greater impact on increasing the production.

Table 4.2: Production Function Estimates (Maximum likelihood estimates)

Variables	Cross districts	Chitwan	Dhading
Land	0.61***	0.68***	0.53***
Chemicals (fertilizer, pesticide and fungicide)	0.22***	0.34***	0.16***
Seed	0.18***	0.07***	0.19*
Livestock	-0.008	0.02***	0.04
Labor	-0.11	-0.11***	-0.13
Const.	4.27	3.88	4.81
$\sigma^2$	0.28	0.16	0.36
Lambda	5.02	1.26e+08	4.32

Note: \*\*\* represents significant at 1% level of significance

#### **4.4.2 Land productivity and Technical Efficiency**

A comparison of average rice productivity in two districts is presented in figure 4.3. Average rice productivity in Chitwan was 140kg/katha while it was 108 kg/katha in Dhading. The difference in land productivity in two districts could be due to various factors like technology, production efficiency, input intensification and other external factors. As this study was focused on analyzing the difference in technical efficiency in two districts, the technical efficiency with respect to respective district frontier and cross-district frontier was estimated. Cross-district frontier technology represents the frontier that is either similar to or superior to district frontier. The result is presented in figure 4.4. The average efficiency score of Dhading with respect to district frontier was slightly higher (just 3 percent) than that of the efficiency with respect to cross-district frontier while there was no difference in two efficiency scores with respect to district and cross-district frontiers in case of Chitwan. This indicates that Chitwan district is slightly superior in terms of rice technology use. Rice is considered as a major staple crop in Nepal and grown every parts of the country except mountain area. The government role in promoting technology is substantial. Thus, the level of technology to a particular location is highly influenced by exogenous factors like government policy and program. This could be the reason for small differences in technological frontiers in two districts. Apart from this, both districts are bordered with each other, thus, a mutual transfer of technology could have made the gap in frontier technology smaller in two districts.

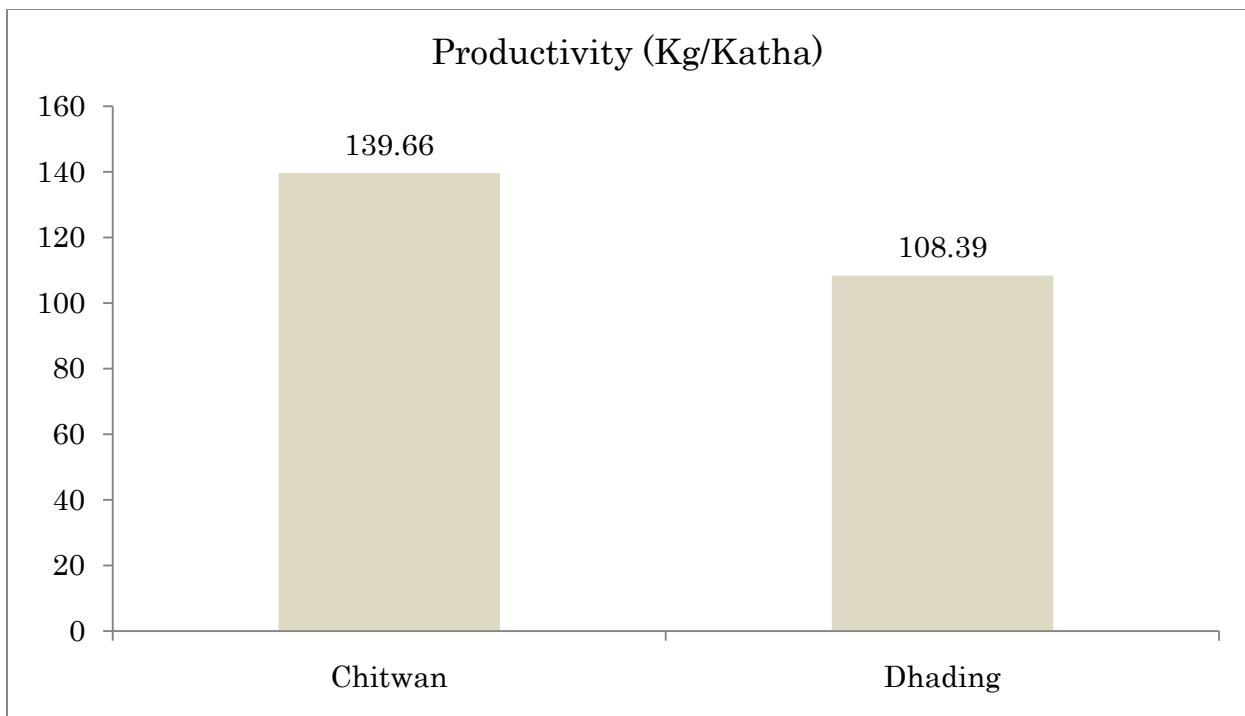


Figure 4.3: Average rice productivity in Chitwan and Dhading

*Source:* Household survey, 2010

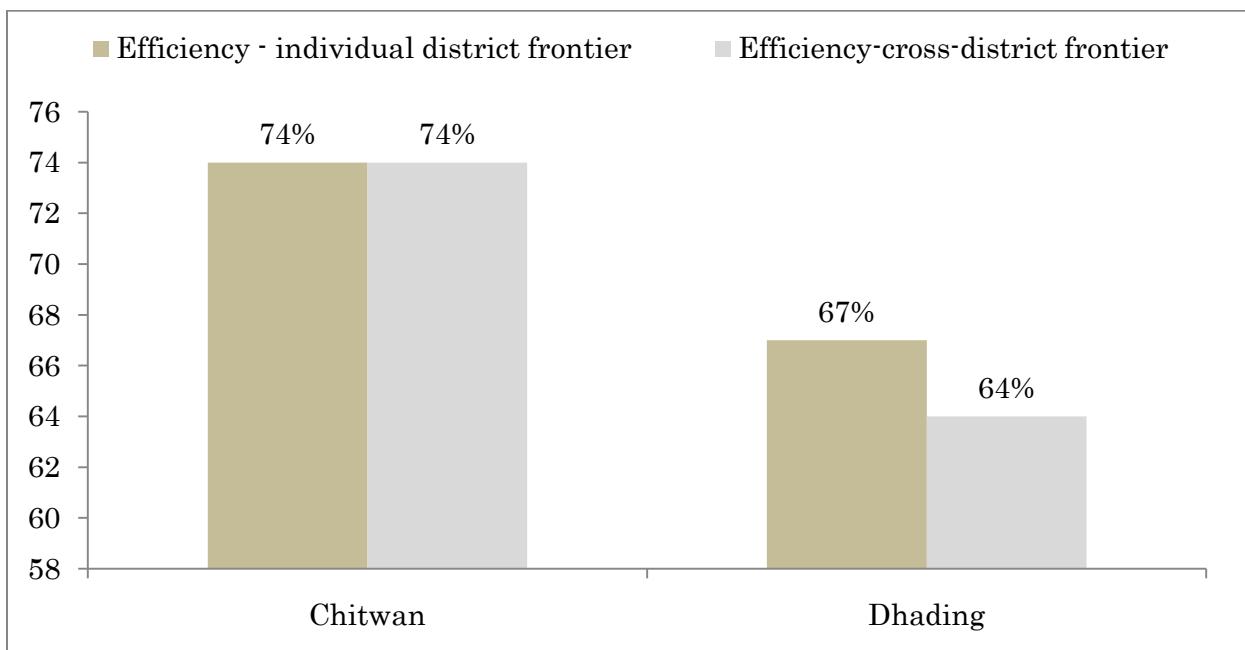


Figure 4.4: Average efficiency in Chitwan and Dhading

Table 4.3 presents the comparative frequency distribution of technical efficiencies with respect to individual district frontiers. The result showed that the average technical efficiency in Chitwan district was 74 percent. This indicates that rice farmers in Chitwan district can improve production by 26% under the existing technology. The case of Dhading was worse than Chitwan. The average technical efficiency was just 67 indicating that farmer could increase rice production by 33 percent in the existing technological state. The frequency distribution showed that more than 50% farmers in Chitwan district had attained the efficiency level of 70-100 percent while in case of Dhading, around 35 percent of farmers had attained that level.

Table 4.3: Frequency distribution of farm-specific technical efficiency in two districts

Technical efficiency (%)	Chitwan (n=60)	Dhading (n= 60)
<30	0	4
30-40	0	4
40-50	3	5
50-60	6	10
60-70	15	12
70-80	12	11
80-90	14	10
90-100	10	4
Average	74	67

#### 4.4.3 Technical efficiency and degree of commercialization

Figure 4.5 presents a comparison of degree of commercialization and technical efficiency in Chitwan and Dhading districts. The result showed that the technical efficiency and the degree of commercialization were higher in Chitwan compare to Dhading district. This indicates that there is a positive association between commercialization and technical efficiency. On an average 30% of total rice production was found to be sold in the market in Chitwan while in case of Dhading it was negligible. This shows that rice farming in Dhading district is mainly subsistence in nature. The higher level of commercialization in Chitwan is mainly due to rice farms located at the adjoining areas of big urban centers and higher marketable surplus.

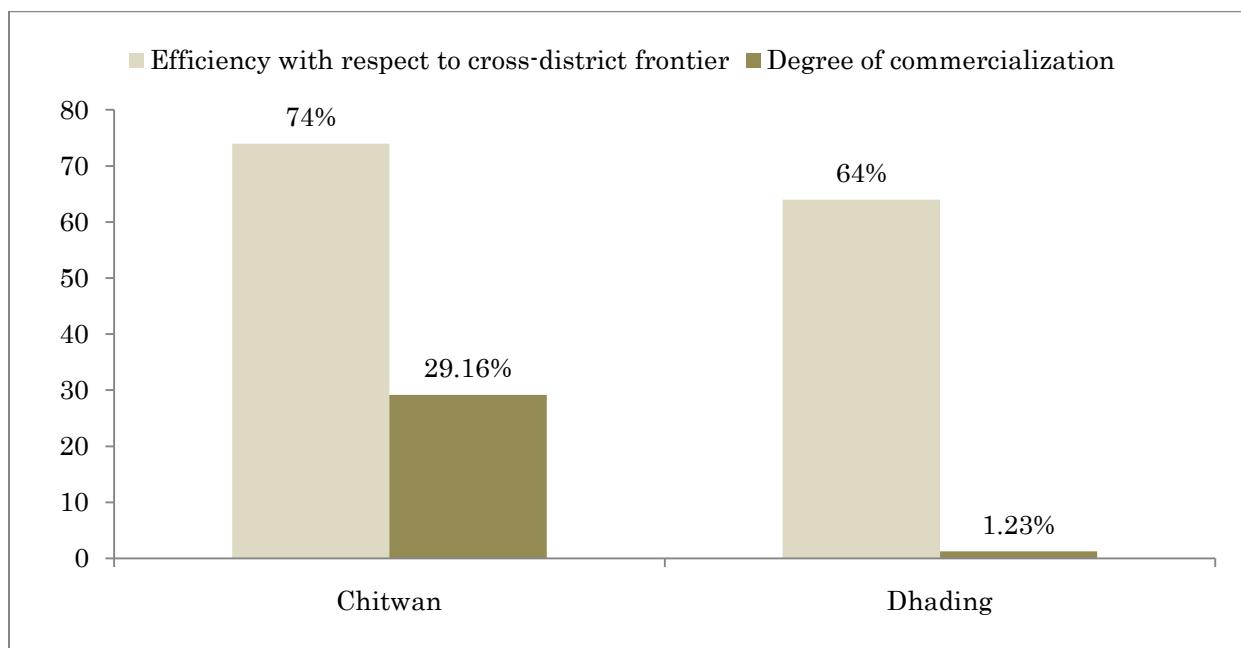


Figure 4.5: Comparative chart of efficiency and degree of commercialization

#### **4.4.4 Factors affecting technical efficiency**

There is a distinct gap in technical efficiencies between two districts. In general, farm household characteristics between two districts do not differ much. However, two districts are distinct in terms of urbanization and market access. Farmers in Dhading district is producing rice in a rural environment while farmers in Chitwan districts in more urban environment. To explain the difference in technical efficiency among farmers within individual district and across districts, three models- Chitwan only, Dhading only and cross-district were estimated. The result is presented in table 6.4. Both commercialization index and household characteristics were used as explanatory variables. As almost all farms in Dhading district was subsistence in nature, the commercialization variable was not included in Dhading model.

The result showed that the level of commercialization had a significant impact on technical efficiency. Every 1% increase in the degree of rice commercialization increases the technical efficiency by 0.13% in Chitwan district and by 0.18 in cross-district case. To assess the impact of education on the level of efficiency, two types of variables, namely the education level of household head and the highest educational level of farm household members were accounted for. The impact of the level of education of household head did not appear significant while the impact of highest level of education of household members had significantly positive only in case of Dhading. Age of household head had a positive impact on efficiency in all three cases. Similarly, share of agricultural income to the total income had a positive

impact on efficiency in all three cases. Sharecropping had negative impact on efficiency in all three cases. However, its magnitude was relatively higher in case of Chitwan compare to Dhading. Cropping intensity did not show any significant impact in all three cases. The overall explanatory power of the models is below 50%. This indicates that there must be other variables that might affect the level of technical efficiency which were not accounted in the study. The main purpose of the study is to compare the efficiency in two different production locations having different market access and see whether the higher level of commercialization lead significant impact on efficiency. Due to time and resource constraints all other potential variables like land quality could not be included in the study. This is the limitation of the study.

Table 4.4: Factors affecting technical efficiency

Variables	Chitwan (Semi-Commercial area)		Dhading (Subsistence area)		Cross-districts	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Degree of commercialization	0.13***	0.08	-	-	0.17**	0.073
Education of HH head	-0.41	0.68	0.23	0.72	0.08	0.51
Highest education in family	-0.54	0.61	1.99**	0.92	0.40	0.54
Age of HH head	0.43**	0.17	0.25***	0.20	0.33*	0.13
Share of agricultural income in total income	0.39***	0.09	0.67***	0.12	0.52***	0.078
Cropping intensity	-0.001	0.02	0.015	0.03	0.01	0.01
Sharecropping	-0.30*	0.16	-0.021*	0.34	-0.33**	0.16
Constant	29.31	24.74	-21.93	18.03	4.16	11.64
F	5.13**		6.90***		11.60***	
R-Sq	0.40		0.45		0.41	
Adj R-sq	0.35		0.40		0.38	

#### **4.5 Conclusion and Policy Recommendation**

The result showed that there is a remarkable gap in land productivity between two districts. The difference in input intensification, technical efficiency and technology are the main reason for difference in productivity. In individual district case, the result showed that farmers in Chitwan district can increase production by 26% while farmers in Dhading district can increase production by 33 % in the existing technological condition. The result concurs with the result of many past studies in developing countries. It seems that farmers residing near to urban areas have higher technological level and technical efficiency relative to farmers residing far away from urban centers. The farmers residing in and near to urban areas have better economic opportunities in the form of market access compare to that residing in rural areas. This could be the plausible reason for higher technical efficiency in Chitwan. Apart from this farmers residing in urban areas are benefitted by easy access to various production and marketing information.

Technical efficiency depends on various factors. The analysis in this study considered only some of the variables. This has limited the scope of the study. However, it succeeded to conclude some of the important facts relating to technical efficiency. Higher level of commercialization increases technical efficiency. This means, a new technology would be capitalized more efficiently in the location where rice farming is relatively more commercialized. Thus, agricultural development policy should focus not only to the technological enhancement but also give equal importance to transform the subsistence agriculture to commercial one. The result

indicated that four household characteristics are important namely age, share of agriculture income to total household income, education of household members and land tenancy system. Sharecropping has a significant negative impact on efficiency in all cases but its magnitude is higher in Chitwan compare to Dhading. The issue of land distribution is always linked with the agricultural productivity. In Nepal, land distribution is not equitable. Many real farmers are working as sharecropper. Thus, to increase the efficiency in rice farming, the government should revisit the tenancy policy. The impact of age of household head and share of agricultural income to the total household income were positive in all cases. This indicates that farming experience and farmers' dependency on agricultural income has positive impact in all types of farms. However, the magnitude of impact of these variables on efficiency differed in two districts. This study also found a positive impact of education but only in case of Dhading. Chitwan showed a negative impact of education on efficiency but was statistically not significant. In summary, agricultural development program and policy should able to conceptualize the dynamics of farming at micro-level. Basically, market strengthening, allocating land to real cropper and education in rural areas should be given a due concern.

# **Chapter 5:**

## **Determinants of Input and Output market orientation and its effect on productivity**

### **5.1 Background of the Study**

The evidence shows that a 1% growth in per capita agricultural gross domestic product (GDP) in developing countries leads to 1.61% increase in per capita income of the bottom quintile of the population, whereas a similar 1% growth in industrial GDP increases the income of the poor by 1.16% (Timmer, 1997). Thus, agricultural development is indispensable to reduce widespread poverty and hunger in developing countries. Agricultural development is more important in the low-income country like Nepal, where more than 60% people are engaged in agriculture and 40% of national GDP is shared by the sector (HMG, 1995). Increasing agricultural production and productivity is the most sought after agendas in the mid-term and long-term annual development plan. However, the performance of agriculture in Nepal has not been as expected. The main cause of low productivity is the low

intensification of modern agricultural inputs like improved seed and fertilizer (on the basis of the result from chapter 2). The green revolution experience showed that replacing local seed for improved one and traditional manure for chemical based manure increased the food production in many Asian countries. However, such transformation is very low in Nepal. Many rural farmers are still engaged in subsistence farming that mainly based on conventional inputs. Nepal government has launched 20-year long term agricultural perspective plan (APP) in 1995. The main objective of the plan is to increase the level of commercialization in agriculture. The strategy is to intensify the use of modern input in the potential production pockets and linking production pockets to the market centers. For this, Nepal government has brought many policy changes. The government considered supply side constraints as the major bottleneck to expedite the intensification of agricultural inputs. This led the government to fully liberalize the fertilizer price fixation and its marketing. With the liberalization of fertilizer marketing, government supposed that private sector would enable to undertake an efficient distribution of fertilizer to every part of nation. However, the reality is very different. Many small poor farmers are still heavily depends on traditional inputs. This indicates that only resolving supply side constraints in input delivery system might not be fruitful to accomplish the targeted outcome in input intensification. More importantly, the demand side constraint should also be given a due concern. Apart from this, the input intensification could not take place if there is a poor output market linkage. Both input and output market components have forward

and backward linkage effects. Higher output commercialization has backward linkage effect on modern input intensification and similarly higher intensification of modern input has forward linkage effect as it increases productivity. In this context, this study was carried out to investigate into the determinant of input and output market orientation and its ultimate effect on productivity of Rice farms in Nepal

Rice is a major staple crop in Nepal. It covers around 42% of cropped land (Piya, 2009). Generally, rice farming in Nepal is subsistence in nature as farming decisions are mainly based on family need rather than market signals. However, with the urbanization and proper market chain development, there are many examples of specialized commercial production of traditional cereal crops. In some urban and peri-urban areas, farmers are engaged in commercial rice farming, while in rural areas, rice is still a subsistence crop. In this study, one urban (Chitwan) and one rural (Dhading) districts are selected to investigate the determinant of commercialization of Rice farming and its impact on productivity.

## **5.2 Theoretical Review**

### **5.2.1 Theory of agricultural productivity**

Various theories on agricultural productivity in developing countries have emerged. The human needs or subsistence needs based theory proposed by Boserup (1965, 1981) posits that agricultural productivity is driven by the immediate biological needs of a population to feed itself. According to this thesis, as population increases, agricultural productivity will increase as a result of innovation and

improved agricultural technology. Another competing theory, known as market demand theory, posits that farmers participating in commodity production respond to market demand in an effort to maximize profit. Thus, smallholder production is divided between subsistence path (produce for consumption) and market demand path (commodity farm products), with differing motivation behind each. Turner, Hyden and Kates (1993) and Turner and Ali (1996) combined two strands into consumption-commodity or induced-intensification theory, which posits that intensification is induced by the need to produce food for both consumption and market. In this study, we assumed that the motivation for being more productive is higher when farmers produce for a market. That means, when a farm transforms from subsistence to commercial farming, the productivity will be increased. In this backdrop, this study was conducted to assess how farm characteristics and market distance affect commercialization and its impact on productivity considering the case of rice farms in Nepal.

### **5.2.2 Process of Agricultural Commercialization**

Agricultural commercialization implies more than the marketing of agricultural products; it means the product choice and input use decisions are based on the principles of profit maximization (Pingali and Rosengrant, 1995). Thus, commercialization of agriculture leads to greater market integration of farm production and progressive substitution out of non-traded inputs in favor of purchased inputs. Apart from this, there is a gradual shift of subsistence food

production in a monoculture system to a diversified market oriented production system. The process of diversification is triggered by the investment in rural infrastructure, technological change and change in food demand structure. As economies grow, income induced demand for staple crops slow down and demand shifts to the higher value agricultural products like meat, fruits, and vegetables. This is the reason for diversification as the level of commercialization increases. However, at farm level, farmers tend to specialize on a specific crop as the level of commercialization increases. The shift of complex multi-crop farming system to the specialized farming is triggered by the change in the objective from food self sufficiency to profit maximization. Table 5.1 presents the characteristics of different level of agricultural commercialization.

Table 5.1: Characteristics of food production systems with increasing commercialization

Level of commercialization	Farmers objectives	Sources of inputs	Product mix
Subsistence system	Food self sufficiency	Household generated (non-traded)	Wide range
Semi-commercial systems	Surplus generation	Mix of traded and non-traded input	Moderately specialized
Commercial systems	Profit maximization	Predominantly traded inputs	Highly specialized

*Source:* Pingali and Rosegrant(1995)

### **5.2.3 Determinants of Agricultural Commercialization**

The transformation of farming differs substantially across farmers of different geographic locations. Walter Chirstaller (1933) cited by Nepal and Thapa (2009) considered the hierarchically organized urban centers as prime drivers of development, including agricultural commercialization. Thus, the location which is less integrated with urban center and urban functions has less opportunity for commercializing agricultural products. Thunen's classical model of land use reinforces this theory. According to Thunen, depending on the distance and biophysical condition, urban centers promote the development of different types of commercial agriculture in their hinterlands (von Thunen, 1966 cited in Fafchamps and Shilpi, 2003). von Braun *et al.* (1994) has outlined determinants of commercialization in an elaborate way. According to von Braun, population change, availability of new technologies, infrastructure and market creation, and macroeconomic and trade policy are the main determinants of agricultural commercialization. These are external factors that are out of control of a farm household. Jaleta *et al.* (2009) also mentioned the internal factors like farm household resource endowments (land and other natural capital, labor, physical capital, and human capital) that affect the level of commercialization. Both internal and external factors are important to transform the structure of farming system in rural areas.

Figure 5.1 illustrates how external and internal factors affect commercialization process. In the figure, stakeholders are represented by farm

household at the one end and input and output traders at the other end. Input and output traders sell their commercial services\*\* in the market while farm household buy these services. To expedite the process of commercialization, there is a need to link between these two stakeholders so that commercial transactions take place between them. External factors affect the availability of commercial input and output traders and the quality of service they provide while internal factors affects the ability of farm household to commercially integrate into the output and input markets. The transactions in input and output market are very small in subsistence farming.

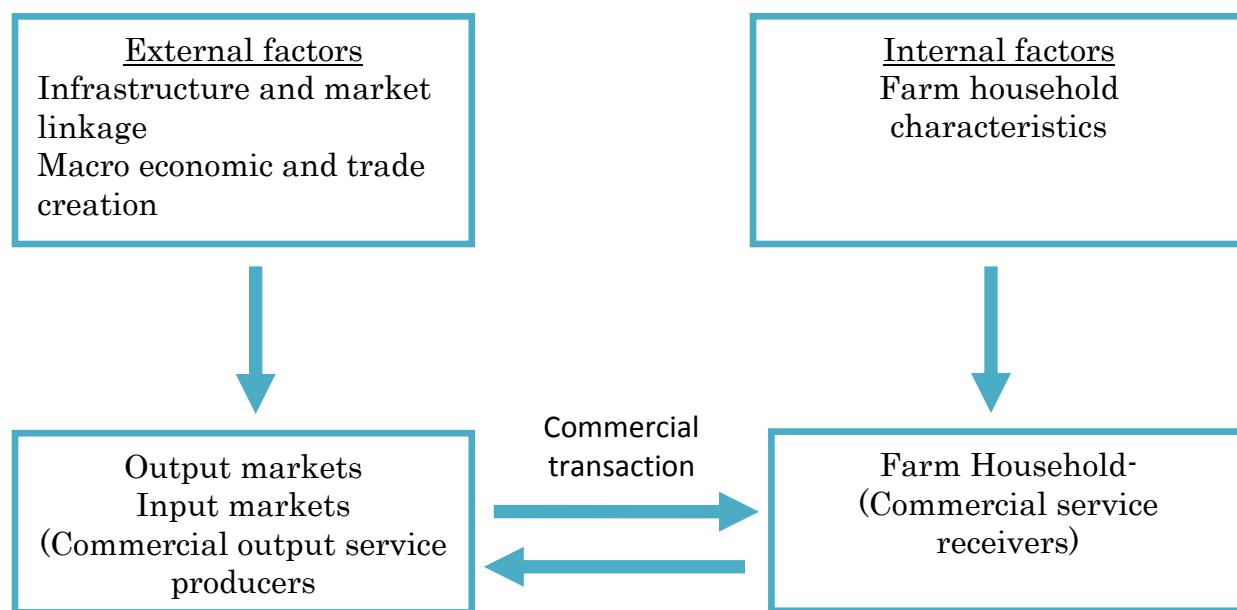


Figure 5.1: External and internal factors affecting commercial service transactions

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\*\* Commercial services are defined in terms of business development services (BDS). All the services like agricultural product buying, packaging, retailing, contracting and input selling, delivering are considered commercial services that help build up agricultural business of a farm household.

Followings are the major sources of constraints that impede the commercial transactions.

1. Constraints due to household characteristics: This includes age, family size, education, and resource endowment
2. Constraints due to geographic characteristics: distance from the main market
3. Constraints due to trade and macro economic policies

Thus, different level of commercial transactions across farm households is due to the difference in constraints mentioned above.

### **5.3 Materials and Methods**

#### **5.3.1 Study Area and Field Survey**

The study area comprises Dhading and Chitwan districts of Nepal. The detail information on study area and field survey is given in the section 4.3 of chapter 4.

#### **5.3.2 Measurement of degree of commercialization**

In the past studies, agricultural commercialization is defined as a proportion of agricultural production that is marketed (Immink and Alarcon, 1993; Strasberg et al., 1999). Some authors (von Braun *et al.*, 1994; Pingali, 1997) tried to see the concept of commercialization beyond just supplying surplus products to markets and considered both input and output markets and decision making behavior of a farmer. von Braun *et al.* (1994) proposed three indices to measure the level of agricultural commercialization. The first index measures the proportion of

agricultural output sold and input acquired to the total value of agricultural production.

$$C_d = (OM+IP)/GV \quad (1)$$

where  $C_d$  = degree of agricultural commercialization, OM = Output marketed, IP= Input purchased, GV= gross value of production

Second index measures the commercialization of rural economy. It is measured as the ratio of the value of goods and services acquired through market transactions to the total household income.

$$C_r = SP/ HI \quad (2)$$

where  $C_r$  = commercialization of rural economy, SP= goods and services purchased in the market, HI= total household income

The third index measures the degree of household integration to the cash economy. It is measured as the ratio of the value of goods and services acquired by cash transaction to the total household income

$$I_c = SP_c / HI \quad (3)$$

where  $I_c$ = household integration to the cash economy,  $SP_c$  = value of goods and services acquired through cash transaction, HI= total household income

Goveresh *et al.* (1999) and Strasberg *et al.* (1999) used a household commercialization index (HCI), which is a ratio of the gross value of all crop sales per household per year to the gross value of all crop production.

$$HCI = GV_s / GV_p \quad (4)$$

In this study, the percentage of agricultural output sold to the total agricultural production in quantitative terms is considered as an index of commercialization.

$$HCI = (Y_s / Y_p) * 100 \quad (5)$$

where  $Y_s$  = Total quantity sales of a crop in a year,  $Y_p$  = total production of the crop in a year

A value of zero would indicate a subsistence-oriented household; the closer the index is to 100, the higher the degree of agricultural commercialization. In this study, indexing method considering the quantitative terms (as mentioned in equation 5) is used to calculate the degree of commercialization across the sample. The reason for selecting this indexing method is its simplicity to calculate and gives a clear picture of marketable surplus. Apart from this, transaction in input market side is also considered separately as the indicator of commercialization. Input transactions are measured by the investment on chemical fertilizer and modern seed.

### 5.3.3 Model Specification

A recursive econometric model is used to explain the factors affecting, input and output market orientation and its effect on productivity. The decision to sell rice in the market and decision to invest on modern inputs are considered as a sequential process whereby output market commercialization leads to input market commercialization. Both output market and input market orientation intern affect the level of productivity.

It is hypothesized that the degree of output market commercialization ( $D$ ) is a function of vector  $x$ , of farm characteristics and market distance  $d$ , such that

$$D = \beta_0 + \beta_i x_i + \lambda_1 d + e_1 \quad (6)$$

It is hypothesized that the input market orientation ( $I$ ) is a function of vector of  $y$ , a different set of farm characteristics and the predicted value of  $D$ , such that

$$I = \delta_0 + \delta_i y_i + \lambda_2 \hat{D} + e_2 \quad (7)$$

As commercialization is defined as the proportion of farm output sold in the market, there were many farm households that did not sell rice in the market which caused the data series truncated at zero. Thus, Tobit regression method is used to estimate equation 6.

$$D^* = \beta_0 + \beta_i x_i + \lambda_1 d + e_1 \quad (8)$$

$$D = \begin{cases} D^*, & \text{if } 0 < D^* \\ 0, & \text{Otherwise} \end{cases} \quad (9)$$

To measure the factors affecting agricultural productivity, It is hypothesized that rice productivity ( $Y$ ) is a function of vector of  $z$ , a different set of household characteristics,  $\hat{D}$ , the predicted value of output market orientation, and  $i$ , investment of modern input per unit land, such that

$$Y = \alpha_0 + \alpha_i z_i + \lambda_3 \hat{D} + \lambda_4 i + e_3 \quad (10)$$

## **5.4. Results and Discussions**

### **5.4.1 Farm Household and Geographic Feature**

Table 5.2 presents a comparative picture of different characteristics of farm households. The major household characteristics considered were age of household head, family size, gender, educational level, land tenure system, land size, and percentage of household income from agriculture. These variables represent the basic characteristics of farm households in rural areas of Nepal. The mean age of farm household is approximately 51 years in both districts. The average family size is higher in Dhading compare to Chitwan. The proportion of female is less than 50% in both districts indicating higher proportion of male members in farm household. The gender ratio (male/female ratio) is slightly higher in Chitwan. The average education of household head is also slightly higher in Chitwan. Another household characteristic considered was the share of agricultural income to the total household income. The result showed that farm household in Dhading districts are more dependent on the non-agricultural source of income compare to Chitwan. This could be due to the difficulty in sustaining livelihood only based on agriculture. The average size of rice farm is slightly larger in Dhading. The proportion of sharecroppers is similar in both districts. In conclusion, household characteristics between Dhading and Terai do not differ much.

Table 5.2: Farm household characteristics

HH character	Statistics	District	
		Chitwan	Dhading
Age of the HH head	Mean	50.86	51.88
	SD	11.19	12.7
Family size	Mean	5.88	6.46
	SD	2.03	2.48
Highest education in family	Mean	11.7	12.03
	S.D	2.66	2.55
Cultivated land size ( in <i>katha</i> )	Mean	21.04	22.42
	SD	13.20	14.64
Share of agricultural income in total HH income (%)	Mean	75.5	65.76
	SD	17.04	17.96
Percentage of farmers under share cropping	Percentage	26.66	25

Source: Household survey, 2009/2010

Though two districts do not differ so much in terms of household characteristics, they differ distinctly in terms of urbanization and linkage to market centers. Table 5.3 presents a comparison of geographic characteristics between two districts. The result showed that one of the major markets of the country, Narayangarh market, is located in Chitwan district. Apart from this, other markets like Butwal market and many other markets in eastern and western zones are near from Chitwan. Kathmandu, the capital of the country, is located near to Dhading district but there is a weak market infrastructure to link production zone to the capital. Chitwan district is comparatively more urbanized and it is one of the

centers of economic activities in Nepal. In Chitwan, all farm households are well connected with the motorable road. Generally, transportation cost from production zone to market center is higher in Dhading district compare to Chitwan districts.

Table 5.3: Characteristic of external factor

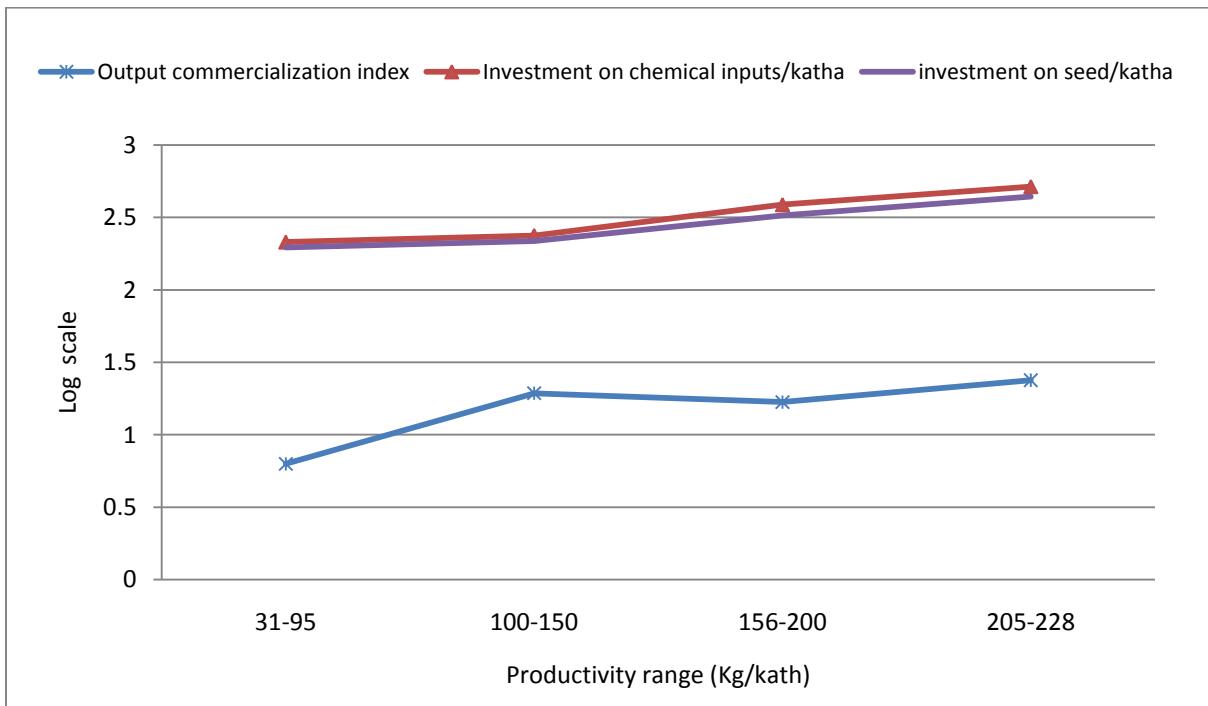
Districts	Category	Av. market distance
Chitwan	Local market	2.55
	Narayangarh market	20.68
	Butwal market	120
	Kathmandu market	158.69
	Pokhara market	120
Dhading	Local market	2
	Narayangarh market	80
	Butwal market	180
	Kathmandu market	82
	Pokhara market	120

*Source:* Household survey, 2009/2010

#### 5.4.2 Input and Output Market Orientations and Productivity

Figure 5.2 illustrates the trend of output commercialization and investment on modern input against different ranges of rice productivity across farmers. Rice is primarily a staple crop and planted to meet the household daily food requirement. However, with the rapid urbanization, this crop is gradually getting more and more market oriented. The result indicated that the level of commercialization was higher at the higher level of productivity. That means, there must be a positive

association between rice productivity and output market commercialization. The trend of investment on seed and chemical fertilizer per unit land showed that investment on modern biological inputs was higher at the higher level of productivity. This indicates a positive association between modern input use and productivity.



**Figure 5.2: Rice productivity, output commercialization and input intensification**  
*Source:* Household survey, 2010

#### **5.4.3 Determinants of Agricultural Input and Output Market Orientation and Its Effect on Productivity**

The result is presented in table 5.4. The result indicated that market distance, family size and land size had significant impact on output market orientation. The

effect of land size was found positive. This indicates that small farm holders may not be able to integrate into the mainstream of commercialization. The impact of market distance was negative. This indicates that many farm household residing in rural areas at a greater distance from the urban markets has less opportunity to commercialize their farm. The family size had significant negative impact on the level of commercialization. This indicates that, in staple crop like rice, the family demand for food has a greater role to define the level of commercialization.

In the second stage, analysis was done to see the factors affecting input market orientation. The investment on chemical fertilizer and improved seed were considered as indicators of input market orientation. The result is presented in the third and fourth columns of table 5.4. The result indicated that land size, level of output market commercialization and contact to input service providers had a positive impact on the investment of fertilizer. Similarly, education, land size and the level of commercialization had a positive impact on the investment of improved seed.

The last column of table 5.4 illustrates the relationship between rice productivity and various household and market related factors. The result indicated that both output market orientation and investment on input had significant positive impact on rice productivity. Apart from this, age of household head was found to have a positive impact on productivity. This could be due to the higher experience represented by the age of household that could have a positive impact on productivity. Alternatively, the impact of land size on productivity was negative. As

land size increases, the level of inefficiency increases due to management and other kinds of inefficiency that might reduce the level of productivity.

Table 5.4: Determinants of input and output market orientation and productivity in rice farms

Variables	Output market orientation		Investment on chemical fertilizer/farm	Investment on modern seed/ farm	Productivity (Kg/Katha)
	Coefficient	Marginal effect			
Highest Education in family (school year)			-22.67	46.18*	-0.20
Market distance (km)	-0.50***	-0.13			
%of HH income from agriculture			3.27	4.86	
Land size (katha)	3.23***	0.88	91.59***	70.81***	-3.53***
Family size (number)	-3.48**	-0.96			
Age (number)			18.98	0.16	0.83**
Share cropping (katha)			0.54	-0.69	-0.26
Commercialization			9.71**	6.21**	0.71***
Investment on chemical and seed per katha					0.13***
Contact to service providers			358.14*	-0.46	
Constant			-40.66	-485.73	85.10
Sigma	28.16				
Mc Fadden's pseudo R2	0.17				
R2	0.68		0.59	0.66	0.43
Adj R2			0.57	0.63	0.39
F			20.80***	27.4	10.64***
LR chi2	93.15***				
Log likelihood	-220.94				

Note: \*, \*\* and \*\*\* represent significant at 10%, 5% and 1% level of significance

## **5.5 Conclusions and Policy Recommendations**

Rice commercialization was mainly affected by market distance, family size and land size. Market distance had a negative impact on the commercialization of Rice. Higher market distance causes diseconomies of scale in marketing. Apart from this, higher transaction cost due to missing information in remote areas could have been the reason for negative impact. As expected, land size had significant positive impact on commercialization. This suggests that small land size in Nepal due to massive land fragmentation and unequal land distribution is one of the bottlenecks to commercialize rice farm in rural area. In this context, the government policy should be directed to develop institutional mechanism like cooperative marketing system that can minimize the constraints due to small land size and higher market distance. Government should enact appropriate land policy to avoid further land fragmentation. The development of rural transportation should be given a due priority to connect rural production pocket to the urban centers. The size of farm family had a negative impact on commercialization. This could be due to the availability of less marketable surplus with the increase of family size. Due to unavailability of non-farm employment in rural areas, daily livelihood is very much dependent on the food produce in their farm. Thus, agricultural commercialization in rural areas is also conditioned upon the availability of non-farm employment.

The result indicated that the investment on modern inputs was affected by the level of output market orientation, the level of education, land size and contact to input service providers. The study suggests that the government intervention to

expedite the input intensification through supply side intervention may not be successful if the structural and many demand side constraints emanating from above mentioned factors are not given a due concern.

Rice productivity was found to be affected significantly both by output market orientation and investment on input and household characteristics like experience of household head. Thus, the government policy to increase productivity through technological enhancement should integrate with market linkage development programs.

# **Chapter 6:**

## **Response of Agricultural Production to the Price and Technological Variables**

### **6.1 Price and non-price policy in agriculture**

Agricultural policies at macro and micro levels affect various aspects of farming business such as use of technology in agriculture, input intensification, crop selection and various market related decisions. However, it is a debatable issue that how likely the exogenous shocks through government policy may have an impact at farmers' level in developing countries where a greater share of agriculture is under subsistence farming. The past study has opined that subsistence farming is not responsive to government policy. The effectiveness of government policy on agricultural development depends on the responsiveness of agriculture to economic incentives. In developing country like Nepal, where rural infrastructure is poorly developed and markets are poorly integrated, responsiveness of farmers to market-based economic incentives may be low. Thus, it is worth while that the agricultural

development policy should be accompanied with other complementary policies that boost up farmers' responsiveness to external shocks.

Government mainly works through two kinds of agricultural policy instruments - price and non-price policies. Policy instruments like subsidy, tax, export and import quota, and export and import duties are related to price policy while investment on irrigation, fertilizer distribution system, technology generation and its dissemination are related to non-price policy. Apart from this, macro policies that are sector neutral such as exchange rate and trade policies affect various sectors of an economy. Price policy affects various exogenous and endogenous factors that ultimately affect the producers and consumers price while non-price policy basically affects the use of technology in agriculture.

The main goal of these policy implementations in developing countries is to boost up domestic production. The effectiveness of such policies can be judged on the basis of change in production due to a unit change in the variables that are being affected by the government policies. These variables are mainly price of a product and the technology that is used in the production process. There have been lots of contesting arguments on the responsiveness of production to price and non-price factors in developing countries in the past. However, there is only limited research conducted on the production response of Nepalese agriculture in the past. Thus, the main aim of this study is to search answer of a number of issues on the production response that is still open in the context of low-income country like Nepal.

Agriculture is perceived as an engine of economic growth in Nepal. Various agricultural development policies have been designed and implemented since Nepal has initiated its first five-year development plan in 1956. All these policies revolve around the issue of technological advancement to transform the traditional agriculture to a commercial agriculture. Different research and extension modalities have been practiced to generate, adopt and extend the technology at farmers' level. Apart from this, price policy was also given a due consideration during the 70s. The government was involved in minimum price fixation of rice with an objective of stabilizing market price of rice. However, it is abolished during the 80s. A big reform was initiated in 1995 with the implementation of Agricultural Perspective Plan (APP)<sup>††</sup>. APP aimed at accelerating agricultural growth through agricultural input intensification and technological advancement. With the implementation of APP, the government system of controlling price and distributing agricultural input was abolished, targeted input intensification program was implemented in various production pockets, and at the same time various liberalization policies have also been implemented. However, the impact of such interventions is not so encouraging and the agricultural growth is stagnant that has an adverse effect on the overall economic growth. This has raised a concern that the responsiveness of Nepalese agriculture to price and non-price variables could be low. In this context, this study tried to find the magnitude of supply response at individual crop and aggregate production level to the increase of price and technological variable.

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<sup>††</sup> Agricultural Perspective Plan (APP) is a 20 years long-term agricultural development plan of Nepal initiated and implemented in 1995.

The remainder of the chapter is organized as follows. Literature review is presented in section 6.2. The theoretical framework in section 6.3 presents a review of relationship between different variables in a production system. Data and methodology, presented in section 6.4, illustrates the pros and cons of Nerlovian method against the error correction method. Ultimately the result is presented in section 6.5 and conclusion is drawn in the last section of the chapter.

## 6.2 Literature Review

The policy undertaken in the agricultural sector varies across countries. Developed country like EU put its emphasis on price policy to make agricultural terms of trade more favorable through price support and quota system (Sarris, 1991). However, during post world-war period, developing countries' policy remained biased towards industrial sector in the expense of agricultural sector (Andrews, 1985). The effectiveness of agricultural policy depends on the responsiveness of agriculture with economic incentives. Any reform to restructure the incentive system at farmers' level requires a detailed knowledge on the behavior of production to different price and non-price shocks. In this respect, there are many studies carried out to assess the behavior of agriculture with price and non-price factors. These studies can be divided into two categories. One category of the study has focused on the individual crop response while another has focused on the aggregate production response. The results and interpretations for policy implication are different in different studies due to differences in coverage,

methodology and scope of the study. The studies based on an individual crop using micro level data have found that production is responsive to price as well as technological variables (Burt and Worthington, 1988; Akinboade, 1999; Farroq, et al., 2001; Aadland and Baley, 2001; Mustaq and Dawson, 2002; Alemu et al., 2003; Nkang et al., 2007; Arnade and Kelch, 2007; Piya, 2009). However, a large number of economists have argued that even though the price elasticity of supply of individual crops may be large, the aggregate agricultural supply response is low (Martin et al., 1993 and Muchapondwa, 2008). This is strongly indicated in the studies considering the case of South Asian countries (Binswanger et al., 1987; Binswanger and Khandker, 1993; Rao, 2004; Deb, 2004; Hazell et al., 1995; Rao, 2004; Mushmmad et al., 2008). The belief of low aggregate price response has been a basis for emphasizing on non-price factors, especially technology, for agricultural development in developing countries. However, this conclusion is not unanimous. Contrary to South Asian case, the study conducted in Sub-Saharan Africa found that the estimated supply elasticity to price factors is positive and appear to have substantial welfare cost due to discrimination against agriculture (Thaile, 2003). While, Gibson and Mcleod (1982) argues that better agricultural terms of trade, when the sector is already in profit, may increase the land rent and reduce the profit from agriculture under the scarce land situation.

The fixed land resource is given as the main reason for the low aggregate supply response to price factor. Another reason mentioned by Johnson (1950) is the parallel adjustment of factor prices to the change in output price. Apart from this,

Schiff and Montenegro (1995) argues that the low supply elasticity of price variable is due to relatively higher share of agriculture in national GDP. Some economists believe that aggregate supply response is not low in fact but it takes time to respond. However, Binswanger et al. (1985) argues that countries generally pursue high or low price strategies for decades, with price peaks and troughs around these policies being maintained for only short periods. Thus, the effect of price change on the production is hardly discernable even we allow a certain time to respond. These facts show that the past studies on production response in various countries depict contrasting conclusions.

## 6.2 Theoretical concept

The study of agricultural supply response deals about the supply and price relationship. However, output is affected by many other factors like level of agricultural input and technology that makes the empirical detection more complicated. Thus, any factors that cause changes in resource allocation may affect the supply behavior. Generally, agricultural growth depends on land expansion, input intensification and factor productivity. Factor productivity depends on efficiency and technical change. These are the fundamental channels through which higher agricultural growth can be realized. Thus, the behavior of supply response will be affected by the change in these variables. Figure 6.1 presents a schematic model of agricultural system. Three components of agricultural system namely input, throughput (production) and output are presented. The factors related to

output has a backward-linkage effect while input has a forward-linkage effect on the agricultural production. According to the system approach, they are interconnected with each other and a shock in one of the parts promptly transmits its effect on the rest. Agricultural input and technical advancement lead an increase of land productivity which intern increases agricultural supply. The price factor has backward-linkage effect on the agricultural supply. The past studies on individual crops showed that the agricultural production is very responsive to the change in price. However, many studies dealing with the aggregate supply showed that the supply is not responsive to price factor. The main reason given is the inelastic nature of land resource. If this is the case, the backward linkage effect of increase of price should be restricted only to the land expansion. However, there is more chance that the effect of price change due to external shock be realized through input intensification and technological enhancement. These variables are considered as supply shifters. The important issue to be discussed is whether the favorable output price translates into the technological advancement and input intensification in developing country like Nepal. The answer is not obvious. Agriculture in Nepal is mainly rural based and has higher market failure. In such condition question can be raised that what is the assurance that favorable price change in agriculture brings an expected change in agricultural growth? Does this ensure the diversion of investment from other sector to agricultural sector? To answer these questions, assessment of the relationships among these variables requires an analysis in a

dynamic setting so that not only the direct effect but also an indirect effect can be assessed.

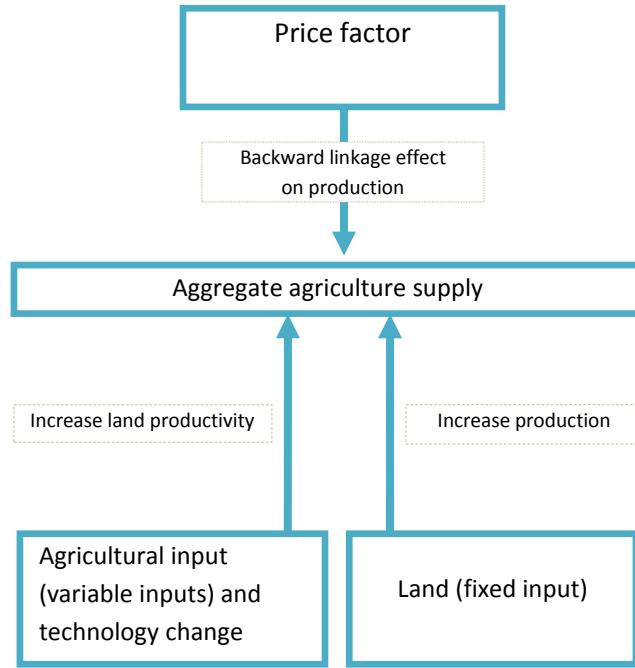


Figure 6.1: Different factors affecting agricultural supply

## 6.3 Materials and Methods

### 6.3.1 Nerlovian method versus Error correction method

The estimation of supply response has foundation in the theory of firm. Here, the interest is mainly towards estimation of supply function looking firm's problem from output perspective. As farmers are merely price taker, the profit maximizing rule is to equate marginal cost to output price. So the supply curve can be distinguished from marginal cost curve. Farmers produce the output above the minimum variable cost. Supply curve is the inverse of the marginal cost function with increasing in the market price. Thus, according to the theory of firm, output

produced depends on own price, price of the complementary and supplementary products and input price. Another issue in the analysis of the firm is a biological lag in input use and output harvest. Apart from this, institutional and technological factors also affect farmers to instantly adjust with output. Thus, agricultural firm may not behave as per the standard theory of firm. The number of literature has dealt this issue through dynamic model specifications like Nerlove Partial Adjustment model. But, Nerlovian model may not give an adequate distinction between short and long-run elasticity (McKay et al., 1999). Estimates from Nerlove method are likely to be downward biased as Nerlove method specifies the dynamics of supply in a very restrictive way (Thiele, 2003). Another concern in the supply response is the underlying assumption of stationarity of data generation process. However, time series data have generally unit root problem. If this is the case, traditional regression analysis with unit root problem leads to the spurious regression (Gujrati, 1995). In this context, Error Correction Model (ECM) resolves the problem of stationarity and analyzes the relationship under dynamic state of affairs (Maddala, 2004). There is empirical evidence for superiority of ECM than partial adjustment model (McKay et al., 1999). Thus, this study used the error correction method to analyze the dynamic relationship among variables.

### 6.3.2 Augmented Dickey Fuller test

Augmented Dickey Fuller test was conducted both with and without trend to assess the presence of unit roots in the individual data series. The number of lags in

the ADF test was chosen so that AIC (Akaike Information Criteria) remains minimum. Following form of ADF was used to assess the unit root problem in the data series.

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^m \Delta Y_{t-i} + e_t \quad (1)$$

### 6.3.3 Cointegration test

After unit root analysis, cointegration test was carried out. There are basically two methods widely used for cointegration test in the literatures- Engle and Granger (1987) and Johansen Maximum Likelihood Estimation (1988). The problem with Engle and Granger method is that it does not allow for the separate estimation of the multiple cointegrating vectors. Thus, this study used Johansen method to test the presence of cointegrating vectors and estimation of the long-run impact. All the variables were considered endogenous and following form of vector auto regressive as postulated by Sims (1980) was considered.

$$Z_t = A_1 Z_{t-1} + \dots + A_k Z_{t-k} + \mu_t \quad (2)$$

where  $Z_t$  is  $(n \times 1)$  vector of endogenous variables,  $A_i$  are  $(n \times n)$  matrices of parameter, and  $\mu_t$  is  $(n \times 1)$  vector of random variables with  $E(\mu) = 0$ . To examine the cointegration relation in equation (1) following form of vector error correction is considered

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \dots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + \mu_t \quad (3)$$

where  $\Delta Z_t$  is a vector of  $I(0)$  exogenous variables,  $Z_t$  is a vector of  $I(1)$  endogenous variables,  $\Pi$  and  $\Gamma_i$  are  $(n \times n)$  matrices of parameters with  $\Gamma_i = -(\mathbf{I} - A_1 - A_2 - \dots - A_i)$ ,  $(i=1, \dots, k-1)$  and  $\Pi = (\mathbf{I} - \Pi_1 - \Pi_2 - \dots - \Pi_k)$ .  $\hat{\Gamma}_1$  and  $\hat{\Pi}$  provides the information about short-run and long-run adjustments to the change in  $Z_t$  respectively. The rank of the matrix  $\Pi$  predicts the number of cointegrating relation in vector  $Z_t$ . If rank of  $\Pi$  equals to  $r$  so that  $r$  is  $0 < r > n$ , then  $\Pi$  can be divided into two  $(n \times r)$  matrices of  $\alpha$  and  $\beta$ . Where,  $\beta$  estimates the long run impact and  $\alpha$  estimates the error correction in the short run impact. Two likelihood ratio (LR) - Trace test and Maximum Eigen Value test were conducted to assess the cointegrating vector.

$$\lambda_{\text{trace}} = -T \sum_{i=r+1}^n \log (1 - \hat{\lambda}_i) \quad (4)$$

where  $r = 0, 1, 2, \dots, n-1$ ,  $T$ = Number of observation,  $\hat{\lambda}_i$ = estimated characteristic roots (eigenvalues).

$$\lambda_{\max} = -T \log (1 - \hat{\lambda}_{t-i}) \quad (5)$$

where  $r = 0, 1, 2, \dots, n-2, n-1$

The estimates of Johansen cointegration is affected by the number of lags order used in VAR. This study used the adjusted likelihood ratio substantiated with AIC criteria to find out the correct order of VAR. Another issue in using Johansen method is the inclusion and exclusion of intercept and trend components in

cointegrating vectors. *Pantula*<sup>#</sup> principle was used to select among the various alternatives.

#### 6.4 Data and Model

In this study, two kinds of data sets, aggregate national level data and individual crop data were considered. For individual crop model, a data series (1968-2005) of crop production, irrigation and output price were considered. While for aggregate production model, due to unavailability of data from 1968, a time series data (1973-2005) of aggregate agricultural production (PROD), gross terms of trade (TOT) and irrigated area (IRRI) were considered.

The aggregate agricultural production is the agricultural value added (constant base year 2000) taken from World Development Indicator, 2010. The index of agricultural terms of trade was considered as an aggregate price factor. In a similar study by Rao (2004), the index of net barter terms of trade was being used as an aggregate price variable, which was estimated by the ratio of index of prices received to the index of prices paid for inputs used in farm production. Due to unavailability of data for calculating net barter terms of trade between agricultural and non agricultural sector, this study used the concept of gross barter terms of trade. It was computed as the ratio between agricultural and non-agricultural (manufacturing and industrial) GDP deflators. The good thing with the gross terms

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<sup>#</sup> According to this principle, first start with the most restrictive model i.e no deterministic component and judge the rank using test statistics, if rejected, continue with the model that restrict constant to the cointegrating space. If this model is also rejected, go to the model with unrestricted constant. In the case of rejection, proceed to the model with linear trend in the variables and the cointegration space. If this is also rejected, repeat the process for next rank. Continue until null hypothesis can not be rejected for the first time

of trade is that it measures the relative returns to investing resources in both sectors and corrects for increases in productivity in both sectors. Econometric results for a national model are not much affected by the choice of either of these indices (Hazell et al., 1995). Thus, in this study, the gross terms of trade was used as an aggregate price variable. Many of the past studies considered irrigation as a proxy for technology (Deb, 2004 and Hazell et al., 1995; Mushtaq and Dawson, 2002). This study also followed the same concept. Time series data on total irrigated area is referenced from FAOSTAT.

Time series data on production of cereal crop (Rice), high value crop (Vegetable) and industrial crop (Sugarcane) was collected from FAOSTAT. Crop output prices were also referenced from FAOSTAT. To arrive at real price of individual crops, nominal price data was deflated by Consumer Price Index (CPI). The annual trend of real price is presented in figure 6.2. As this study used the long time series data, the effect of rainfall is considered random over time. Followings are the production response models considered in this study.

$$\Delta \text{RICEprod} = \alpha_{10} + \alpha_{11} \Delta \text{RICEprod}_{t-1} + \alpha_{12} \Delta \text{RICEpr}_{t-1} + \alpha_{13} \Delta \text{IRRI}_{t-1} - \lambda_1 (\text{RICEprod}_{t-1} - \beta_{10} \text{RICEpr}_{t-1} - \beta_{11} \text{IRRI}_{t-1}) \quad (6)$$

$$\Delta \text{SCANEprod} = \alpha_{20} + \alpha_{21} \Delta \text{SCANEprod}_{t-1} + \alpha_{22} \Delta \text{SCANEpr}_{t-1} + \alpha_{23} \Delta \text{IRRI}_{t-1} - \lambda_2 (\text{SCANEprod}_{t-1} - \beta_{20} \text{SCANEpr}_{t-1} - \beta_{21} \text{IRRI}_{t-1}) \quad (7)$$

$$\begin{aligned} \Delta \text{VEGprod} = & \alpha_{30} + \alpha_{31} \Delta \text{VEGprod}_{t-1} + \alpha_{32} \Delta \text{VEGpr}_{t-1} + \alpha_{33} \Delta \text{IRRI}_{t-1} - \lambda_3 (\text{VEGprod}_{t-1} - \\ & \beta_{30} \text{VEGpr}_{t-1} - \beta_{31} \text{IRRI}_{t-1}) \end{aligned} \quad (8)$$

$$\Delta \text{PROD} = \alpha_{40} + \alpha_{41} \Delta \text{PROD}_{t-1} + \alpha_{42} \Delta \text{TOT}_{t-1} + \alpha_{43} \Delta \text{IRRI}_{t-1} - \lambda_4 (\text{PROD}_{t-1} - \beta_{40} \text{TOT}_{t-1} - \beta_{41} \text{IRRI}_{t-1}) \quad (9)$$

Where PROD= Aggregate agricultural production, ToT=Agricultural terms of trade, RICEprod=Rice production, RICEpr=Rice price, WHEATpr=Wheat price, SCANEprod= Sugarcane production, SCANEpr=Sugarcane price, VEGprod= Vegetable production, VEGpr= Vegetable price, IRRI= Irrigated cropped area.  $\alpha$ ,  $\beta$  and  $\lambda$  are short-run, long-run and error correction term respectively.

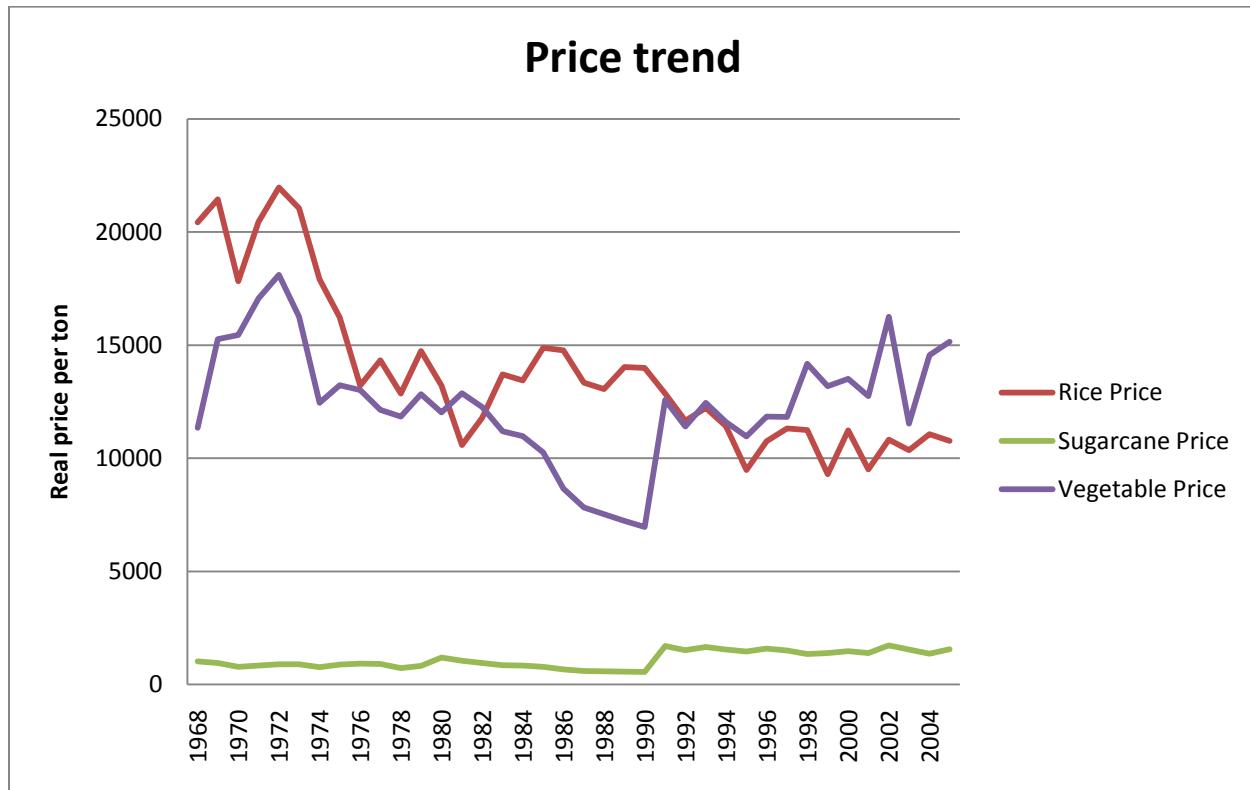


Figure 6.2: Annual real price trend of rice, sugarcane and vegetable

Source: data from FAOSTAT

## 6.5 Results and Discussions

### 6.5.1 ADF test results

Most of the time series data are non-stationary. The regression result on such variables may be spurious. Thus, the Augmented Dickey Fuller (ADF) test was conducted to test the stationarity of the time series data. Lag length for the ADF test was selected so as to make AIC value minimum. Table 6.1 reports the test results of ADF both with and without trend for all variables of individual crop model and aggregate crop model respectively. The result indicated that all the variables considered had a unit root problem at level form and stationary at differenced form. Thus all the data series were integrated of order 1.

Table 6.1: Unit Root (ADF) tests

Variable	Constant	p-value	Const + trend	p-value
PROD	0.66	0.98	-2.46	0.34
D(PROD)	-6.29	0.00	-6.62	0.00
ToT	-1.12	0.69	-1.50	0.80
D(ToT)	-6.43	0.00	-6.42	0.00
IRRI	-2.31	0.17	-2.58	0.28
D(IRRI)	-1.97	0.29	-3.34	0.07
SCANEprod	-0.50	0.87	-3.35	0.07
D(SCANEprod)	-4.76	0.00	-4.70	0.00
SCANEpr	-1.79	0.37	-2.71	0.23
D(SCANEpr)	-6.48	0.00	-6.42	0.00
RICEprod	-0.23	0.92	-5.10	0.00
D(RICEprod)	-6.68	0.00	-6.65	0.00
RICEpr	-1.94	0.31	-5.74	0.00
D(RICEpr)	-4.40	0.00	-4.14	0.01
VEGprod	-2.00	0.28	-0.89	0.94
D(VEGprod)	-1.38	0.57	-8.95	0.00
VEGpr	-2.10	0.24	-2.06	0.55
D(VEGpr)	-7.94	0.00	-7.96	0.00

### 6.5.2 Cointegration Result

In this study, the Johansen reduced rank procedure (1988) was used to test for the cointegrating relationship. The first step in the Johansen procedure is to determine the order of the VAR. In order to determine the optimal lag, an unrestricted VAR model with order three was estimated and then using a likelihood ratio (LR) and Akaike Information Criteria (AIC), the optimum order of VAR was decided. The LR statistic is based on the null hypothesis that the order of the VAR is  $k$  against the alternative that it is 3 where  $k=0,1,2$ . Another criterion like AIC was also given due consideration to determine the appropriate length of VAR. The result of VAR order determination is given in table 6.2. The VAR order of 2 was selected for all the models.

After assessing the VAR order, test was done to determine the cointegrating rank. The results are presented in Table 6.3. The important issue when working on cointegrating relationship is whether to include intercept and trend term in the model. The specification is sometimes decided based on experimentation with different combinations of intercepts and trends (Hossain, 2008). In this study, Trace test and maximum Eigen value test were used to check the cointegrating relationships among variables. Result showed that all the variables were cointegrated of order 1.

Table 6.2: VAR order determination

Model	Lag order	Log likelihood	LR	AIC
logSCANEprod, logSCANEpr, logIRRI	0	-55.17	NA	3.32
	1	81.51	242.13*	-3.97
	2	90.77	14.81	-3.98*
	3	94.44	5.28	-3.68
logRICEprod, logRICEpr, logIRRI	0	2.77	NA	0.01
	1	99.21	170.83	-4.98
	2	112.28	20.91*	-5.21*
	3	117.02	6.76	-4.97
logVEGprod, logVEGpr, logIRRI	0	-16.49	NA	1.11
	1	110.13	224.31	-5.60
	2	127.39	27.61*	-6.07*
	3	132.85	7.79	-5.87
logPROD, log IRRI, logToT	0	49.99	NA	-3.13
	1	213.38	283.21*	-13.42
	2	223.43	15.40	-13.49*
	3	231.33	10.52	-13.42

Note: \* VAR order

Table 6.3: Cointegrating rank determination

Crop	$H_0$ : No. of Cointegrating equation	Rank Test	
		Trace Test	Maximum Eigen value
Sugarcane	None	39.54**	30.68***
	At most 1	8.86	7.29
	At most 2	1.56	1.56
Rice	None	35.03**	25.04**
	At most 1	9.98	8.88
	At most 2	1.10	1.10
Vegetable	None	39.53**	26.75**
	At most 1	12.77	6.98
	At most 2	5.78	5.78
Aggregate production	None	51.99***	33.10***
	At most 1	18.89	11.75
	At most 1	7.13	7.13

Note: \*\*\* significant at 1 % level of significance, \*\* significant at 5% level of significance

### 6.5.3 Error Correction Model (ECM)

The result is presented in Table 6.4. The error correction term (EC) was significant in all cases. The significance of ECs implies the presence of causal relations from independent variables to the dependent variable, even in the case when the lagged independent variables are individually insignificant. The error correction term was higher in case of rice compare to the rest of the crops. The result indicated that around 55% of short-run disturbance in sugarcane production and 44% in short-run disturbances in aggregate production model were immediately adjusted to its long-run trend. While in case of rice, almost all disturbances were immediately adjusted to its long-run trend. Alternatively, the adjustment of short-run disturbance in case of vegetable was quite slow.

The estimated cointegrating vectors were given an economic interpretation by normalizing production variables and presented at the bottom of the table 6.4. The result showed that ToT had no long-run impact on aggregate production. Alternatively, in individual crop case, the long-run own price elasticities of rice, sugarcane, and vegetable were positive and statistically significant. Comparatively, Vegetable was more responsive with elasticity value 1.74 compare to 0.53 and 0.32 of Rice and Sugarcane respectively. The long-run production response to irrigation variable was positive and statistically significant for sugarcane, vegetable and aggregate production while it was statistically not significant in case of rice. In this case also, vegetable was found the most responsive comparatively. The insignificant elasticity of irrigation in rice was contrary to the expectation. The plausible

explanation could be relatively large area of rice compare to the total irrigated area so that small increment of irrigated area could have insignificant effect. Moreover, the majority of rice in Nepal is grown under rain-fed condition.

In the short run, own price elasticity was statistically insignificant in all crops. Similarly, the short-run impact of ToT on aggregate production was statistically not significant. This indicates that farmers take decision on the basis of long-run price trend. In the short run, the production was positively responsive to irrigation variable only in case of vegetables and aggregate production while individually, rice and sugarcane showed insignificant result. In summary, at individual crop level, production was responsive to both price and technological variables while at aggregate level, aggregate production was responsive only to the technological variable. The result of insignificant response to terms of trade is similar to the result of past studies.

Table 6.4: Error Correction Model

Variables	$\Delta \text{SCANE}_{\text{prod}}$	$\Delta \text{RICE}_{\text{prod}}$	$\Delta \text{VEG}_{\text{prod}}$	$\Delta \text{PROD}$
Constant	0.05	-0.02		-0.02
$\Delta \text{IRR}_{t-1}$	-0.33	0.17	0.51***	0.67***
$\Delta \text{RICE}_{\text{prod}, t-1}$		-0.01		
$\Delta \text{RICE}_{\text{pr}, t-1}$		-0.23		
$\Delta \text{VEG}_{\text{prod}, t-1}$			-0.65***	
$\Delta \text{VEG}_{\text{pr}, t-1}$			-0.08	
$\Delta \text{SCANE}_{\text{prod}, t-1}$	0.51***			
$\Delta \text{SCANE}_{\text{pr}, t-1}$	0.04			
$\Delta \text{PROD}_{t-1}$				-0.11
$\Delta \text{TOT}_{t-1}$				-0.05
$\text{EC}_{t-1}$	-0.55***	-1.0***	-0.04***	-0.42***
$R^2$	0.36	0.55	0.48	0.34
Adj $R^2$	0.28	0.48	0.43	0.24
F	4.44***	7.47***	9.97***	3.39***

Note: \*, \*\*, \*\*\* indicates significant at 10, 5 and 1 percent level of significance respectively.

### Normalized long-run relation

$$\text{SCANE}_{\text{prod}} = 8.64 + 0.06^{***} \text{T} + 0.10^{**} \text{IRRI} + 0.32^{***} \text{SCANE}_{\text{pr}}$$

$$\text{RICE}_{\text{prod}} = 10.03 + 0.03^{***} \text{T} - 0.07 \text{IRRI} + 0.53^{***} \text{RICE}_{\text{pr}}$$

$$\text{VEG}_{\text{prod}} = -14.13 + 0.99^{***} \text{IRRI} + 1.74^* \text{VEG}_{\text{pr}}$$

$$\text{PROD} = 17.60 + 0.03^{***} \text{T} + 0.22^{***} \text{IRRI} - 0.05 \text{ToT}$$

## 6.6 Conclusions and Policy Recommendations

Past studies argued that the aggregate production response to the price variable like ToT is not significant while the impact of technological variable is positive and significant on production and productivity (Binswanger and Khandker, 1993; Rao, 2004). The result of this study supports the previous conclusion made on other developing countries.

The result of individual crop response model showed that the impact of short-run fluctuation of price on production was not so significant across crops. However, the long-run impact of the price variable on production was significant. The long-run price elasticity ranged from 0.53 for cereal, 1.74 for commercial crops and 0.32 for industrial crop. In Nepal, vegetables are grown with a commercial orientation. This could be the reason for the higher level of price elasticity of vegetables. The price response of cash crops was moderate. It may be due to inadequate agro-industry in Nepal. As the impact of price on production is higher in the long run compare to that of the short-run, the government should focus on the policies that ensure the profitable price to the producers in the long run. Another fact is that the price response is higher for the commercial crop like vegetables. Thus, the price-

policy instruments would work better in commercial crops. As commercial farming is possible only in the potential areas where the market linkage is strong, it would be imperative to develop market infrastructure along with better long term price policies. The result of aggregate production response model showed that the effect of terms of trade on aggregate production was insignificant both in short-run and long-run. That means, favorable terms of trade to agricultural sector does not increase aggregate production. This study could not explain empirically the reason for insignificant impact of favorable terms of trade to agriculture. The plausible reason could be due to poor agricultural market development and inadequate rural infrastructure. The long-run production response to the irrigation variable was higher in vegetables compare to cereal and industrial crops. Looking into the higher production response of the irrigation variable on commercial crop like vegetables, government policy should be directed to develop irrigation facilities to more potential areas where farmers can take opportunity of commercial ventures.

# **Chapter 7:**

## **Relation between Export and Agricultural Productivity in Nepal**

### **7.1. Export Strategy: Specialization versus Diversification**

There are two competing arguments among trade policymakers. The classical trade model advocates that a country should specialize on those products on which it has more comparative advantage (Bhagwati and Srinivasan 1983). Another school of thought supports the idea of diversification to avoid risk due to specialization (Turnovsky 1974; Ruffin 1974). Specialization provides an opportunity to utilize the scarce resource in a more efficient way but it increases the degree of vulnerability to external shocks. Economists like Prebisch (1950) and Singer (1950) have warned of the detrimental effects of terms of trade shocks in developing countries that depend on a few products for their export earnings. One of the reasons for increasing trade vulnerability is the market imperfection in domestic as well as in international markets. In this regard, Ghos and Ostry (1994) argued that the diversification policy makes countries less vulnerable to the adverse terms of trade by stabilizing export revenue and by channelizing positive terms of trade into growth. Brenton et

al. (2007) mentioned three factors that provide trade diversification opportunities. First is the increasing spread of global production chains; second is the rapid increasing demand in newly emerging economies like China and India and the third is the growing importance of trade in services driven by rising income and outsourcing of more and more service activities.

## **7.2 Agricultural Export diversification and Productivity**

Past studies have shown that there is a positive link between agricultural export performance and economic growth of developing countries (Osakwe 2007; Pineres 1999). Many agricultural based economies have embraced the strategy of export-led economic growth after the macro policy shift from inward to more outward oriented economy in the 80s. In this context, the export diversification has got a good attention in many developing countries to reduce the instability in export earnings. Generally, agricultural export diversification ensures a sustained growth in agricultural export that generates a positive impact on domestic production and productivity. The link between agricultural export diversification and productivity growth is presented in figure 7.1. Theoretically, the export diversification brings a positive impact through two channels- one is through new investment on exporting crops and the other is through new technological and managerial innovations. As land is a fixed natural resource, the increased export is realized either through the substitution of traditional crops by the exporting crops or through the increase of productivity of exporting crops. However, it is worthwhile to assume that such

impact at aggregate level would depend on various factors like the size of export relative to AGDP and the level of commercialization in agriculture.

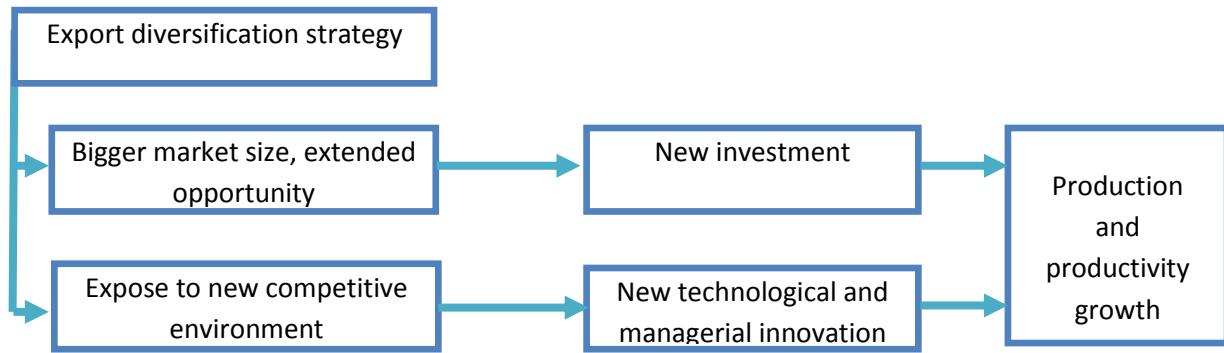


Figure 7.1: Effect of Agricultural export on productivity growth

In Nepalese context, the export-led agricultural growth got momentum after the shift of macro policy from closed to open economy in the early 90s. Nepal still depends on the export of primary agricultural products. Due to the narrow range of exporting products and export destinations, the instability in the export of agricultural products is quite high. In this regard, Nepal government has given a priority for agricultural export diversification to increase and stabilize export growth. Both product diversification (from primary cereal based export to high value and processed agricultural products) and geographic diversification (diversifying export from India to other countries) are given a due concern. However, as the size of export is very small compare to the share of agriculture to the overall economy and most of the productions are carried out in a subsistence environment, there is a doubt that the export diversification strategy could work well in Nepal.

There has not been any study in the context of Nepal that shows the impact of export diversification on the overall production and productivity is positive. This study tried to fulfill this gap.

### **7.3 Geo-political Feature of Nepal**

Nepal shares a 1590-kilometer long border with India and 1414 kilometers with China (Bhattarai 2005). To the north of this nation lies Tibet, the autonomous region of China; to the east, west, and south are the federal states – Bengal, Bihar, and Uttar Pradesh of the republic of India. Due to such a geographic position of Nepal, its access to the sea is made possible only by railways through Indian territories. Calcutta, its nearest Indian port, is located at about one thousand kilometers. Since the country has been facing enormous problems in the area of transit, it has tried to exploit the alternative route with Bangladesh, although its effective utilization still depends on the political relation between India and Nepal since Nepal and Bangladesh have no common borders (Muni 1992). Though India has not denied the transit routes for Nepal except for a brief period in 1989, the use of that route has proved prohibitive owing to the high costs of transport and all sorts of administrative problems brought about by the application of India's domestic laws designed primarily for Indian trade and not for transit (Glassner 1978). This situation has, in the past, forced Nepal to pursue the policy of economic and trade diversification (Khadka 1997). Since the open door policy adopted by China, Nepal's trade volume with this country has increased considerably. However,

the agricultural export is still very much dependent on India. The major production zones of exportable crops lie at the plain areas of Nepal which are bordered with India. Apart from this, the socio-cultural tie-up with India due to its historical, religious, economic, and social relationship is also an important factor to trade with India. Thus, Nepal is economically dependent on the larger neighboring country. Such a dependency has led to a situation where Nepal's economic development is conditioned by the economic development of India. However, the bordered states of India represent the least developed regions. Thus, there is hardly any sign that the economic progress of India is reflected in the economy of Nepal.

#### **7.4 Trade Policy in Nepal**

Prior to the implementation of first five-year plan in 1956, Nepal had a trade-neutral regime. After 1956, trade policy was oriented towards a closed and protectionist regime. It regulated industrial investment through a rigorous licensing system. Domestic industries were highly protected through tariff and quantitative restriction measures. Imports were also subjected to import licensing. There was a restriction in the use of foreign exchange. In 1982, Nepal shifted its inward looking policy to more outward-looking liberal policy under the slogan of "Exports for Development". The government opened up a wide international market for many products that used to be confined only in the domestic market. The policy was intended to simplify the import licensing system, reduce import tariffs and narrow down the dispersion in tariff rates associated with imports.

In 1992, a new trade policy was implemented. The main objective was to enhance the role of trade in the national economy by increasing private sector participation in domestic as well as international trade; diversifying trade through creating new products; and reducing trade deficit through the expansion of trade. After the enactment of this policy, many changes have occurred in the export and import sectors. The currency was devaluated several times; the foreign exchange market was liberalized for current account transactions and efforts were made to make the exchange rate sensitive to the market (Sharma *et al.*, 2001). In addition, the investment policy was revisited and revamped. License system for export was abolished except for the banned or quantitatively restricted items. No duty levied on raw materials and auxiliaries imported by industries in export promotion zone (EPZ). Industries exporting more than 80 percent of the production are also granted similar facilities as that to the industries in EPZ. Apart from this, Nepal government has revised the export and import duties on various products.

## **7.5 Agricultural Export Structure of Nepal**

The average figures of agricultural export to different countries over different periods are presented in table 7.1. The general trend indicates that India is the prime export destination. Its share was 60-95% of the total agricultural export during the 70s and mid 80s. From mid 80s to mid 90s, India's share decreased remarkably. The political tension between India and Nepal on the bilateral trade issue could have negatively affected the agricultural export to India during that

period. In 1990, democracy was re-established in Nepal after the abolition of 30-year long *Panchayat*<sup>ss</sup> system and a new bilateral trade treaty between India and Nepal took place in 1992. The effect of this agreement could be seen as an increase of agricultural export to India from mid 1990 to 2005. Compare to India, Nepal exported negligible quantity of agricultural products to China, the other bordered country. Developed countries like Japan, USA, Singapore and EU shared just 2-24 per cent of agricultural export during the study period. Similarly, other South Asian countries shared a negligible portion of Nepalese agricultural export. All these figures indicate that the geographic diversification of Nepalese export is quite narrow. The landlocked geography is one of the major bottlenecks for trade diversification. As the extension of agricultural trade to China is rather difficult due to inaccessible mountainous rocky areas at the northern parts of Nepal, the agricultural export primarily depends on Indian markets. The trade pattern indicates that the export was more diversified from the mid 80s to the mid 90s, the period when Nepalese export to India decreased by 30-40%. Thus, the agricultural export diversification of Nepal is conditioned by the level and nature of dependency on India. Another plausible reason for the low geographic diversification is the low exportable surplus in Nepal.

Table 7.2 presents the share of different commodities exported to India. The agricultural export to India was mainly dominated by cereal crops like rice (60% share in total export) in the 70s. However, onwards early 80s, agricultural export

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<sup>ss</sup> *Panchayat* system was a political system in Nepal during the direct rule of monarchy. In this political system, all the political parties were legally banned to operate in Nepal.

has been more diversified to other high value and processed products like vegetables and spices and industrial crops like sugarcane, tobacco, and honey. Apart from this, the export of oils, oil seed and processed animal and vegetable oils and fats also increased remarkably. This indicates a gradual transformation of export from cereals to high value and processed agricultural products.

Table 7.1: Share of agricultural export by different countries (%)

<i>Country</i>	<i>1970-74</i>	<i>1975-79</i>	<i>1980-84</i>	<i>1985-89</i>	<i>1990-94</i>	<i>1995-99</i>	<i>2000-05</i>
India	95.07	72.63	64.74	52.57	53.98	71.36	89.67
China	0.00	0.24	0.00	7.60	1.51	7.17	3.65
Other South Asia	1.11	3.69	7.72	20.06	27.67	9.78	2.14
Developed country	3.46	14.72	24.16	18.65	15.05	10.68	2.30
Others	0.06	8.72	3.37	1.12	1.79	1.02	2.24

*Source:* Authors' own calculation based on data series from COMTRADE

Table 7.2: Share of agricultural export to India by different commodities (%)

<i>Year</i>	<i>1970-74</i>	<i>1975-79</i>	<i>1980-84</i>	<i>1985-89</i>	<i>1990-94</i>	<i>1995-99</i>	<i>2000-05</i>
Beverages	0.21	0.00	0.00	0.00	0.00	0.38	6.62
Total cereals	67.60	46.99	24.90	7.78	0.74	0.67	0.16
Cereal prep	5.07	17.65	17.37	20.33	20.30	12.24	10.84
Vegetables, roots & tubers, fresh or dried	4.49	7.77	13.87	11.54	10.54	20.15	9.11
Spices	2.25	3.83	4.91	4.54	27.10	15.21	13.43
Industrial	0.00	0.02	0.21	0.41	0.93	0.64	3.95
Milk and milk products	13.49	9.57	3.66	2.82	1.49	1.47	0.97
Animal and vege fats	0.00	4.43	5.12	13.81	16.90	40.63	46.81
Oil seeds and oils	6.06	8.44	8.15	12.04	15.22	1.92	0.75
Live animals	0.54	1.00	1.04	2.14	6.60	2.69	0.44
Others	0.29	0.29	20.77	24.59	0.17	3.99	6.93

*Source:* Authors' own calculation based on data series from COMTRADE

Table 7.3: Share of agricultural export to all countries by different commodities (%)

<i>Products</i>	<i>1970-74</i>	<i>1975-79</i>	<i>1980-84</i>	<i>1985-89</i>	<i>1990-94</i>	<i>1995-00</i>	<i>2001-05</i>
Beverage	0.21	-	-	-	0.04	0.33	5.85
Total cereals	64.00	48.8	20.7	5.01	0.83	1.00	0.17
Total cereal preparation	5.13	13.78	14.88	13.7	11.91	14.85	10.72
Vegetables, roots & tubers, fresh or dried	4.71	7.36	30.61	24.93	38.72	22.64	8.72
Industrial crop	0	0.79	0.06	0.48	0.88	1.10	6.57
Spices	6.28	13.37	14.45	17.73	14.78	10.62	12.89
Dairy product	12.85	5.95	2.88	2.19	0.63	1.08	0.86
Animal and vegetable oils	-	2.65	3.99	17.69	9.59	31.17	45.29
Oil seeds and oils	5.16	5.64	6.92	12.06	17.39	9.93	0.55
Live animals	0.52	0.56	0.84	1.38	3.36	2.01	0.38

*Source:* Authors' own calculation based on data series from COMTRADE

Table 7.3 presents the share of different commodities exported to the rest of the world. The trend indicates that the composition of agricultural export changed over time. Cereals had a greater share in the agricultural export in the 70s and the early 80s. During that time, Nepal was known as a rice exporting country. However, after the mid 80s, the situation was just reversed and Nepal became a net rice importing country with the export more diversified to other high value products like animal and vegetable oils and industrial crops. The share of animal and vegetable oils increased from zero to 45% over the study period while the export of cereals decreased from 64% to 0.17% during the same period. The change in the demand structure might have caused the diversification of agricultural products. Generally, with the increase of income level, cereal based consumption tends to diversify to

high value crops. However, the diversification of exportable commodities did not result into the diversification of export destinations. As Nepalese export is more concentrated to India, the demand pattern of Indian markets might have influenced the commodity composition of Nepalese export.

## 7.6 Materials and Methods

Four variables namely total agricultural export (AX), geographic concentration (GC), product concentration (PC) and agricultural productivity (Y) were considered in the analysis. Agricultural productivity was measured in terms of constant international dollar value per unit agricultural land. Agricultural export was measured in real term by deflating with export indices. Gini–Hirschman coefficient of concentration was used to calculate the geographic and product concentration indices. Following formula was used to calculate the indices.

$$GC_{xt} = 100 \sqrt{\sum_{i=1}^n \left[ \frac{X_{it}}{X_t} \right]^2} \quad (1)$$

where  $GC_{xt}$  = Index of geographic concentration;  $X_{it}$  = export of all commodities to country i at time t;  $X_t$  = total export to all countries at time t.

$$PC_{xt} = 100 \sqrt{\sum_{i=1}^n \left[ \frac{y_{it}}{X_t} \right]^2} \quad (2)$$

$PC_{xt}$  = Index of product concentration;  $y_{it}$  = Export of commodity i to all countries at time t;  $X_t$  = total export to all countries at time t

All four variables were considered endogenous to the model and the vector auto regression (VAR) method was used to analyze the relationship between and among these variables as shown by equations 3, 4, 5 and 6. As there was a unit root problem in the data series, the VAR analysis was carried out in differenced form. Thus, the results represent the short-run relationship among variables. To establish a long-run relationship among these variables, a cointegration test was carried out. As geographic concentration and productivity data series had unit root problem while product concentration and export data series were stationary at 10% level of significance, the cointegration test could not be carried out using both Engle and Granger (1987) and Johansen Maximum Likelihood Estimation (1988). Thus, Auto Regressive Distributed Lag (ARDL) bound-testing method developed by Pesaran et al. (2001) was used to test for the cointegration but the series did not show any cointegration. Thus the idea of assessing the log-run relationship was dropped out and simple ordinary least square method was used to see the average relationship among variables. As the data series tend to be stationary when the trend component is included, a simple ordinary least square regression was carried out both with and without trend component to assess the average relationship among variables.

After VAR, granger causality test was carried out to see the direction of causality among the variables. Then, impulse response function was estimated to see the effect of exogenous shocks on the targeted variables.

$$\log dY = f(\log dGC, \log dAX, \log dPC) \quad (3)$$

$$\log dGC = f(\log dY, \log dAX, \log dPC) \quad (4)$$

$$\log dAX = f(\log dGC, \log dY, \log dPC) \quad (5)$$

$$\log dPC = f(\log dGC, \log dAX, \log dY) \quad (6)$$

where  $\log dAX$  = lag difference of Agricultural export;  $\log dGC$  = lag difference of geographic concentration;  $\log dY$  = lag difference of agricultural productivity; and  $\log dPC$ = lag difference in product concentration

The export data was referenced from the COMTRADE data-base. Due to inadequate update of data from Nepal side, SITC Rev-1 mirror data was considered in the study. Agricultural products included under the SITC code 0, 1, 2 and 4 were considered. However, as the production of hydrogenated vegetable oil in Nepal is based on the raw materials imported from other countries, the vegetable oil is dropped out in the calculation of product and geographic diversifications. Export data series were transformed into the real export value deflating by the export price index. Data on agricultural production and agricultural land were referenced from the FAOSTAT. All the data series were ranged from 1970 to 2005.

## 7.7 Results and Discussions

### 7.7.1 Comparative trend of agricultural export, geographic concentration, product concentration and agricultural productivity

Table 7.4 and figure 7.2 give a general trend of agricultural export, geographic concentration, product concentration and agricultural productivity. The result showed that the agricultural productivity has been gradually increasing over time,

however, agricultural export gradually decreased until 1985 and then started to increase onwards 1985. This indicates that export and productivity trends are not proportionate to each other. The trend in geographic and product concentrations followed more or less similar to that of the agricultural export. This indicates that the agricultural export of Nepal is more influenced by the geographic and product concentration of export. Both export value and concentration indices fluctuated quite randomly over the period. This indicates a higher instability in agricultural export in Nepal.

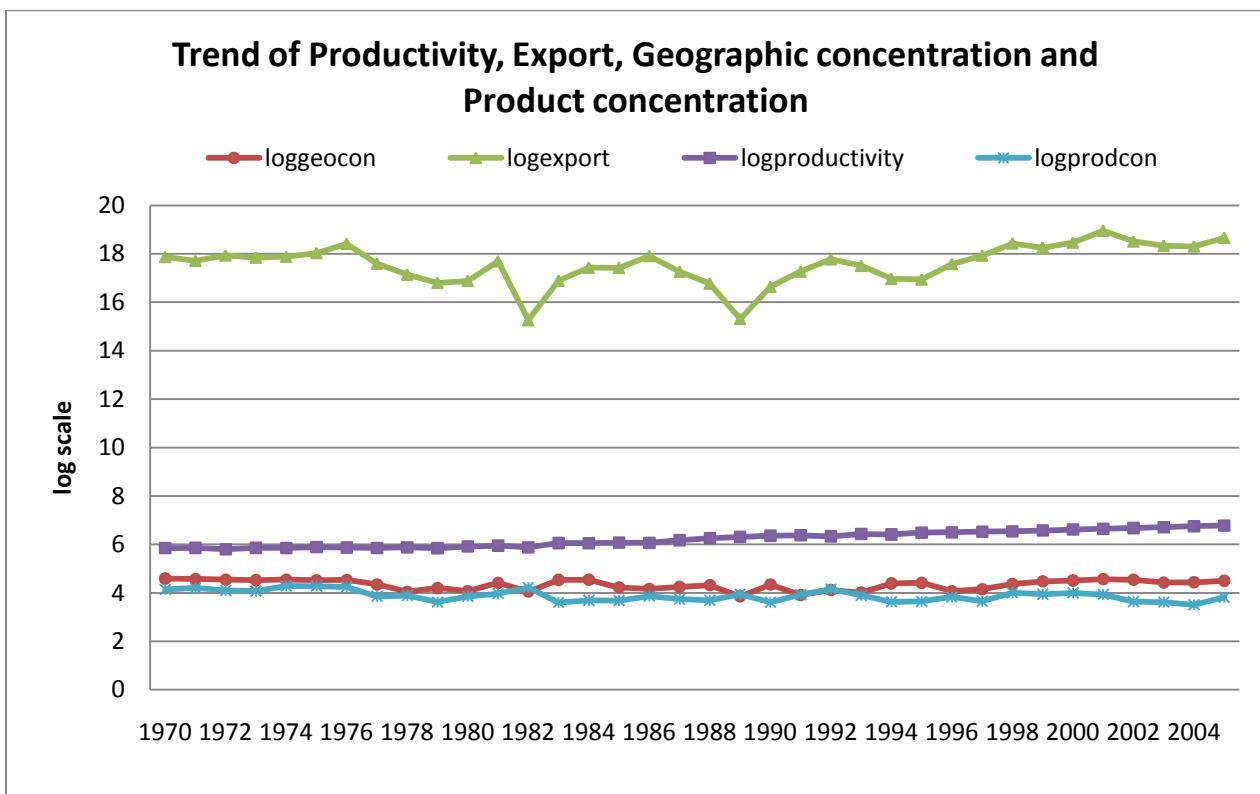


Figure 7.2: Comparative trend of productivity, geographic concentration, product concentration and agricultural Export

*Source:* Based on data from COMTRADE and FAOSTAT.

Table 7.4: Comparative Statistics of Export, Geographic Concentration, Product Concentration and Agricultural Productivity

<i>Variables</i>	1970- 75	1976- 80	1981- 85	1986- 90	1991- 95	1996- 00	2001- 05
Agricultural Export (million \$)	58.37	42.4	29.6	26.3	34.03	78.8	117.7
Geographic concentration (%)	94.6	70.5	79.1	66.5	65.9	75.8	89.7
Commodity concentration (%)	65.69	50.14	47.62	43.79	48.03	49.13	41.08
Agricultural Productivity (I\$/ha)	348.07	355.70	405.58	512.47	608.09	700.90	823.99

*Source:* Based on data from COMTRADE and FAOSTAT.

### 7.7.2 Augmented Dickey Fuller (ADF) test

Table 7.5 illustrates the result of Augmented Dickey Fuller (ADF) test. The ADF test conducted both with and without trend and the lag length was selected so as to make the value of Akaike Information Criteria (AIC) minimum. The result showed that the agricultural export had the unit-root problem; that is; data series was not stationary at five per cent level of significance while its first difference showed no unit-root problem. Similarly, the test results of geographic concentration and agricultural productivity also confirmed the unit root problem while the data series of product concentration did not show the unit root problem at 5 % level of significance. As the data series were found different in nature in terms of unit-root problem, the cointegration could not be established. Thus, a simple ordinary least square (OLS) regression was run to assess the average effect of export volume and export diversification on agricultural productivity. As the data series tend to be stationary when the trend component is considered in the ADF test, OLS regression

was also carried out using the detrended data series. To assess the dynamic relationship between and among variables, the vector auto regression (VAR) analysis was carried out. As there was a unit-root problem in the data series, all the data are first differenced to convert it to stationary form. Thus, the interpretation of VAR should be restricted to its short-run dynamics.

Table 7.5: Augmented Dickey Fuller Test (Unit Root Test)

<i>Variable</i>	<i>Constant</i>	<i>p-value</i>	<i>Constant + trend</i>	<i>p-value</i>
Log AX	-2.67	0.08	-2.93	0.16
D(log AX)	-7.36	0.00	-4.76	0.00
Log GC	-2.39	0.15	-3.68	0.03
D(log GC)	-10.02	0.00	-4.21	0.01
Log CC	-2.92	0.04	-3.44	0.04
D(log CC)	-4.92	0.00	-4.84	0.00
Log Y	0.74	0.99	-2.19	0.49
D(log Y)	-3.24	0.01	-3.38	0.05

### 7.7.3 Relation between agricultural export, export concentration and agricultural productivity

The regression result is presented in table 7.5. The results showed that the effect of agricultural export on productivity was positive and significant while the effect of geographic and product concentration on productivity was negative. However, the result was quite different with the trend component included in the model. The result showed that the geographic concentration had a positive impact on agricultural productivity while the effect of product concentration and export volume did not show any significant impact on productivity.

Table 7.6: Relation between productivity and agricultural export

Log Y	Coefficient (without trend)	Coefficient (with trend)
Log GC	-0.36** (0.16)	0.15** (0.06)
Log PC	-0.47*** (0.11)	0.06 (0.05)
Log AX	0.21*** (0.04)	-0.01 (0.02)
Trend	-	0.03*** (0.002)
Constant	5.83 (1.09)	5.02 (0.35)
R-sq	0.66	0.96
Adj R-sq	0.63	0.96
F	21.28***	217.67

Note: \*\* and \*\*\* indicate significant at 5 % and 1% level, Figure within parenthesis represents standard error

Table 7.6 presents the result of vector auto regression (VAR) analysis. The lag order was chosen as 4. The value of lag order was chosen on the basis of likelihood ratio (LR) and Akaike Information criterion (AIC). The result depicts the short-run dynamics of four variables. The result showed that the agricultural productivity was positively influenced by the past productivity at lag order 4. The short-run effect of product and geographic concentrations on productivity was found positive at lag order 1. The effect of agricultural export on productivity was slightly negative at lag order 1. Thus, the result indicates that agricultural productivity is positively influenced by the concentration of export to a particular country especially India.

The short-run impact of agricultural productivity on product concentration at lag order 2 and 3 was positive and statistically significant. However, the level of product concentration in the past had a negative impact on the current level of product concentration. Similarly, geographic concentration at lag order 3 and 4 had a negative impact on product concentration. Alternatively, export volume showed a positive impact on product concentration at lag order 1. The result indicates that

both productivity and product concentration moves parallel to each other. The result also indicates that when export is more concentrated to India, the product diversification increases. The relative market size of India compare to the total supply capacity of Nepal is so big that it can absorb whatever increase in production, thus it provides an ample opportunity to diversify agricultural export when export increases to India.

The short-run relation between geographic concentration and all other variables are presented in the third column of table 7.6. The result showed that the productivity at lag order 2 negatively affects the geographic concentration. Product concentration showed a positive impact on geographic concentration at lag order 1 and 3. Alternatively, the past value of geographic concentration and export seemed to have a negative impact on the current level of geographic concentration. The result indicates two important facts. First, as the level of productivity increases, the export tends to diversify out of India; second, as the product range narrows down, the export tends to concentrate to India.

The short-run impact of all variables on agricultural export is presented in the last column. The result indicated that the effect of productivity on export was positive only at lag order 3 while it was negative at lag order 1 and 2. This indicates that it takes a certain time to translate the effect of productivity increment on export. Product concentration at lag order 3 had a positive impact on export while the effect of past value of export at lag order 2 and 3 showed a negative impact on

current export. Alternatively, the geographic concentration did not show any significant impact on export volume.

Table 7.7: Vector Auto Regression (VAR) Model

Variables	Equations			
	D.logY	D.logPC	D.logGC	D.logAX
D.logY <sub>t-1</sub>	-0.12(0.18)	0.16 (0.92)	1.29 (0.90)	-6.41** (2.79)
D.logY <sub>t-2</sub>	-0.24(0.22)	2.06* (1.13)	-2.85*** (1.10)	-6.85** (3.41)
D.logY <sub>t-3</sub>	0.01 (0.20)	2.11** (1.01)	-0.07 (0.98)	7.66** (3.05)
D.logY <sub>t-4</sub>	0.40** (0.19)	-1.24 (0.96)	0.23 (0.93)	-2.35 (2.88)
D.logPC <sub>t-1</sub>	0.05* (0.03)	-0.48*** (0.17)	0.53*** (0.17)	0.83 (0.53)
D.logPC <sub>t-2</sub>	-0.008 (0.03)	-0.30* (0.17)	0.07 (0.16)	-0.07 (0.52)
D.logPC <sub>t-3</sub>	-0.009(0.03)	-0.26 (0.16)	0.40*** (0.16)	1.01* (0.50)
D.logPC <sub>t-4</sub>	-0.01(0.03)	-0.32* (0.18)	-0.01 (0.17)	-0.02 (0.54)
D.logGC <sub>t-1</sub>	0.15*** (0.04)	0.006 (0.24)	-0.20 (0.23)	0.10 (0.73)
D.logGC <sub>t-2</sub>	0.008 (0.04)	-0.18 (0.22)	-0.35* (0.21)	0.34 (0.67)
D.logGC <sub>t-3</sub>	0.067 (0.04)	-0.68*** (0.24)	0.30 (0.23)	0.87 (0.72)
D.logGC <sub>t-4</sub>	0.041 (0.04)	-0.54** (0.22)	0.04 (0.21)	0.18 (0.67)
D.logAX <sub>t-1</sub>	-0.07*** (0.01)	0.23*** (0.08)	-0.17** (0.08)	-0.15 (0.26)
D. logAX <sub>t-2</sub>	0.001 (0.01)	0.02 (0.06)	0.05 (0.06)	-0.51** (0.20)
D. logAX <sub>t-3</sub>	-0.01 (0.01)	0.05 (0.074)	-0.12* (0.07)	-0.66*** (0.22)
D. logAX <sub>t-4</sub>	-0.03 (0.01)	0.03 (0.07)	0.005 (0.07)	0.03 (0.23)
Constant	0.03 (0.01)	-0.18 (0.06)	0.07 (0.06)	0.41 (0.19)
R-sq	0.61	0.62	0.64	0.66
Chi2	49.26	51.73	55.26	0.63
P>chi2	0.00	0.00	0.00	0.00

*Notes:* Value inside parenthesis represents standard error. \* and \*\* indicate significance level at 10% and 5%, respectively.

To assess the direction of causality among variables, the granger causality test was also carried out and the result is presented in Table 7.7. The result showed that the product concentration granger causes productivity and vice versa. Similarly,

export granger causes geographic concentration. Both geographic and product concentration granger causes agricultural export.

Figure 7.3 presents the result of orthogonalized impulse response function. The impulse response function shows the effects of shocks on the adjustment path of the variables. The result indicated that the shocks in the present growth rate of agricultural export has an impact on the future growth of agricultural export but it has a very small impact on geographic and product concentration which quickly dies out while its impact on productivity is negligible. Similarly, the shocks in geographic concentration has very random impact on agricultural export while its impact on future geographic concentration has initially negative which dies out quickly and its impact on product concentration is slightly positive initially which also dies out instantly. Alternatively, the impact of geographic concentration on productivity is negligible. The present shocks in product concentration brings small changes in future export, geographic and product concentrations which lasts nearly 3-4 years while its impact on productivity is marginal. Lastly, the impact of exogenous shocks in productivity on the agricultural export is quite random and lasts nearly 6 years while its impact on future productivity and product and geographic concentrations is very minimum. In conclusion, the agricultural productivity seems not so much responsive to the changes in agricultural export and its diversification policy. The result confirms the initial doubt that the agricultural export and its diversification in Nepal may not have a profound impact on productivity.

Table 7.8: Granger Causality Wald Tests

Equation	Excluded	Chi2	Prob>chi2
D.logY	D.logPC	4.381	0.35
	D.logGC	10.47	0.033
	D.logAX	31.32	0.00
D.logPC	D.logY	7.11	0.13
	DlogGC	15.66	0.00
	DlogAX	12.27	0.01
DlogGC	DlogY	10.07	0.03
	DlogPC	16.02	0.00
	DlogAX	6.97	0.13
DlogAX	D.logY	18.76	0.00
	DlogPC	5.86	0.21
	DlogGC	2.04	0.72

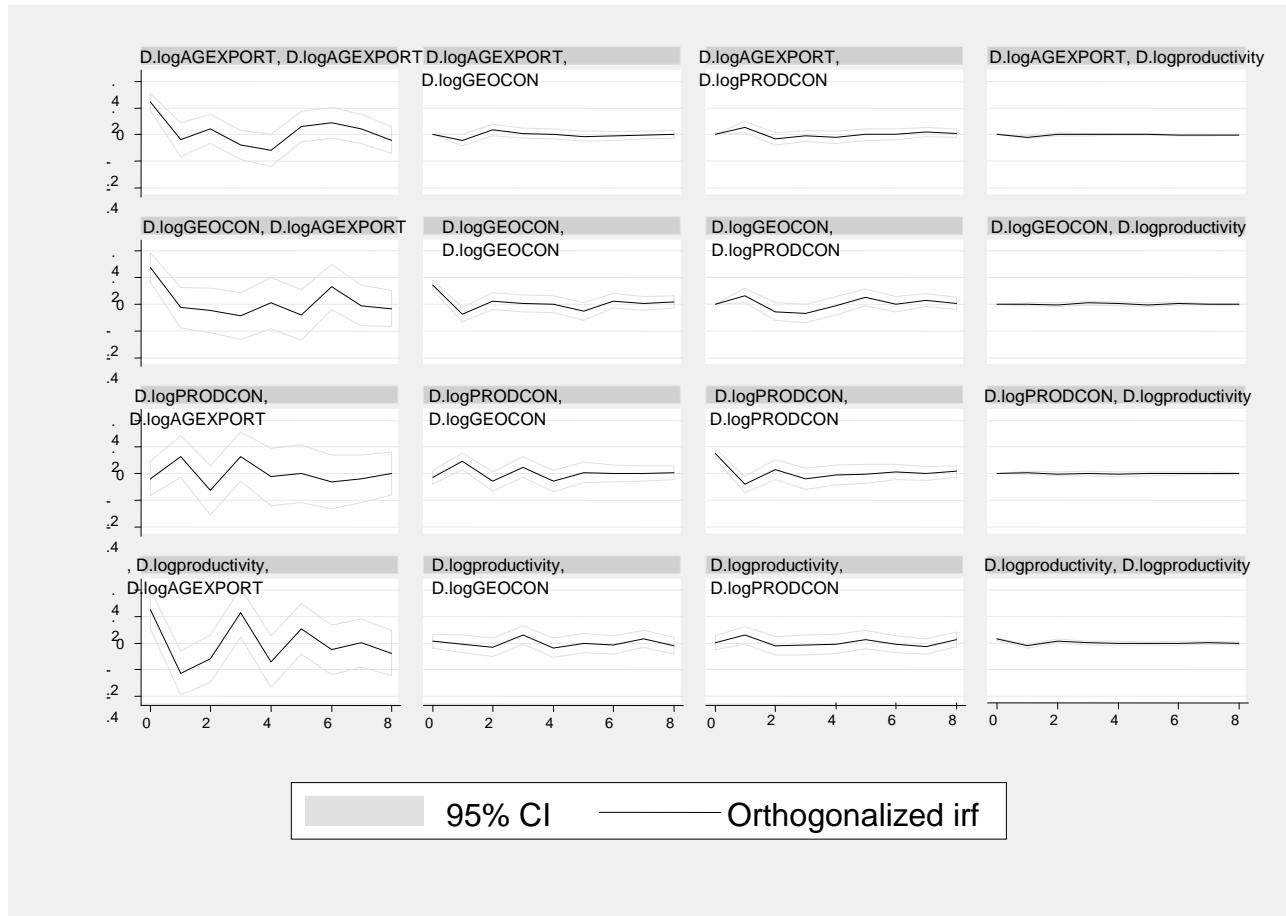


Figure 7.3: Orthogonalized impulse response function

## **7.8 Conclusions and Policy Recommendations**

The effect of agricultural export on productivity was statistically not significant. This indicates that the increase of export has a very weak relation to the productivity of Nepalese agriculture. The plausible reason could be due to a very small share of export in the total volume of production. There are different ways that the export could affects productivity. Generally, the agricultural export surge instigates a new investment in agriculture that could trigger productivity. But this type of impact depends on the responsiveness of domestic production to the external shocks and the relative size of shocks. It seems that in case of Nepal, a small shock in export may not be able to bring a positive impact on productivity. The granger causality test also confirmed that the export does not granger cause productivity and vice versa. The effect of export diversification on productivity was positive but very small and its effect immediately dies out as shown by the impulse response function. The positive effect of geographic and product concentration on productivity indicates a higher level of dependency on Indian market. The scale of agricultural export is so small that it is enough to create diseconomies for diversification. This situation is a major bottle-neck to harness the opportunity from multilateral trade arrangements.

The short-run dynamics of product and geographic concentration indicated that the agricultural productivity positively affects the product concentration while it affects the geographic concentration negatively. Similarly, the export volume had a small negative impact on geographic concentration while it had no significant

impact on product concentration. However, the impulse response function showed that the impact of shocks in export and productivity on export concentration instantly dies out. The short-run dynamics showed that the effect of productivity on export was not definite at different lag periods. The product concentration had a positive effect while the geographic concentration has no effect. The granger causality test confirmed that both product and geographic concentration granger causes export while productivity does not granger cause export.

On the basis of the conclusion outlined above, some policy recommendations are outlined. It seems that Nepal government should focus on structural constraints that are responsible for the low integration between production and market. The level of commercialization of agriculture in Nepal is so small that it might have affected the responsiveness of agriculture to the increment on export. Apart from this, the volume of export relative to the size of agriculture in Nepal is so small that its impact is hardly discernable. Thus, in a status quo, the export diversification policy may not help boost up productivity much. Thus, the government has to focus on increasing the total export volume as well as increasing the commercialization of agriculture.

# CHAPTER 8:

## Conclusions and Policy Recommendations

### 8.1 Conclusion

#### 8.1.1 Background of the study

In many developing countries, agriculture plays a dominant role in the national economy. However, the performance of agricultural in these countries is not as expected. As mass still depends on agriculture for their daily livelihood, the poor performance of agriculture in these regions has caused a widespread poverty in rural areas that is responsible for mass dissatisfaction and social unrest. Thus, enhancing agricultural performance is the most sought after agendas in these countries. Agricultural growth in developing countries brings many positive effects through its backward and forward linkage to the non-agricultural sector. Past studies showed that the agricultural growth in developing countries has a broader development effect through its direct impact on the bottom quintal of the population.

As land is a scarce natural resource and already brought under cultivation, there is no option other than to increase productivity to realize a higher growth in

agriculture. The current level of productivity is quite below compare to the developed nation. So, there is an untapped potential to increase the current productivity with specific interventions. Many developing countries have implemented different policies with an objective of increasing agricultural production and productivity. However, these policies have not been so effective to bring a substantial improvement in the performance of agriculture. This provides an important ground to study the issues related to agricultural productivity in developing countries. Different factors that affect agricultural productivity are accounted and analyzed in this study. Specifically, three issues were covered. First, what factors affect the sources of productivity growth (modern input use, technical change and technical efficiency). Second, how responsive is the agricultural production with price and non-price variables and third, agricultural export strategy and its effect on agricultural productivity. To analyze these issues, study was carried out at cross-country level, country level and grass-root level.

### **8.1.2 Sources of agricultural productivity growth**

A wide variation in modern and conventional input use among South and Southeast Asian countries was found. The use of modern inputs like fertilizer and tractor was comparatively very low in Nepal. Empirical study indicated that the variation in agricultural productivity growth across 10 South and Southeast Asian countries was mainly explained by the variation in modern input intensification like fertilizer and tractor. These two variables explained around 70 percent of variation

in land productivity growth. The role of technology to explain the variation in productivity growth was not so high. This indicates that the difference in fertilizer and tractor intensification per unit land is the main source of variation in productivity growth rather than the technological difference.

The average productivity of agriculture in Nepal was quite below compare to other South and Southeast Asian countries. This indicates an untapped potential to increase production through increasing productivity. For this, the intensification of modern inputs especially fertilizer is a necessary condition.

### **8.1.3 Total factor productivity growth in Nepal: a comparison to Asian and African Developing Countries**

The empirical study on total factor productivity of 31 countries, 22 low income countries (LIC) and 9 lower middle income countries (LMIC), from Asian and African continents showed that the total factor productivity growth is positive in both LIC and LMIC. However, the rate of growth was found little bit higher in LMIC. All LMIC countries showed a positive factor productivity growth while out of 22 LIC, 5 countries from African continent showed a negative growth in factor productivity. Comparatively, Nepal showed a higher level of positive factor productivity growth. Factor productivity was further divided into technical change and technical efficiency change. The average technical change and technical efficiency change were positive both in LIC and LMIC. However, the result indicated that the technical change was the main contributor in total factor

productivity growth. Contrary to this, the contribution of technical efficiency was found higher in case of Nepal. Over the 20 years period, the general trend of total factor productivity across 31 countries was not definite. During the first half of the study period, the total factor productivity across the countries neither converged nor diverged but was random in nature however, after 1990, the total factor productivity was found converging within and across two economic groups. The shift of policy from closed to liberal economy in many developing countries might have contributed to the exchange of technology across the regions and economic groups that led to the convergence of factor productivity.

#### **8.1.4 Factors affecting technical efficiency of rice farms in Nepal**

The empirical study on rice farms in Nepal showed that rice production can be increased by 30 percent through improving technical efficiency in a given technological condition. The result showed that many factors affect the technical efficiency of rice farm. The impact of commercialization was found positive and statistically discernable. Apart from this, the household characteristics like share of agricultural income to total household income, age of household head, and education level have also shown a positive impact. Alternatively, rice area under share cropping showed a negative impact. The result suggests that the productivity can be increased substantially by increasing technical efficiency of rice farms in a given technological condition by subsiding constraints that mainly arise due to low human capital, higher market distance, share cropping, and share of agricultural income.

### **8.1.5 Determinants of input and output market orientation and its effect on productivity**

Output market orientation was mainly affected by market distance, farm size and family size. Market distance and family size had a negative impact while farm size had a positive impact. The level of output market orientation had a positive impact on input market orientation. Apart from this, household characteristics like education of family members, farming experience of household head and farmers' access to input service provider had also significant positive impact on input market orientation. The result indicated that both input and output market orientations had significant positive impact on rice productivity. The result suggests that the government addressing supply side constraints to increase the level of input use may not be sufficient as many demand side constraints emanating from the nature of geography and farm characteristics also affect the input intensification in Nepalese agriculture.

### **8.1.6 Response of agricultural production to the price and technological variables.**

To increase production and productivity in agriculture, Nepal government used various policy instruments such as price policy and investment on agricultural infrastructure like road, irrigation, market etc. These policies affect the level of input and output prices, technological advancement, and input intensification. Thus, the effectiveness of such policies depends on the responsiveness of agricultural

production with respect to change in these variables. The empirical result suggests that the responsiveness differs from crop to crop. It also varies at micro and macro level. Commercial crop like vegetable was found more responsive to price and technological variables compare to other cereal and industrial crops in the long run. The result was very different at aggregate national level. Aggregate production was found not responsive to price factor in the long run. However, aggregate production was highly influenced by technological variable.

#### **8.1.7 Relation between export and agricultural productivity in Nepal**

Nepal's agricultural export is mainly concentrated to India. Nepal exports more than 80% of its agricultural products to India. This indicates very high level of geographic concentration of export. Contrary to this, product diversification has been gradually increasing. During the 70s, the export commodities were mainly dominated by cereal crops but in the recent periods, the export was found more diversified to high value and processed products.

The result showed that the effect of agricultural export on productivity was statistically insignificant. The effect of product and geographic diversification was positive. That means, as long as export keeps concentrating to a particular country, its impact on productivity will be positive. The result is contradictory to the established facts. This might be due to the small volume of exportable surplus and very high dominance of Indian market due to land locked geography.

## **8.2 Policy Implications**

To expedite the modern input use, the government should focus on removing the constraint at farm level that arises due to socio-economic characteristics of farms apart from the supply side constraint. Three factors are more importantly affects the input market orientation- the level of output market commercialization, land size and number of input service providers contacted. Specifically, the government should link rural farms to urban center through developing rural infrastructure that will help commercialize the crop and help boost up input use. The government has to bring a policy to fix the minimum size of farm to avoid the negative effects of small farm size. Apart from this, the policy should be directed to abolish the share-cropping system and replace it by the land-renting system.

Only concentrating input intensification may not sustain the agricultural growth in the long run. Thus, the government has to focus on increasing total factor productivity through technological advancement and through improving efficiency of technology use. Nepalese agriculture is found very responsive to technological variable both at crop and aggregate production level. Thus, government has to bring specific policy that help increase the level of technology. Specifically, the government should invest more on technology development and promote macro policy that supports the trade integration and helps inter-country and inter-regional technological transfer.

Low technical efficiency is associated with many institutional and farm household structural constraints such as share cropping, land size, share of

agricultural income, age of household head and level of commercialization of farm. Policy should focus on fixing minimum size of a farm to discourage massive land fragmentation; agricultural extension should give a priority to the full time and experienced farmers; and focus should be given to increase market linkage through investment on infrastructure.

As Nepalese production is found responsive to price variable only for commercial crop but not for aggregate production, the government should implement specific price policy targeting specific commercial crops like vegetable. Protecting Nepalese producer through import tariff as well as quantitative restriction for the selected commodities could be an option to increase the domestic price in the long run that will ultimately increase the production of the targeted crop.

The export concentration seems to have a positive effect on productivity. This contradictory result indicates a big dominance of Indian markets in Nepalese export. Thus, at status quo, the diversification policy may not work well in Nepal. Two strategies may be helpful for Nepal, first diversifying the export products targeting Indian market and second, diversifying the export destination through producing niche products that has a more prominent market in the developed country. As small exportable surplus could be one of the bottlenecks for export diversification to have a positive impact on productivity, the government should focus on domestic policy to commercialize the agriculture that can generates more exportable surplus.

To finance all these changes the government may confront the financial challenges. Thus, the government has to make priority on the basis of its impact on production and productivity. The scarce financial resource should be diverted first to the priority areas like rural infrastructure.

# References

- Aadland, D. and Bailey, D., "Short-run supply response in the U.S. beef-cattle industry", *American Journal of Agricultural Economics*, Vol. 83(4), 2001, pp. 826-839.
- Aigner, D.J., Lovell, C.A.K. and Schmidt, P., "Formulation and estimation of stochastic frontier production function models", *Journal of Econometrics*, Vol. 6, 1977, pp. 21-37.
- Akinboade, O. A., "A supply-response analysis of Botswana's livestock and sorghum: An error correction approach", *Development Southern Africa*, Vol. 16(1), 1999, pp.125-140.
- Alemu, Z.G., Oosthuizen, K. and Schalkwyk, H.D.V., "Grain supply response in Ethiopia: An error-correction approach", *Agrekon*, Vol. 42, 2003, pp. 389-404.
- Ali, M. and FLINN, J.C., "Profit efficiency among basmati rice producers in Pakistan's Punjab", *American Journal Agricultural Economics*, Vol.71, 1989, pp. 303-310.
- Ali, M. and Chaudhary, M.A., "Inter-regional farm efficiency in Pakistan Punjab: A frontier production function study", *Journal of Agricultural Economics*, Vol.41 (1), 1990, pp. 62-74.
- Andrews, M.S., "Agricultural terms of trade and distributional perversities in a new Ricardian model", *Journal of Development Economics*, Vol. 17, 1985, pp. 117-129.

Arnade, C., "Using a programming approach to measure international agricultural efficiency and productivity", *Journal of Agricultural Economics*, Vol. 49(1), 1998, pp. 67-84.

Arnade, C. and Kelch, D., "Estimation of area elasticities from a standard profit", *American Journal of Agricultural Economics*, Vol. 89(3), 2007, pp. 727-737.

Battese, G.E. and Coelli, T.J., "A model for technical efficiency effects in a stochastic frontier production function for panel data", *Empirical Economics*, Vol. 20, 1995, pp. 325-332.

Battese, G.E., Malik, S.J. and Gill, M.A., "An investigation of technical inefficiencies of production of wheat farmers in four districts of Pakistan", *Journal of Agricultural Economics*, Vol. 47, 1996, pp. 37-49.

Bhagwati, J. and Srinivasan, T.N., "Trade policy and development", Rudiger Dornbusch and Jacob A. Frenkel eds., *International Economic Policy Theory and Evidence*, Baltimore: John Hopkins University Press, 1983.

Bhattarai, R., "*Geopolitics of Nepal and international responses to conflict transformation*", Friends for Peace, FFP publication, Series 006, Kathmandu, Nepal, 2005.

Binswanger, H. P., Mundlak, Y., Yang, M-C and Bowers, A., "On the determinants of cross-country aggregate agricultural supply", *Journal of Econometrics*, Vol. 36, 1987, pp. 111-131.

Binswanger, H.P. and Khandker, S.R., "How infrastructure and financial institutions affect agricultural output and investment in India", *Journal of Development Economics*, Vol. 41, 1993, pp. 337-266.

Binswanger, H. and McIntire, J., "Behavioral and material determinants of production relations in land-abundant tropical agriculture", *Economic Development and Cultural Change*, Vol. 36, 1987, pp. 73-99.

Boserup, E., *The conditions of agricultural growth: The economics of agrarian change under population pressure*, Chicago: Aldine, 1965.

Boserup, E., *Population and technological change*, Chicago: University of Chicago press, 1981.

Bravo-Ureta, B.E. and Antonio, E.P., "Efficiency analysis of developing country agriculture: A review of the frontier function literature", *Agricultural and Resource Economics Review*, Vol. 22, 1993, pp. 88-101.

Brazdik, F., "Non-parametric analysis of technical efficiency: factors affecting efficiency of west java rice farms", Center for Economic Research and Graduate Education, Charles University, Working Paper Series 286, 2006.

Brenton, P., Newfarmer, R. and Walkenhorst, P., "Export diversification: A policy portfolio approach", Paper presented to the growth commission conference on development, Yale University, 2007.

Burt, O.R. and Worthington, V.E., "Wheat acreage supply response in the United States", *Western Journal of Agricultural Economics*, Vol. 13 (1), 1988, pp. 100-111.

Caves, D.W., Christensen, L.R. and Diewert, W.E., "The economic theory of index numbers and the measurement of input output, and productivity", *Econometricia*, Vol. 50, 1982, pp.1393-1414.

Coelli, T.J. and Rao, D.S.P., "Total factor productivity growth in agriculture: A Malmquist index analysis of 93 countries, 1980-2000", *Agricultural Economics*, Vol. 32, 2005, pp. 115-134.

Craig, B.J., Pardey, P.G. and Roseboom J., "International agricultural productivity patterns", Center for international food and agricultural policy, University of Minnesota, Working paper WP94-1, 1994. <http://ideas.repec.org/p/ags/umciwp/14470.html>

De Janvry, A., Marcel F. and Elisabeth S., "Peasant household behaviour with missing markets: Some paradoxes explained", *The Economic Journal*, Vol. 101, 1991, pp. 1400-1471.

Deb, S., "Terms of Trade and investment behavior in Indian agriculture: A cointegration analysis", *Indian Journal of Agricultural Economics*, Vol. 59(2), 2004, pp. 209-230.

de Pineres, S.A.G., "Externalities in the agricultural export sector and economic growth: A developing country perspective", *Agricultural Economics*, Vol. 21(3), 1999, pp. 257-267.

Dhungana, B.R., Nuthall, P.L. and Nartea, G.V., "Measuring the economic inefficiency of Nepalese rice farms using data envelopment analysis", *The Australian Journal of Agricultural and Resource Economics*, Vol. 48 (2), 2004, pp. 347-369.

Diao, X., Hazell, P., Resnick, D. and Thurlow, J., “*The role of agriculture in development: Implications for Sub-Saharan Africa*”, International Food Policy Research Institute, Research report 153, 2007.

<http://www.ifpri.org/sites/default/files/publications/rr153.pdf>

Engle, R.F and Granger, C.W.J., “Co-integration and error correction: Representation, estimation, and testing”, *Econometrica*, Vol. 55(2), 1987, pp. 251-76

Fafchamps, M., and Shilpi F., “The spatial division of labor in Nepal”, *The Journal of Development studies*, Vol. 39, 2003, pp. 23-66.

FAO, *FAO statistical database*, 2010. <http://faostat.fao.org/default.aspx>

Fare, R., Grosskopf, S., Norris, M. and Zhang, Z., “Productivity growth, technical progress and efficiency changes in industrialized countries”, *American Economic Review*, Vol. 84, 1994, pp. 66-83.

Farrell, M., “The measurement of productivity efficiency”, *Journal of the Royal Statistical Society*, Vol. 120, 1957, pp. 253-290.

Farroq, U., Trevor Y., Noel R. and Muhammad, I., “The supply response of Basmati rice growers in Punjab Pakistan: Price and non-price determinants”, *Journal of International Development*, Vol. 13, 2001, pp 227-237.

Foster, A.D. and Rosenzweig, M.R., “Economic development and the decline of agricultural employment”, *Handbook of Development Economics*, Vol. 4, 2008, pp. 3052-3082.

Frisvold, G. and Ingram, K., “Sources of agricultural productivity growth and stagnation in Sub-Saharan Africa”, *Agricultural Economics*, Vol. 13, 1995, pp. 51-61.

Fulginiti, L.E. and Perrin, R.K., "Agricultural productivity in developing Countries", *Agricultural Economics*, Vol. 19, 1998, pp. 45-51.

Ghos, A.R. and Ostry, J., "Export instability and the external balance in developing countries", IMF Working Paper, No. 94/8, 1994.

Gibson, B. and Mcleod, D., "Terms of trade policy in a model with non-produced means of production", *Journal of Development Economics*, Vol.10, 1982, pp. 31-45.

Glassner, M., "Transit rights for land-locked state and the special case of Nepal", *World Affairs*, Vol. 40(4), 1978, pp.131-148.

Goveresh, J., Jayne, T.S. and Nyoro, J., "Smallholder commercialization, interlinked markets and food crop productivity: Cross-country evidence in eastern and southern Africa", East Lansing, Mich., U.S.A.: Michigan State University (MSU), Department of Agricultural Economics & Department of Economics, 1999.

[Http://www.aec.msu.edu/fs2/ag\\_transformation/atw\\_govereh.PDF](http://www.aec.msu.edu/fs2/ag_transformation/atw_govereh.PDF)

Gujarati, D.N., *Basic econometrics*, McGRAW-HILL International Editions, New Delhi, 2004.

Hart, G., "Regional linkages in the era of liberalization: A critique of the new agrarian optimism", *Development and Change*, Vol. 29(1), 1998, pp. 27-54.

Hayami, Y. and Ruttan, V.W., *Agricultural development: An international perspectives*, John Hopkins University Press, Perspective, Baltimore, 1971.

Hayami, Y. and Ruttan, V. W., *Agricultural development: An international perspective*, Johns Hopkins University Press, Baltimore, 1985.

Hazell, P. and Diao, X., "The role of agriculture and small farms in economic development", In *The future of small farms*, International Food Policy Research Institute, 2005.

Hazell, P., Misra, V.N. and Hojjati, B., "Role of terms of trade in Indian agricultural growth: A national and state level analysis", International Food Policy Research Institute, EPTD Discussion Paper, Paper No. 15, 1995.

HMG/N, *Agricultural perspective plan*, Agriculture Project Service Center, Kathmandu and John Mellor Associates, Inc, Washington D.C, 1995.

Hossain, A.A., "The agricultural terms of trade in Bangladesh: An econometric analysis of trends and movements 1952-2006", *Australian Economic Papers*, Vol. 47 (1), 2008, pp. 38-52.

Idiong, I.C., "Estimation of farm level technical efficiency in small scale swamp rice production in cross river state of Nigeria: A stochastic frontier approach", *World Journal of Agricultural Sciences*, Vol. 3 (5), 2007, pp. 653-658.

IFPRI, "Ensuring food and nutritional security in Nepal", USAID Nepal, 2010.  
<http://nepal.usaid.gov/in-the-spotlight-archive/363-ensuring-food-and-nutritional-security-report-unveiled.html>

Immink, M.D.C. and Alarcon, J.A., "Household income, food availability and commercial crop production by smallholder farmers in the western highlands of Guatemala", *Economic Development and Cultural change*, Vol. 41 (2), 1993, pp. 319-342.

Jaleta, M., Gebremedhin, B. and Hoekstra, D., “*Smallholder commercialization: Process, determinants and impact*”, International Livestock Research Institute, Discussion Paper No. 18, 2009.

Jamison, D.T. and Peter, R.M., “Farmers education and farm efficiency in Nepal: The role of schooling, extension services, and cognitive skills”, *World Development*, Vol. 12 (1), 1984, pp. 67-86.

Johansen, S., “Statistical analysis of cointegration vectors”, *Journal of Economic Dynamics and Control*, Vol. 12 (2-3), 1988, pp. 231-254.

Johnson, D.G., “The nature of the supply function for agricultural products”, *American Economic Review*, Vol. 40, 1950, pp. 538-64.

Johnston, B.F. and Mellor, J. W., “The role of agriculture in economic development”, *American Economic Review*, Vol. 51, 1961, pp. 566-593.

Kalirajan, K.P., “The importance of efficient use in the adoption of technology: A macro panel data analysis”, *Journal of Production Analysis*, Vol. 2, 1991, pp. 113-126.

Kawagoe, T. and Hayami, Y., “The production structure of world agriculture: An intercountry cross-section analysis”, *Developing Economies*, Vol. 21, 1983, pp. 87-92.

Kawagoe, T., Hayami, Y. and Ruttan, V.W., “An intercountry comparison of agricultural production efficiency”, *American Journal of Agricultural Economics*, Vol. 67, 1985, pp. 87-92.

Kawagoe, T., Hayami, Y. and Ruttan, V.W., "The inter-country agricultural production function and productivity differences among countries", *Journal of Development Economics*, Vol. 19, 1985, pp. 113-132.

Khadka, N., *Foreign Aid and Foreign Policy, Major Powers and Nepal*, Delhi: New Vikas Publishing House, 1997.

Kumar, P., Mittal, S. and Hossain, M., "Agricultural growth accounting and total factor productivity in South Asia: A review and policy implications", *Agricultural Economics Research Review*, Vol. 21, 2008, pp. 145-172.

Lau, L.J. and Yotopoulos, P.A., "The meta production function approach to technological change in world agriculture", *Journal of Development Economics*, Vol. 31, 1989, pp. 241-269.

Luh, H.Y., Chang, C.C., and Huang, F.M., "Efficiency change and productivity growth in agriculture: A comparative analysis for selected East Asian economies", *Journal of Asian Economics*, Vol. 19, 2008, pp. 312-324.

Lustig, N., "Coping with rising food prices: Policy dilemmas in the developing world", Center for Global Development, Working Paper 164, 2009.

<http://www.cgdev.org/content/publications/detail/1421334>

Maddala, G.S. and Kin, I.M., *Unit Roots, Cointegration, and Structural Change*, Cambridge University Press, 2004, pp. 249-258.

Martin, W. and Mitra, D., "Productivity growth and convergence in agriculture and manufacturing", The World Bank, Policy Research Working Paper 2171, 1999.

<http://ideas.repec.org/p/wbk/wbrwps/2171.html>

Martin, W and Warr, P. G., "Explaining the relative decline of agriculture: A supply side analysis for Indonesia", *The World Bank Economic Review*, Vol. 7, 1993, pp. 381-401.

McKay, A., Morrissey, O. and Vailand, C., "Aggregate supply response in Tanzanian agriculture", *The Journal of International Trade & Economic Development*, Vol. 8(1), 1999, pp.107-123.

Meeusen, W. and van den Broeck, J., "Efficiency estimation from Cobb-Douglas production function with composed error", *International Economic Review* 8, 1977, 435-444.

Mendola, M., "Farm household production theories: A review of institutional and behavioral response", *Asian Development Review*, Vol. 24, 2007, pp. 49-68.

Ministry of Agriculture and Co-operatives (MoAC), *Statistical Information on Nepalese Agriculture*, 2009.

Mitchell, D., "A note on rising food demand", The World Bank, Policy Research Working Paper 468, 2008. <http://go.worldbank.org/31PG0020G0>

Muchapondwa, E., "Estimation of the aggregate agricultural supply response in Zimbabwe: The ARDL approach to cointegration", School of Economics, University of Capetown, Working Paper No. 99, 2008, pp. 1-13.

<http://www.commerce.uct.ac.za/Economics/staff/emuchapondwa/2008/ERSA%20-%20Supply%20Response%20of%20Zimbabwean%20Agriculture20080822.pdf>

Muni, S. D., *Foreign policy of Nepal*, New Delhi: Konark Publishers, 1992.

Murgai, R., "The green revolution and the productivity paradox: Evidence from the Indian Punjab", *Agricultural Economics*, Vol. 25, 2001, pp. 199-209.

Mushmmad, A., Muhammad, S. and Sabinuddin, B., "Growth in agriculture terms of trade and aggregate supply response model: A case study for Pakistan", HPRA Paper No. 8928, 2008. <http://mpra.ub.uni-muenchen.de/8928/>

Mushtaq, K. and Dawson, P.J., "Acreage response in Pakistan: A co-integration approach", *Agricultural Economics*, Vol. 27, 2002, pp. 111-121.

Nepal, R. and Thapa, G.B., "Determinants of agricultural commercialization and mechanization in the hinterland of a city of Nepal", *Applied Geography*, Vol. 29, 2009, pp. 377-389.

Nguyen, D., "The plausibility of agriculture-led development", *Review of Development Economics*, Vol. 4(2), 2000, pp. 204-218

Nin, A., Arndt, C. and Preckel, P.V., "Is agricultural productivity in developing countries really shrinking? New evidence using a modified nonparametric approach", *Journal of Development Economics*, Vol. 71, 2002, pp. 395-415.

Nkang, N.M., Ndifon, H.M. and Edet, E.O., "Maize supply response to change in real prices in Nigeria: A vector error correction approach", *Agricultural Journal*, Vol. 2(3), 2007, pp. 419-425.

Nkamleu, G.B., "Productivity growth, technical progress and efficiency change in African agriculture", *African Development Review*, Vol. 16, 2004, pp. 203-222.

Osakew, P.N., “*Foreign aid, resources and export diversification in Africa: A new test of existing theories*”, African Trade Policy Center, Economic Commission for Africa, Work in Progress No. 61, 2007.

<http://www.uneca.org/atpc/Work%20in%20progress/61.pdf>

Pesaran, M.H., Shin, Y. and Smith, R.J., “Bounds testing approaches to the analysis of long-run relationship”, *Journal of Applied Econometrics*, Vol. 16, 2001, pp. 289-326.

Pingali, P.L. and Rosegrant, M.W., “Agricultural commercialization and diversification: Process and policies”, *Food Policy*, Vol. 20, 1995, pp. 171-185.

Piya, S., “The effect of price and non-price factors on agricultural production in Nepal: A cointegration analysis”, *Journal of Rural Economics*, The Agricultural Economics Society of Japan, Special issue, 2009, pp. 575-582.

Prebisch, R., *The economic development of Latin America and its principal problems*, United Nations, Lake Success, 1950.

Rahman, S., Aree W., Songsak, S. and Yaovarate C., “Production efficiency of Jasmine rice producers in northern and north-eastern Thailand”, *Journal of Agricultural Economics*, Vol. 60(2), 2008, pp. 419-435.

Rahman, S., “Women’s labour contribution to productivity and efficiency in agriculture: Empirical evidence from Bangladesh”, *Journal of Agricultural Economics*, Vol. 61(2), 2010, pp. 318-342.

Rao, N.C., “Aggregate agricultural supply response in Andhra Pradesh”, *Indian Journal of Agricultural Economics*, Vol. 59, 2004, pp. 91-100.

Rao, D.S.P., Sharma, K.C. and Shepherd, W.F., "On the aggregation problem in international comparisons of agricultural production aggregates", *Journal of Development Economics*, Vol. 35, 1991, pp. 197-204.

Rosenzweig, M.R., "Risk implicit contracts and the family in rural areas of low-income countries", *Economic Journal*, Vol. 98, 1988, pp. 1148-70.

Ruffin, R.J., "International trade under uncertainty", *Journal of International Economics*, Vol. 4, 1974, pp. 243-259.

Ruttan, V.W., "Productivity growth in world agriculture: Sources and constraints", *Journal of Economic Perspectives*, Vol. 16, 2002, pp. 161-184.

Sarris, A.H., "European agriculture, international markets and LDC growth and food security", *European Review of Agricultural Economics*, Vol. 18, 1991, pp. 289-310.

Schiff, M. and Montenegro, C.E., "Aggregate agricultural supply response in developing countries- A survey of selected issues", The World Bank, Policy Research Working Paper Series 1485, 1995.

Schultz, T.W., *Transforming traditional agriculture*, New Haven: Yale University Press, 1964

Shafiq, M. and Rehman, T., "The extent of resource use inefficiencies in cotton production in Pakistan's Punjab: An application of data envelopment analysis", *Agricultural Economics*, Vol. 22, 2000, pp. 321-330.

Sharma, K.C., Rao D.S.P. and Shepherd, W.F., "Productivity of agricultural labor and land: An international comparison", *Agricultural Economics*, Vol. 4, 1990, pp.1-12.

Sharma, K.R., Leung, P. and Zaleski, H.M., "Technical, allocative and economic efficiencies in swine production in Hawaii: A comparison of parametric and nonparametric approaches", *Agricultural Economics*, Vol. 20, 1999, pp. 23-35.

Sharma, K., Edward, O. and Sisira, J., "Liberalization, export incentives, and trade intensity: new evidence from Nepalese manufacturing industries", *Journal of Asian Economics*, Vol. 12, 2001, pp. 123-135.

Sims, C.A., "Macroeconomics and reality", *Econometrica*, Vol. 48(1), 1980, pp. 1-48

Singer, H.W., "The distributions of gains between investing and borrowing countries", *American Economic Review*, Papers and Proceedings, 1950, pp. 473-85.

Singer, H.W., "Success stories of the 1970's: Some correlations", *World Development*, Vol. 12, 1984, pp. 951-952.

Squires, D. and Tabor, S. "Technical efficiency and future production gains in Indonesian agriculture", *The Developing Economies*, Vol. XXXIX(3), 1991, pp. 258-270.

Strasberg P.J., Jayne, T.S., Yamano, T., Nyoro, J., Jaranja, D and Strauss, J., "Effects of agricultural commercialization on food crop input use and productivity in Kenya", Michigan State University, International Development Working Papers, No. 71, 1999. <http://www.aec.msu.edu/fs2/papers/idwp71.pdf>

Suharyanto, K. and Thirtle, C., "Asian agricultural productivity and convergence", *Journal of Agricultural Economics*, Vol. 52, 2001, pp. 96-110

Tadesse, B. and Krishnamoorthy, S., "Technical efficiency in paddy farms of Tamil Nadu: An analysis based on farm size and ecological zone", *Agricultural Economics*, Vol. 16, 1997, pp. 185-192.

The World Bank, *World development indicator*, 2010.

<http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2>

The World Bank, *Agriculture for development*, World Development Report, 2008.

[http://siteresources.worldbank.org/INTWDR2008/Resources/WDR\\_00\\_book.pdf](http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf)

Thiele, R., "Price incentives non-price factors and agricultural production in sub-Saharan Africa: A cointegration analysis", *African Development Bank*, 2003, pp. 425-438

Tiffin, R. and Irz, X., "Is agriculture the engine of growth?", *Agricultural Economics*, Vol. 35, 2006, pp. 79-89.

Timmer, C.P., "How well do the poor connect to the growth process?", Harvard Institute for International Development, CAERII discussion paper No. 17, 1997.

Trueblood, M.A. and Coggins, J., "Intercountry agricultural efficiency and productivity: a Malmquist Index Approach", World Bank, Washington, DC, 2003.  
<http://www.apec.umn.edu/faculty/jcoggins/documents/Malmquist.pdf>

Turner, B.L., Hyden, G., and Kates, R.W., *Population growth and agricultural change in Africa*, Miami: University Press of Florida, 1993.

Turner, B.L., and Ali, A.M.S., “*Induced intensification: Agricultural change in Bangladesh with implications for Malthus and Boserup*”, Proceedings of the National Academy of Sciences 93: 14984-91, 1996.

<http://www.pnas.org/content/93/25/14984.full.pdf>

Turnovsky, S.J., “Technical and price uncertainty in a Ricardian model of international trade”, *Review of Economic Studies*, Vol. 41(2), 1974, pp. 201-17.

von Braun, J., Bouis, H., and Kennedy, E., “Conceptual framework”, J. von Braun, and E. Kennedy Eds., *Agricultural commercialization, economic development and nutrition*, International Food Policy Research Institute, The Johns Hopkins University Press, 1994.

von Thunen, J. H., *Isolated state: An English edition of Der Isolierte Staat*, Oxford: Pergamon press, 1966.