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CROP PRODUCTIVITY IN NEPAL: SPATIAL AND TEMPORAL DIMENSIONS

Prakash Raj Sapkota

HMG-USAID-GTZ-IDRC-WINROCK PROJECT

STRENGTHENING INSTITUTIONAL CAPACITY IN THE FOOD AND AGRICULTURAL SECTOR IN NEPAL

FOREWORD

This Research and Planning Paper Series is funded through the project, "Strengthening Institutional Capacity in the Food and Agricultural Sector in Nepal," a cooperative effort by the Ministry of Agriculture (MOA) of His Majesty's Government of Nepal and the Winrock International Institute for Agricultural Development. This project has been made possible by substantial financial support from the U.S. Agency for International Development (USAID), the German Agency for Technical Cooperation (GTZ), and the Canadian International Development Research Centre (IDRC).

One of the most important activities of this project is funding for problem-oriented research by young professional staff of agricultural agencies of the MOA and related institutions. In particular, funding is provided by the IDRC to support the activities of the Research and Planning Unit (RPU) of the Agricultural Projects Services Centre (APROSC). This research is carried out with the active professional assistance of the Winrock staff.

The purpose of this Research and Planning Paper Series is to make the results of the research activities of APROSC's Research and Planning Unit available to a larger audience, and to acquaint younger staff and students with advanced methods of research and statistical analysis. It is also hoped that publication of the Series will stimulate discussion among policymakers and thereby assist in the formulation of policies which are suitable to the development of Nepal's agriculture.

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Michael B. Wallace
Series Editor

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Prakash Raj Sapkota*

INTRODUCTION

Overview

Agriculture is the primary economic activity of almost 95 percent of Nepal's population. This sector provides about 60 percent of the gross domestic product (GDP) and 80 percent of export earnings. The crop sector alone provides about 55 percent of the agricultural GDP. In cropland, paddy, maize, and wheat account for over 85 percent of the total cropland and about 94 percent of the country's foodgrain production. Millet and barley, mostly grown in the hills and mountains, account for five percent of the total cropland. The remaining ten percent is planted with cash crops such as potato, oilseeds, sugarcane, jute and tobacco, mostly grown in the Tarai plains.

Despite the tremendous attempt made by the government to develop the agriculture sector, the performance of this sector is rather disappointing. The severe decrease in productivity of major agricultural crops in the hill and mountain regions not only indicates the increasing cultivation of marginal lands but also foretells the consequences that will befall the environment. Productivity throughout this report is used to mean the yield in MT./ha. of a crop.

The moderate growth of agricultural productivity in the Tarai is far from satisfactory, especially in view of the increasing attention paid to this belt for agricultural development. This study focuses on the overall national agricultural situation and tries to estimate input-output relations that have changed during the last decade and a half.

The objectives of this study are to review the agricultural production pattern in Nepal, estimate input-output relations by formulating a suitable production function incorporating regional and temporal dimensions, and suggest appropriate policy guidelines based on the empirical evidence.

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*Prakash Raj Sapkota is an Economist at the Agricultural Projects Services Centre (APROSC). He is currently on leave to pursue M.A. studies at the Australian National University. A longer version of this paper, including more statistical information, was originally published by APROSC in January 1985, titled "Study on Crop Productivity in Nepal (Spatial and Temporal Dimensions)." Readers desiring more detail are referred to this earlier publication.

LITERATURE REVIEW

Very few studies have been conducted in the past to ascertain the relative contributions of the various resources on the agricultural production process. However, since the mid-1970s, the flow of micro-level studies have encompassed many areas of agricultural productivity. Historically, "Physical Input-Output Characteristics of Cereal Grain Production in Selected Areas of Nepal: Crop Year 1965/66" (HMG et al., 1966) was the first attempt to compute the physical input-output coefficient of a few cereal crops for different areas of the country. As the purpose of the study was to acquaint graduate students with research methodology, the ambiguous definition of many variables led to insignificant results. The sample size of this study covered 1000 households from 50 village panchayats of five different areas.

A Farm Management Study (DFAMS, 1972) was first conducted in Nepal by the Ministry of Food and Agriculture, in 1968/69. Analyzing 177 panchayats representing 14 districts, the study focused on the organization and operations of farms in the existing input-output relationship.

The Agricultural Credit Survey (NRB, 1972) held in 1969 is another major study. The sample size of the survey was 3195 households in 22 districts representing six ecological sub-regions among 52 village panchayats. Though the study focused on demand and supply aspects of credit and the effects of borrowing activity on farmer's income, it estimated the Cobb-Douglas type of production function for all the major crops, and separate production functions for large, medium, and small farmers. The major independent variables used in the analysis were seeds, manure, fertilizer, pesticides, human labor, and bullock power. The results varied according to district, crop, and type of farmer.

The Agricultural Credit Review Survey (NRB, 1980) was conducted in 1976 as a follow-up study to review changes during the seven-year period. The Agricultural Credit Survey was confined to the cost-return analysis of crops, while in the later study, cost-return analysis of farm business consisted of crop, livestock, and horticulture. The sample of the Review Survey consisted of 2655 farm households from 45 village panchayats of 14 districts representing the eight ecological sub-regions in the hills and Tarai. The hills and mountains were included as one belt and the present Mid-Western Region was included in the Far-Western Region at that time. Thus, with this sub-division four Development Regions of the country were further divided into hills (including mountains) and the Tarai. The data were collected as a random sample. A Cobb-Douglas production function was estimated for individual crops and for farm business income, as a whole. Independent variables used in the analysis were the same as the earlier survey.

On a macro-level, Chapagain (1983) analyzed the agricultural productivity pattern for the whole country and for eight ecological sub-regions of the hills and Tarai. The methodology consisted of the total and partial productivity as well as multiple regression analysis. During the period of the study (1961-74), the average rate of growth of agricultural output was 1.7 percent per annum, while the growth rate of agricultural inputs was about the same as output. However, the growth rate of output and inputs was 2.4 and 1.9 percent in the later period (1967-1974). Total factor productivity, which was computed as a residual between the growth in output and inputs, remained almost constant during 1961-1974, but increased slightly by 0.5 percent per year during 1967-1974. From the production function analysis, the coefficients of land and labor were significant with the expected positive sign while the coefficient of animal labor was negative. The coefficients of most modern inputs were insignificant or barely significant. Some of the elasticities were less than unity and indicated decreasing returns to scale. From the marginal analysis, MVP was observed to be less than unity in the case of labor, suggesting overutilization of this input. Tractors, and agricultural credit were found fairly productive.

In the areas of resource allocation to agricultural research, R.P. Sharma (1981) analyzed financial and manpower resource allocation by major research area as well as by major commodity headings. Using different criteria, Sharma found that there was misallocation of research among the agricultural sub-sector, during the Fifth Five Year Plan (1975-80). During this period, investment within the crop sector had increased relative to the growth in the value of production, while investment in livestock research revealed an abysmally low level of financial and manpower resources. The study also found that food crops were under-invested compared to the cash crops, revealing a contradiction in the goals and actual implementation of government programs.

At the micro-level, several studies have adequately addressed the input-output relations as well as productivity differentials of modern technology. Moreover, the problems associated with the adoption and the consequences of modern technology in employment promotion and income distribution have been addressed.

Factors affecting the adoption of modern rice varieties were analyzed by Rawal (1981). The study was based on information gathered from farmers in the eastern Tarai. From the analysis of the cross sectional data, the educational status of the farmer, exposure to extension, and past farming experience are important determinants for adoption of improved technology. Findings of the study suggest modern varieties are much higher yielding than local ones, though the total labor requirement is the same. However, the proportion of hired labor is higher in the case of a modern variety as compared to the traditional one.

The impact of modern-variety (MV) rice on farm-income generation and income distribution was analyzed by Karki (1981). This study was also confined to the eastern Tarai, with a sample of 180 farmers. Using the CES production function, the elasticity of substitution between two production technologies was estimated. From the analysis, new technology is neither labor nor capital biased. Regarding the input-output relations and its implications on income distribution, the costs of inputs were higher for modern varieties than for traditional varieties (TVs), while relatively higher yield per hectare from the modern varieties (MVs) results in higher net income for the adopters of new technology. The study also showed that the absolute share of hired labor was higher for the MVs compared to the TVs, and the relationship between farm size and adoption of MVs was statistically independent.

The issue of farm size and productivity has been addressed by Hamal (1983) and R. K. Sharma (1983). They found a significant inverse relationship between farm size and productivity.

The effects of irrigation on productivity have been analyzed in various studies. The Agricultural Credit Review Survey (NRB, 1980) showed a significant positive yield response to irrigation in the majority of cases. Karki et al., (1983) showed higher resource productivity in irrigated farms of the eastern Tarai, for both improved and local rice varieties. Khoju (1982) found a strong impact of pump irrigation in the eastern Tarai, for both yield and intensity and concluded 79 percent of increment in yield and 34 percent of increment in intensity are attributed to irrigation alone.

The process of mechanization and increasing productivity has been analyzed by Thapa and Roumasset (1980). Employing various econometric techniques, and analyzing a sample of 150 farms in the Tarai, this study found that mechanized farms had higher cropping intensities, higher yield per hectare, higher level of labor use (except in land preparation), a higher percentage of hired labor, and lower level of labor in land preparation compared to non-mechanized farms.

This discussion of previous studies shows that modern technology explains productivity growth adequately in the micro-areas, while contribution to productivity growth in the macro-context is yet to be seen.

METHODOLOGY

The data used in this study are published statistics of various public organizations involved in the agricultural sector of Nepal. The study has been severely limited by a lack of disaggregated data in many areas. Because continuous data series on some of the variables are not available, inter-census figures have been utilized.

Production Function

To examine the regional and temporal effects of productivity, the Cobb-Douglas type of production function based on time series of cross sections is used with the appropriate pooling technique.

There are two advantages in pooling cross-sectional and time series data for production function. Firstly, the lesser information over time can also be used with the data across regions to estimate behavioral relationships. Secondly, it helps avoid the problem of simultaneous equation biases existing in time series data. The model used here is discussed in Balestra-Nerlove (1966), Mukhopadhyay (1976), T.W. Anderson and C. Hsio (1981). A Cobb-Douglas production function for each region is estimated in this analysis.

The five Development Regions of the country have been divided into 15 ecological belts. In view of the small contribution of the mountain region in terms of overall acreage and production, it is not included in the empirical estimation. Therefore, ten belts--five each from the hills and the Tarai--have been incorporated for the estimation. The hills and Tarai are estimated together as well as separately Empirical estimation covers the time period 1970/71-1979/80.

Devisia Value Index

There is an index number problem in the valuation of gross value of crop output. If the Laspayer's index is used, it will underestimate the current valve of output while the opposite problem will occur if Pasche's index is used. To overcome these biases on the valuation of gross value of output, the Devisia Value Index is used. The advantage of the Devisia Value Index is that it permits relative prices to vary.

Let V, p, and q represent value, price and quantity, and V*, p*, q* the corresponding time derivatives. For n commodities,

$$V = V + V1 + V2 + \ldots + Vn$$

$$= p1q1 + p2q2 + \ldots + pnqn$$

Differentiating with respect to time:

$$V = p1^*q1 + p1q1^* + p2^*q2 + p2q2^* + \ldots + pn^*qn + pnqn^*$$

or, $V^*/V = wipi^*/pi + wiqi^*qi$ (Devisia Value Index)

where V^*/V = rate of growth of the value of output;

pi^*/pi = rate of growth of prices;

qi^*/qi = rate of growth of quantities;

wi = share of each commodity in the total value of output.

As farm gate prices of major agricultural commodities are not available, retail prices of agricultural commodities as published by the Department of Food and Agricultural Marketing (DFAMS) are used. For the aggregation of the gross value of output, ten major crops are taken into account: paddy, maize, wheat, millet, barley, potato, oilseeds, sugarcane, jute, and tobacco.

Dependent and Independent Variables

The gross value of ten agricultural crops aggregated through the Devisia Value Index is the dependent variable. The independent variables are as follows:

<u>Land:</u> Cultivated land figures are not available for many ecological belts as cadastral surveys have not been conducted in many hill districts. Cropland of the ten major crops is used as a proxy for land.

<u>Fertilizers:</u> Annual fertilizer sales have been assumed as the consumption of fertilizer. Fertilizer in nutrients of nitrogen, phosphorous, and potash are used rather than gross fertilizer.

<u>Improved Seeds:</u> Estimates of improved seed consumption are difficult as farmers produce and sell the seeds themselves. The Agricultural Inputs Corporation's (AIC) seed supply are used as an indicator for the consumption of improved seed because it is the only public sector agency undertaking responsibility for the distribution of modern inputs.

<u>Agricultural</u> <u>Credit:</u> As 85 percent of the credit needs in the country have been met by the Agricultural Development Bank/Nepal (ADB), the annual disbursement of agricultural credit by the ADB are used as the proxy of institutional credit in the agricultural sector.

<u>Improved</u> <u>Tools:</u> Total volume of the sale of improved tools by AIC are used as an indicator of mechanization.

<u>Agricultural</u> <u>Labor:</u> The economically active population engaged in agriculture is used as the indicator of agricultural labor. Inter-census years were interpolated to make the series continuous.

<u>Rainfall:</u> Average rainfall (mm) for each ecological belt is the total average annual rainfall of the different districts in each belt.

<u>Prices:</u> Annual retail prices of agricultural crops as published by the Department of Food and Agricultural Marketing Services (DFAMS) have been used for the aggregation of crop output. Prices are available both at the national and regional levels. On the regional level, both the hills and Tarai are divided into four sub-regions. The same prices are used for the mid-western and far-western regions. Because of the erratic nature of available price data, prices of some sub-regions are used as proxy for other sub-regions. For the food crops, except barley, prices are available for all the sub-regions of the hills and Tarai. Barley prices in all the areas are estimated as 25 percent less than the respective wheat prices. In the hill sub-regions, the prices of oilseed in the central hills are used as proxy for the eastern and western hills. Tobacco prices of the central hills are used as proxy for the eastern hills. The jute price for the central hills are used as a proxy for the jute prices of the western hills. In the Tarai, jute prices of the eastern Tarai are used as a proxy for the sub-regions. For sugar-cane, the prices of central Tarai (purchase prices of Birganj Sugar Factory) are used to represent prices in all other regions.

PRODUCTION PATTERNS

This section reviews regional production patterns between the triennial average ending 1969/70 and 1982/83, emphasizing regional cropping patterns, and differences in productivity. Unless otherwise indicated, the former period refers to the triennial average ending in 1969/70, and the later to the triennial average ending in 1982/83.

Nepal can be divided into three ecological belts: mountains, hills and the Tarai, with a population distribution of 8.6, 47.7, and 43.7 percent, respectively. The distribution of cropland is five percent in the mountains, 32 percent in the hills, and 63 percent in the Tarai. The distribution of the total value of production at constant prices in these regions are 5.3, 33.1, and 60.3 percent, respectively.

Major Crops and Cropping Patterns

Cropland in the country increased from 2,134,175 ha. in the triennium ending 1969/79 to 2,574,240 ha. in the triennium average ending 1982/83, representing an increase of 440,065 ha. between the periods. The composition of this increased cropland is 420,597 ha. from cereals and 19,468 ha. from cash crops. In cereals, the increased wheat cropland accounted for 47 percent of the total increased cropland, while sugarcane accounted for two-thirds of the increased cash cropland areas.

Paddy, maize, and wheat are the predominant crops of Nepal accounting for about 85 percent of cropland in the country. The overall cropping pattern of Nepal is dominated by paddy, which is produced wherever possible even in the steep high hills. The cropping pattern of Nepal during the triennium ending 1982/83 was: paddy (49.6 percent), maize (18.8 percent), wheat (16.5 percent), millet (4.8 percent), barley (1.0 percent), potato (2.1 percent), oilseeds (4.4 percent), sugarcane (0.9 percent), jute (1.4 percent), tobacco (0.3 percent).

The most noticeable change in the overall cropping pattern between the two triennium average periods was in wheat cropland, which increased from 205,665 ha. to 411,790 ha. This increase changed the relative importance of wheat in terms of national cropland from 9.8 percent to 16.5 percent. Paddy cropland increased from 1,162,015 ha. to 1,296,530 ha., maize from 421,510 ha. to 486,100 ha., millet from 108,330 ha. to 120,560 ha., and barley from 25,643 ha. to 28,780 ha. Of the cash crops the most noticeable change was in sugarcane cropland which increased from 12,303 ha. to 25,170 ha., an increase of more than 100 percent. Other crops which experienced increased cropland are potato and oilseed; potato area increased from 43,300 ha. to 52,010 ha. and oilseed area from 100,710 ha. to 111,140 ha. Cropland under jute decreased from 46,025 ha. to 35,320 ha. and tobacco area from 8674 to 6840 ha.

Regional Differences in Productivity

There is a wide range of variation in crop productivity among the various ecological regions and sub-regions. During the two periods the national yields of paddy, wheat, and millet improved, while the yields of maize and barley declined. Among the cash crops, yield improvement was observed in all crops--especially sugarcane. The respective improvement or decline for each of the three regions was as follows:

The Mountains: In the former period, paddy yield was 25 percent higher than the national level, but only six percent higher in the later period. The maize yield, which was three percent higher decreased by 14 percent in the later period. The wheat yield, 15 percent higher in the former period declined 36 percent from the national average in the later period. The yield of millet, which was 5.6 percent higher in the former period improved slightly to seven percent higher in the later period. Barley, which was 13 percent higher in the former period declined to a level two percent less than the national average in the later period. The yield of potato, 11 percent less than the national average in the former period improved to slightly more than the national average in the later period. For oilseed, the yield in the mountains, 29 percent less than the national average, improved to 23 percent in the later period. The relative yield of sugarcane declined to 40 percent in the later period from 23 percent less in the former period.

The Hills: The paddy yield, which was 30 percent higher in the former period was reduced to 22 percent in the later period. The yield for maize was six percent higher in the former period, but reduced to two percent higher in the later period. The wheat yield, which was 15 percent higher than the national yield in the former period reduced to the level of two percent less in the later period. Millet, which was four percent higher in the former period decreased to two percent higher in the later period. The barley yield, which was six percent higher in the former period, dropped to the national average in the later period. The yield for potato, which was higher by one percent in the former period, was also reduced to the national average in the later period. The yield of oilseeds, which was less than three percent in the former period, decreased to 31 percent less than the national average in the later period. The yield of sugarcane, which was 15 percent less than the national average reduced to the level of 31 percent in the later period. The yield of jute was 17 percent less in the former period--statistics are not available for the later period. The yield of tobacco which was 15 percent less than the national average improved to the level of 10 percent less in the later period.

The Tarai: The yield of paddy which was six percent less in the former period improved to the level of around five percent less in the later period. The yield of maize, which was 13 percent less in the former period improved to the level of about one percent higher in the later period. The yield of wheat, which was 15 percent less in the former period improved significantly to three percent above the national average. The yield of barley, which was 28 percent less than the national average in the former period improved to the level of 14 percent less in the later period. The yield of barley, which was 24 percent less in the former period vastly improved to the level of two percent higher than the national average in the later period. Thus, in all cereal grains, the Tarai experienced improved productivity in relation to the average yield of the country.

Of cash crops, the yield of tobacco, which was seven percent in the former period, dropped one percent lower in the later period. The yield of oilseed, which was 1.6 percent higher in the former period, increased to 3.5 percent higher than the national average in the later period. Sugarcane yield, which was three percent higher than the national average, reduced slightly to only 2.7 percent higher in the later period. The yield of jute in the Tarai represent the national yield level.

CROP PRODUCTIVITY

Trends in Aggregate Crop Productivity

During 1967-1982, crop productivity in Nepal decreased by 0.5 percent annually. Productivity declined in the mountains and hills, by 0.7 and one percent respectively. The Tarai witnessed a decline in productivity of 0.3 percent annually.

From Tables 1-4, it is clear that annual growth in the value of production has not matched the annual growth in cropland, resulting in an annual decline in crop productivity.

In the mountain region, cropped land increased by 0.02 percent annually, however, production and productivity have declined by 0.5 and 0.7 percent annually. In the hills, cropped area and production increased by 1.5 percent and 0.6 percent annually, while productivity declined by one percent annually. Within the hills, the highest annual growth in cropped area occured in the eastern hills (2.7 percent), followed by the western (1.9 percent), midwestern (1.8 percent) and central hills (0.5 percent). In the far western hills, cropped area decreased by 0.1 percent annually. The annual growth in the value of production was highest in the eastern hills (1.6 percent), followed by the western hills (0.5 percent), central and mid-western hills (0.4) percent. In the far-west, the value of production decreased by 1.6 percent annually. Crop productivity has declined annually in all belts, with the highest decline occuring in the far western hills (1.6 percent), followed by the western and mid-western hills (1.4 percent), eastern hills (1.1 percent), and the central hills (0.2 percent).

In the Tarai, cropped area and the value of production increased by 1.1 and 1.9 percent annually, while crop productivity increased by 0.3 percent annually. Among the sub-regions of the Tarai, growth in cropped areas occured in the far-western Tarai (3.1 percent), followed by western (1.5 percent), mid-western (1.1 percent), central (1.0 percent), and eastern (0.5 percent). In the value of production, the highest annual growth was observed in the far-west, followed by the western (0.9 percent), central, and mid-western (0.8 percent each), and eastern (0.7 percent). Annual growth in crop productivity was positive in the eastern Tarai (0.1 percent). In other belts, however, the growth in productivity was negative. The highest annual decline in crop productivity was in the far-western Tarai, followed by the west (0.6 percent), mid-west (0.4 percent), central (0.2 percent), and eastern (0.1 percent).

Table 1. Nepal: Regression Trends in Cropped Area, Value of Production and Crop Productivity (1967-1982)

Development Region	Dependent Variable (Natural Logarithm)	Constant	Trend	R-squared
Eastern	Area	13.3 (1817.7)	0.01 (14.0)	0.95
	Value of Production	14.2 (700.2)	0.06 (4.6)	0.66
	Productivity	0.9 (67.5)	-0.002 (-0.5)	0.02
Central	Area	13.5 (1512.1)	0.008 (7.6)	0.84
	Value of Production	14.5 (760.2)	0.006 (2.7)	0.40
	Productivity	0.9 (72.3)	-0.003 (-1.3)	0.13
Western	Area	12.9 (2142.8)	0.02 (21.7)	0.98
	Value of Production	13.8 (582.5)	0.007 (-2.6)	0.37
	Productivity	0.9 (35.5)	-0.009 (-2.6)	0.38
Mid-Western	Area	12.4 (1143.8)	0.01 (7.4)	0.83
	Value of Production	13.4 (1629.1)	0.002 (2.4)	0.35
	Productivity	0.9 (65.5)	-0.008 (-4.2)	0.61
Far-Western	Area	12.0 (1009.8)	0.02 (10.6)	0.91
	Value of Production	12.9 (407.4)	0.001 (0.4)	0.01
	Productivity	0.9 (43.1)	-0.01 (-5.2)	0.71
Nepal	Area	14.6 (2874.9)	0.01 (118.9)	0.97
	Value of Production	15.5 (844.4)	0.007 (3.2)	0.48
	Productivity	0.9 (67.4)	-0.005 (-2.6)	0.39

Figures in parentheses are t-statistics. Trends were fitted to three years moving average data of area, value of production, and yield. Data were obtained from DFAMS and the National retail prices. Three years moving average data of area, production, and yield of ten major crops aggregated with the three year average national retail prices (1970/71-1972/73) of crops for the aggregation of value of production and yield productivity.

Table 2. Mountains: Regression Trends in Cropped Area, Value of Production and Crop Productivity (1967-1982)

Development Region	Dependent Variable (Natural Logarithm)	Constant	Trend	R-squared
Eastern	Area	10.2	0.04	0.94
		(443.5)	(13.5)	
	Value of Production	11.3	0.03	0.94
		(562.9)	(13.6)	
	Productivity	1.2	-0.005	0.11
		(37.3)	(1.2)	
Central	Area	10.3	0.004	0.70
		(1390.6)	(5.1)	
	Value of Production	11.5	0.006	0.45
		(752.4)	(-2.9)	
	Productivity	1.2	-0.01	0.80
		(94.4)	(-6.8)	
Western	Area	8.9	-0.02	0.81
		(365.3)	(-6.9)	
	Value of Production	9.9	-0.01	0.47
		(403.2)	(-3.1)	
	Productivity	0.9	0.01	0.41
		(28.9)	(2.7)	
Mid-Western	Area	10.3	-0.03	0.83
		(297.6)	(-7.3)	
	Value of Production	11.3	-0.04	0.95
		(532.3)	(-14.5)	
	Productivity	0.9	-0.008	0.52
		(59.7)	(-3.5)	
Far-Western	Area	10.3	-0.01	0.77
		(520.6)	(-6.1)	
	Value of Production	11.2	-0.03	0.95
		(609.8)	(-14.2)	
	Productivity	0.9	-0.02	0.89
		(43.1)	(-5.2)	
Total Mountain	Area	11.6	0.002	0.12
		(847.7)	(1.2)	
	Value of Production	12.7	-0.005	0.74
		(2065.7)	(-5.5)	
	Productivity	1.1	-0.007	0.60
		(83.6)	(-4.1)	

Figures in parentheses are t-values.
Source: Computed from data provided by DFAMS and the National retail prices.

Table 3. Hills: Regression Trends in Cropped Area, Value of Production and Crop Productivity (1967-1982)

Development Region	Dependent Variable (Natural Logarithm)	Constant	Trend	R-squared
Eastern	Area	11.7 (1719.4)	0.02 (31.4)	0.99
	Value of Production	12.9 (633.7)	0.02 (6.5)	0.79
	Productivity	1.2 (74.4)	-0.01 (-5.4)	0.72
Central	Area	12.2 (774.5)	0.005 (2.6)	0.39
	Value of Production	13.3 (649.26)	0.004 (1.6)	0.19
	Productivity	1.1 (88.90)	-0.002 (-.73)	0.04
Western	Area	12.04 (1852.6)	0.02 (23.2)	0.98
	Value of Production	13.1 (546.4)	0.005 (1.9)	0.25
	Productivity	1.1 (44.3)	-0.01 (-4.4)	0.64
Mid-Western	Area	11.4 (530.5)	0.02 (6.8)	0.81
	Value of Production	12.4 (996.5)	0.004 (2.9)	0.44
	Productivity	1.0 (64.4)	-0.01 (-6.9)	0.81
Far-Western	Area	10.8 (495.0)	-0.001 (-0.01)	-0.0009
	Value of Production	11.8 (370.8)	-0.01 (-3.9)	0.59
	Productivity	0.9 (82.0)	-0.02 (-10.7)	0.91
Total Hills	Area	13.4 (2099.9)	0.02 (18.9)	0.97
	Value of Production	14.5 (810.5)	0.006 (2.8)	0.41
	Productivity	1.1 (79.6)	-0.01 (-5.32)	0.72

Figures in parentheses are t-values

Source: Computed from data provided by DFAMS and the National retail prices.

Table 4. Tarai: Regression Trends in Cropped Area, Value of Production, and Crop Productivity (1967-1982)

Development Region	Dependent Variable (Natural Logarithm)	Constant	Trend	R-squared
Eastern	Area	12.9	0.005	0.68
		(1338.2)	(4.8)	
	Value of Production	13.8	0.007	0.40
		(606.9)	(2.7)	
	Productivity	0.9	0.001	0.06
		(54.2)	(0.9)	
Central	Area	13.1	0.01	0.89
		(1565.1)	(9.6)	
	Value of Production	14.0	0.008	0.45
		(636.4)	(3.0)	
	Productivity	0.92	-0.002	0.92
		(41.8)	(-0.7)	
Western	Area	12.3	0.02	0.92
		(1164.1)	(11.6)	
	Value of Production	13.2	0.009	0.41
		(476.4)	(2.7)	
	Productivity	0.9	-0.006	0.14
		(25.9)	(-1.3)	
Mid-Western	Area	11.8	0.01	0.92
		(1504.5)	(11.3)	
	Value of Production	12.7	0.008	0.70
		(1003.4)	(5.0)	
	Productivity	0.9	-.0004	0.21
		(62.1)	(-1.7)	
Far-Western	Area	11.3	0.03	0.94
		(594.9)	(13.2)	
	Value of Production	12.2	0.02	0.54
		(271.7)	(3.6)	
	Productivity	0.9	-0.01	0.37
		(25.7)	(-2.5)	
Total Tarai	Area	14.1	0.01	0.95
		(2249.8)	(14.4)	
	Value of Production	15.03	0.009	0.52
		(716.9)	(3.5)	
	Productivity	0.9	-0.003	0.08
		(50.8)	(-0.9)	

Figures in parentheses are t-values.

Source: Computed from data provided by DFAMS and National retail prices.

Trends in Individual Crop Productivity

Average annual growth rates of area, production, and yield are presented in Tables 5 to 9. In an overview of the trends, it is seen that productivity decline is severe in the mountains and hills while moderate in the Tarai. Impressive growth in yields of the major cereals is observed in the Kathmandu Valley.

During the period, the yield rate of growth of major cereals declined despite growth in cropped area. Paddy yield decreased at the rate of 0.8 percent and production by 0.03 percent, despite and increase in area by 0.7 percent. Maize yield declined by 1.4 percent and production declined by 0.6 percent, despite an increase of 0.8 percent in area. Wheat yield increased at the rate of 1.5 percent, while area and production rose by 5.6 and 7.1 percent respectively. Barley yield declined by 0.5 percent. Potato yield registered a growth rate of 0.2 percent as compared to area and production increases of 1.3 and 1.4 percent. Among the cash crops, oilseed yield increased at the rate of 1.5 percent, corresponding to both area and production increases of 1.2 and 2.7 percent. Likewise, sugarcane yield also increased by 2.7 percent, corresponding to both area and production increases of 5.7 and 8.5 percent. Jute yield increased by 5.7 percent, owing to a sharp decline of 0.9 percent. Similarily, tobacco yield declined by 0.3 percent, with area and production declining by 1.1 and 1.3 percent respectively.

Table 5. Growth Rates* of Area, Production and Yield of Major Crops: Nepal (1967-1982) (percentage)

Crops	Area	Production	Yield
Paddy	0.7	-0.03	-0.8
Maize	0.8	-0.6	-1.4
Wheat	5.6	7.1	1.5
Millet	1.04	0.4	-0.6
Barley	-0.05	-0.6	-0.5
Potato	1.3	1.4	0.2
Oilseeds	1.2	2.7	1.5
Sugarcane	5.7	8.5	2.7
Jute	-6.7	-0.9	5.7
Tobacco	-1.1	-1.3	-0.3

*Estimated from the form: lnyt = lna + bt.
Source: Data Bank, APROSC, from data published by DFAMS.

<u>The mountains:</u> The yield decline is severe for the mountain region. Despite an increase in area by 2.8 and one percent per annum in paddy and maize, the yield of these crops declined at rates of 1.6 and 2.4 percent annually. Potato is the only cereal crop that registered positive yield growth in the mountains, with an average annual growth of 0.9 percent. Other crops are not important in the mountains.

<u>The hills:</u> The decline in yield is almost as severe in the hills in almost all cereal crops except potatoes. The yields of paddy, maize, wheat, millet, and barley declined at the rates of 1.3, 1.9, 0.1, 0.8, and 1.0 percent respectively. Potato yield increased by 0.5 percent. Likewise, area and production increased by 2.5 and 3.0 percent.

Table 6. Growth Rates* of Area, Production and Yield of Major Crops: Mountains (1967-1982) (percentage)

Crops	Area	Production	Yield
Paddy	2.8	1.2	-1.6
Maize	1.0	-1.4	-2.4
Wheat	-3.7	-5.9	-2.2
Millet	0.7	-0.3	-1.0
Barley	0.5	-1.5	-1.9
Potato	1.6	2.6	0.9
Oilseeds	-1.8	-0.4	1.5
Sugarcane	3.4	3.8	0.1
Tobacco	-3.5	-3.6	-0.06

*Estimated from the form: lnyt = lna + bt.

Source: Data Bank, APROSC, from the data published by DFAMS.

Table 7. Growth Rates* of Area, Production and Yield of Major Crops: Hills** (percentage)

Crops	Area	Production	Yield
Paddy	2.6	1.3	-1.3
Maize	1.4	-0.5	-1.9
Wheat	5.5	5.4	-0.06
Millet	1.3	0.6	0.8
Barley	0.8	-0.2	-1.0
Potato	2.5	3.0	0.5
Oilseeds	-0.4	0.3	0.7
Sugarcane	-0.7	-0.1	0.6
Jute	-0.9	-3.4	6.4
Tobacco	-3.8	-3.3	0.5

*Estimated from the form: lnyt = lna + bt.

** Excluding Kathmandu Valley.

Source: Data Bank, APROSC, from data published by DFAMS.

Kathmandu Valley: Highest yield growth was achieved for wheat, followed by maize and paddy. Paddy yield increased by 1.4 percent per annum, while area and production declined by 0.2 percent, respectively. Maize yield increased by 1.5 percent per annum while area and production fell by 0.6 and 0.1 percent. Wheat yield increased by 2.7 percent while area and production increased by 0.5 and 3.2 percent. Millet yield declined by 0.2 percent; area and production declining by 3.7 and 3.8 percent. Barley yield increased by 1.1 percent; area and production increased by 9.5 and 10.6 percent. Potato yield declined by 1.2 percent; area and production fell by 5.5 and 6.7 percent. Oilseed yield increased by 0.9 percent while area declined by 5.4 percent and production by 4.4 percent. Sugarcane yield declined by 3.0 percent annually.

Table 8. Growth Rates* of Area, Production and Yield of Major Crops: Kathmandu Valley (1967-1982) (percentage)

Crops	Area	Production	Yield
Paddy	-0.2	-0.2	1.4
Maize	-0.6	-0.1	1.5
Wheat	0.5	3.2	2.7
Millet	-3.7	-3.8	-0.2
Barley	9.5	0.6	1.1
Potato	-5.5	-6.7	-1.1
Oilseeds	-5.4	-4.4	0.2
Sugarcane	-4.8	-7.8	-3.0
Jute	-	-	-
Tobacco	-	-	-

*Estimated from the form: lnyt = lna + bt.
Source: Data Bank, APROSC, from data published by DFAMS.

Tarai: The growth in area, production, and yield in this belt is of crucial importance. Paddy yield over the years declined by 0.6 percent despite an increase in area of 0.4 percent. Maize yield increased by 1.5 percent; area and production increased by 8.3 and 12.9 percent. Millet yield declined by 0.5 percent, although area and production increased by 1.4 and 0.9 percent. Barley yield increased only by 2.7 and percent despite an increase in area and production by 7.7 and 4.9 percent. The potato yield decreased by 2.8 percent.

Of cash crops, oilseed yield increased by 3.0 percent; area and production increased by 1.8 and 3.9 percent. Sugarcane yield increased by 2.4 percent per annum; area and production increased by 7.6 and 10.0 percent. Jute yield increased by 5.6 percent; area and production decreased by 6.5 and 0.8 percent. Tobacco yield and production fell 0.2 percent and 0.09 percent; area increased 0.09 percent.

Table 9. Growth Rates* of Area, Production and Yield of Major Crops: Tarai (1967-1982) (percentage)

Crops	Area	Production	Yield
Paddy	0.4	-0.4	-0.6
Maize	6.1	7.9	1.5
Wheat	8.3	12.9	4.6
Millet	1.4	0.9	-0.5
Barley	-7.7	-4.9	2.7
Potato	2.8	1.8	-0.9
Oilseeds	1.8	3.9	3.0
Sugarcane	7.6	10.0	2.4
Jute	-6.5	-0.8	5.6
Tobacco	0.09	-0.09	-0.2

*Estimated from the form lnyt = lna + bt.
Source: Data Bank, APROSC, from data published by DFAMS.

AGRICULTURAL INPUTS

Modern agricultural growth largely stems from the provision of improved seed and chemical fertilizer with assured irrigation facilities. In the following sub-section, regression coefficients of aggregate inputs are presented, followed by a discussion of trend and regional distribution of modern inputs.

Trends in Aggregate Inputs

The regression coefficients in Table 10 indicate the compound annual rate of growth. The high R-squared value and significant t-statistics reveal that input in the agricultural sector has increased in a sustained manner over the years.

Table 10. Regression Coefficients of Trends in Aggregate Inputs

Dependent Variable (Natural logarithm)	Constant	T	R-squared	Time Period
Cultivated Land	7.5 (1383.9)	0.01 (28.1)	0.98	1965/66- 1982-83
Gross chemical Fertilizer	8.7 (40.7)	0.1 (7.5)	0.78	1965/66- 1982/83
Nitrogen	7.3 (54.14)	0.2 (12.01)	0.92	1966/67- 1980/81
Improved Seeds	5.7 (27.57)	0.1 (8.05)	0.80	1965/66- 1982/83
Improved Tools	5.4 (7.64)	0.2 (2.74)	0.36	1966/67- 1980/81
Agro-Chemicals	3.7 (14.3)	0.3 (9.7)	0.88	1966/67- 1980/81
Institutional Credit	8.0 (27.59)	0.3 (10.85)	0.88	1965/66- 1982/83
Public Expenditure on Agriculture	9.8 (57.95)	0.2 (9.99)	0.88	1966/67- 1980/81

Source: Regression estimates are based on the data provided by DFAMS, AIC, ADB/N, the Ministry of Finance, and the Central Bureau of Statistics.

During the last 15 years, total cultivated land increased by 1.4 percent per annum. Among modern inputs, gross chemical fertilizer increased by 14.7 percent per annum, while growth in nitrogen fertilizer was 17.8 percent per annum, indicating the increasing share of nitrogenous fertilizer over the years. Growth in improved seed, tools, and agro-chemicals were 15.4, 21.4, and 28.3 percent per annum, respectively. Institutional credit increased by 29.1 percent per annum. The government's development expenditure on agriculture increased by 18.6 percent per annum. This is indicative of the continuously increasing flow of public funds to the agricultural sector. It should be recalled that the concept of regional development and the formulation of different Development Regions was initiated under the Fourth Five Year Plan.

Growth and Regional Distribution of Modern Inputs

Chemical Fertilizer: The use of chemical fertilizer in Nepal started in the early 1960s, but reliable distribution figures as provided by the AIC are only available from the beginning of Third Five Year Plan with the consumption of 2096 metric tons in the year 1965/66. During the Third Five Year Plan, total distribution of chemical fertilizer amounted to 45,075 mt. The distribution was highly concentrated in the Central Developed Region representing 89.6 percent of the sale volume. The distribution of fertilizer in Fourth Five Year Plan amounted 148,877 mt. which was more than twice that of the sale volume of the Third Plan. In the Fourth Plan, the concentration of fertilizer in the Central Development Region decreased in relative terms but considerably increased in absolute amount. The share of the Eastern, Central, Western, and Far-Western Development Regions in overall distribution of chemical fertilizer in the Fourth Plan was 75.7, 9.9, 11.8, and 2.5 percent, respectively. During the Fifth Plan, the sale of fertilizer reached 210,007 mt. and almost 70 percent of sales were concentrated in the Central Development Region, mostly in Kathmandu Valley.

During the first three years of the current Sixth Five Year Plan, the distribution of gross fertilizer totaled 184,162 mt. In this period, the five development regions of Eastern, Central, Western, Mid-Western, and Far-Western accounted for 10.8, 68.9, 15.9, 3.1, and 1.2 percent of the fertilizer distributed, respectively. The Sixth Plan target was to raise the consumption of fertilizer to 215,402 mt. In the initial three years of the Sixth Plan, the consumption of fertilizer in nutrients reached 77,559 mt., which was 36 percent of the target.

The distribution of fertilizer among the ecological belts is highly skewed. The shares of the mountains, hills, Kathmandu Valley, and the Tarai during the triennium ending 1982/83 are 3.7, 13.6, 28.8, and 53.8 percent, respectively. In the latter period, the shares of mountain and hills have remarkably improved, but concentration is still high in the Kathmandu Valley which uses one-third of the fertilizer on only three percent of the croplands in the country (AIC, 1983).

In the mountain belts, the central mountain area has the highest supply of fertilizer (32.6 kg./ha.), followed by western mountain (7.9 kg./ha.). In the hills, Kathmandu Valley has the most (74.5 kg./ha.), followed by central (18.3 kg./ha.), western (6.3 kg./ha.), mid-western (1.3 kg./ha.), and far-western (1.7 kg./ha.). In the Tarai, the highest supply is in the central Tarai (15.3 kg./ha.), followed by western (11.9 kg./ha.), mid-western (4.5 kg./ha.), eastern (5.3 kg./ha.), and far-western Tarai (2.1 kg./ha.) (Ministry of Agriculture, 1971).

Improved Seed: The consumption of improved seed started in the mid-1960s. The distribution figures obtained from the AIC are available from the Third Five Year Plan onwards. In the Third Plan, 2458 mt. of improved seed consisting of paddy , maize, and wheat were supplied.

During the Third Plan, the share of wheat in the overall basket of improved seeds was 61 percent while paddy and maize accounted for 33.8 and 8.8 percent. During the Fourth Five Year Plan, 7456 mt. of improved seed was consumed, which was more than three times the consumption during the Third Plan. During the Fifth Plan the consumption of improved seed jumped to 12,232 mt.-- a 64 percent increase over the Fourth Plan. The share of wheat during both the Fourth and Fifth Plan was 83 and 80 percent, respectively. During the Sixth Five Year Plan, the government target is to distribute 25,725 of improved seed. During the first three years of the Sixth Plan, 10,101 mt. of improved variety seed were distributed, which was 39.3 percent achievement of the target. In the Sixth Plan thus far, the percentage of paddy, maize, and wheat of the total improved seed are 11.4, 83.4 and 5.2, respectively.

The regional distribution pattern of seed was initially confined to the Central Development Region which consumed about 60 percent of the total seed distributed in the country. In the Fourth Plan, the share of the Central Development Region dropped to 39 percent and in the Fifth Plan to 29.1 percent. Despite the decline in relative shares, in absolute terms the consumption in the Central Development Region in the Fourth Plan was twice that of the Third Plan, and in the Fifth Plan it was 22.9 percent higher than in the Fourth Plan.

According to one study, the percentage of national seed requirement met by AIC is only 1.4 percent in maize, 0.3 percent in paddy, and 5.6 percent in wheat. The area under improved variety of seeds is estimated at 25 percent for maize and paddy, and 85 percent for wheat. During 1981/82, AIC provided 28 percent of the requirement of improved variety maize seed, 17 percent for paddy seeds, and 33 percent for wheat seeds. The rest of the improved variety was met from the private sources.

Agro-Chemicals: The use of agro-chemicals in Nepal is very limited, and one of the reasons could be the traditional nature of Nepalese subsistence farming. Modernization has only marginally affected millions of Nepal's farm families. As reported by the AIC (1983), use of agro-chemicals began during the third Five Year Plan, when Rs.418 thousand worth were sold. In the fourth Five Year Plan, consumption quadrupled (Rs.1867 thousand). In the Fifth Plan, consumption reached Rs.7766 thousand. In 1980/81, consumption of agro-chemicals reached Rs.1599 thousand. The regional distribution pattern among the Eastern, Central, Western, Mid-Western, and Far-Western regions was 15.9, 37.3, 27.5, and 2.8 percent, respectively.

Since the Third Plan, concentration in the Central Development Region lessened with each succeeding plan. In the Third Plan, the Central Development Region alone accounted for 83 percent of the total consumption of agro-chemicals. During the Fourth and Fifth Plans, total consumption dropped to 43 and 38.6 percent, respectively. Consumption by the Central Development Region has not decreased in absolute terms, rather the relative share of other Development Regions has increased.

Agricultural Tools: Farmers' needs for agricultural tools and implements are met mostly by small workshops and artisans throughout the country. A few privately-owned engineering workshops produce and sell agricultural implements mostly on a job-order basis. In addition, many tools, implements, and various machinery are imported directly by farmers themselves or by private entrepreneurs. The government-owned Agricultural Tools Factory also produces a significant number of tools and implements of which AIC is the sole distributor.

In the Third Five Year Plan, according to the AIC (1983), the sale of agricultural tools and implements amounted to Rs.1.62 million. In the Fourth Five Year Plan, it jumped to Rs. 28.3 million. In the Fifth Five Year Plan, it dwindled to half that of the Fourth Plan (Rs.14.1 million). During the first three years of the Sixth Plan, improved tools amounting to Rs.3885 thousand have been sold. The regional distribution among the Eastern, Central, Western, Mid-Western, and Far-Western Development Regions is 10.6, 46.2, 20.9, 17.9, and 4.3 percent, respectively. Thus, in improved tools the concentration of the sales volume is also in the Central Development Region.

CONCLUSIONS AND POLICY IMPLICATIONS

In the analytical framework of the model explained in the methodology section, it is the value of p (rho) that explains the regional effects which are time-invariant in the combined disturbances. For the Tarai, the value of p is 0.2, meaning only 16 percent of the variance of the combined disturbances can be attributed as region-specific time invariant component. The value of p for Nepal as a whole and the hill region are even less than that of the Tarai. The value of p for those regions are 0.1 and 0.06, respectively. Even if the value of p is small the coefficients obtained through transforming the original variables should be efficient and consistent. Thus, results from the transformed model are used for interpretation of coefficients and to derive policy implications. The results are in Tables 11-13.

Table 11. Nepal: Cobb-Douglas Production Function

(Dependent Variable: Agricultural Production: Devisia Measure)
(1970/71 - 1979/80)

Variables	Original Variables Coefficient	Original Variables t-Value	Transformed Variables Coefficient	Transformed Variables t-Value
Fertilizer	-0.03	-1.1	-0.003	-0.1
Improved Seed	0.2	3.2	0.08	2.5
Improved Tools	-0.01	-0.5	-0.01	-0.6
Credit	0.1	3.8	0.2	4.5
Crop Land	-0.5	-7.9	-0.6	-6.9
Labor	0.06	1.2	0.08	-1.1
Rainfall	-0.07	-0.6	-0.08	-0.7
Constant	9.9	10.3	106.2	8.5
R-squared (adjusted)	0.45		0.45	p = 0.1
F	12.4		12.6	
(DF)	(7.9)		(7.9)	

Table 12. Hills: Cobb-Douglas Production Function

(Dependent Variable: Agricultural Production: Devisia Measure)
(1970/71 - 1979/80)

Variables	Original Variable Coefficient	Original Variable t-Value	Transformed Variables Coefficient	Transformed Variables t-Value
Fertilizer	0.001	-0.02	0.005	0.2
Improved Seed	0.07	1.4	0.08	1.5
Improved Tools	-0.005	-0.2	-0.01	-0.5
Credit	0.1	1.9	0.1	2.3
Crop Land	-1.06	-3.5	-1.2	-3.5
Labor	0.5	1.6	0.6	1.6
Rainfall	-0.01	-0.07	0.01	-0.05
Constant	9.6	4.5	115.3	3.8
R-squared (adjusted)	0.47		0.45	p = 0.06
F	6.8		6.5	
(DF)	(7.4)		(7.4)	

Table 13: Tarai: Cobb-Douglas Production Function

(Dependent Variable: Agricultural Production: Devisia Measure)
(1970/71 - 1979/80)

Variables	Original Variables Coefficient	Original Variables T-Value	Transformed Variables Coefficient	Transformed Variables T-Value
Fertilizer	-0.03	-0.4	0.02	0.3
Improved Seed	0.07	1.2	0.02	0.4
Improved Tools	-0.03	-1.2	-0.02	-0.7
Credit	0.2	3.3	0.2	2.8
Crop Land	-1.6	-3.7	-1.5	3.8
Labor Force	1.06	2.4	1.05	2.5
Rainfall	-0.2	1.4	0.09	0.7
Constant	8.5	5.7	155.9	5.6
R-squared (adjusted)	0.53		0.56	p = 0.2
F	8.6		9.5	
(DF)	(7.4)		(7.4)	

As the dependent variable is the index of the crop output growth rate, the estimated elasticity coefficients have been explained in terms of their effect on the growth rate of output value. Fertilizer, improved tools, labor, and rainfall were not found to be significant variables. The coefficients of improved seed and credit are highly significant and positive. The elasticity of cropland is found to be negative and highly significant. As revealed from the value of adjusted R-squared, only 45 percent variation in the output growth is explained by the measured inputs while the rest depends on other exogenous factors in the case of Nepal and the Hills, while for the Tarai regions, 56 percent variance in the output growth is explained by inputs incorporated in the model.

Policy Implications

As the empirical assessments are based on poor quality agricultural data, the parameters estimated from these data may be ambiguous and vague. Still, the following policy implications have been derived from the empirical analysis.

1. The use of improved seed and credit should be increased as their signs are both positive and significant. As the coefficient of NPK is negative, either fertilizer use if very low or the proper input mixes have not been made to render benefit. On the other hand, given the wide use of this input in the Kathmandu Valley and the central region, the rest of the country is neglected from this input. Thus, proper attention should be given to distribution.

2. The coefficients of labor, though not significant in the general model, are significant in separately-estimated models of the hills and Tarai. As the coefficient after the transformations has been increased for the hills, though there are no market changes in the Tarai, the use of this variable should probably be reduced for the hills.

3. The coefficients of cropland are negative and highly significant. The elasticity of the coefficient is higher in the Tarai than in the hills, implying increasing use of this input even under circumstances of decreasing output growth rate per unit increases in this input. The negative response of the crop area variable reflects the following: as the crop area variable incorporates the effects of irrigation, land improvement and other omitted management variables, the negative response of this input should be viewed in terms of above mentioned criteria and not in the proxy of net cultivated land. Thus, the negative elasticity coefficients reflect the pertinent lack of the land augmenting technical change in the management of the agricultural sector in the forms of irrigation, water management, and land improvement. Moreover, it implies the need to consider land capability aspects and land use planning. Otherwise, the increased land input alone does not suffice for accelerated agricultural growth in the context of the highly-eroded ecological situation already existing in Nepal.

REFERENCES

Asian Development Bank (1982), Agriculture Sector Strategy Report, Volume I and II, Manila, Philippines, December.

Agricultural Inputs Corporation (1983), Basic Statistics of Agricultural Inputs in Nepal, Kathmandu, Nepal.

Anderson, T.W. and C. Hasio (1981a), "Estimation of Dynamic Models with Error Components," Journal of the American Statistical Association 76, 598-606.

----------. (1981b), "Formulation and Estimation of Dynamic Models Using Panel Data," Journal of Econometrics 18 (1982) 47-82, North-Holland Publishing Company.

Balestra, P. and M. Nerlove (1966), "Pooling of Cross-Section and Time-Series Data in the Estimation of Dynamic Model: The Demand for Natural Gas," Econometrica, July.

Bardhan, Pranab K. (1973), "Size, Productivity and Returns to Scale: An Analysis of Farm Level Data in Indian Agriculture," Journal of Political Economy, December.

Chetty, V.K. (1968), "Pooling of Time Series and Cross Section Data," Econometrica, April.

Christensen, L.R., D.W. Jorgenson and J.L. Lau (1973), "Transcendental Logarithmic Production Functions," Review of Economics and Statistics, February.

Chapagain, D.P. (1983), "Agricultural Productivity Pattern in Nepal and Its Regional Variations," Research Paper Series No. 21, A/D/C-APROSC, May, Kathmandu, Nepal.

Dandekar, V.M. (1964), "Regional Variation in Agricultural Development and Productivity," Indian Journal of Agricultural Economics, Vol. XIX, January-March, 1964, No.1.

Dhungana, Bhawani, ed. (1976), Seminar on Research Productivity and Mechanization in Nepalese Agriculture.

Dharma Narain (1977), "Growth of Productivity in Indian Agriculture", Indian Journal of Agricultural Economics, Vol. XXXII, January-March, No.1.

Douglas, J.E. (1983), Document on National Seed Program and Consultancy Report, Seed Production and Input Storage Project, Kathmandu, Nepal.

Evenson, Robert E. and Kisley Yoav (1975), Agricultural Research and Productivity, New Haven and London, Yale University Press.

Griliches, Zvi (1963), "Estimation of the Aggregate Agricultural Production Function From Cross-Sectional Data," Journal of Farm Economics 45:419-428, May.

Hamal, K.B. (1983), "Farm Size and Productivity: A Case Study of Nepalese Tarai Farmers," APROSC Staff Paper No.5, APROSC, Kathmandu, Nepal.

Hayami, Yujiro and V.W. Ruttan (1971), "Agricultural Productivity Differences Among Countries," American Economic Review, 60:895-911, December.

His Majesty's Government of Nepal, Ministry of Economic Planning and Department of Economics and Commerce (1966), "Physical Input-Output Characteristics of Cereal Grain Production in Selected Areas of Nepal, Crop Year 1965/66," Tribhuvan University (Mimeo).

-----------., Ministry of Food, Agriculture and Irrigation (1971a), Farm Management Study in the Selected Regions of Nepal, 1968-69, Kathmandu, Nepal.

-----------., (1971b), Agriculture Statistics of Nepal, Kathmandu, Nepal.

Karki, B.B. (1981), "The Impact of Modern Varieties of Rice on Farm Income and Income Distribution in Eastern Nepal," Research Paper Series No.12, A/D/C- APROSC, September, Kathmandu, Nepal.

-----------., and T. Rawal and J.C. Flinn (1976), "Rice Production in the Tarai of Kosi Zone Nepal," Research Paper Series No. 13, A/D/C-APROSC, September, Kathmandu, Nepal.

Mukhopadhyay, S.K. (1976), Sources of Variation in Agricultural Productivity: A Cross-Section Time-Series Study in India, Macmillan Company of India Limited.

Nepal Rastra Bank (1972), Agriculture Credit Review Survey, Nepal, Vols. I-IV, Kathmandu, Nepal.

-----------. (1980), Agriculture Credit Review Survey, Nepal Vols. I-IV, Kathmandu, Nepal.

Rawal, T. (1981), "An Analysis of Factors Affecting the Adoption of Modern Varieties in Eastern Nepal," Research Paper Series No. 11, A/D/C-APROSC, September, Kathmandu, Nepal.

Rokaya, C.M. (1983), "Impact of the Small Farmers Credit Program on Farm Output, Net Income and the Adoption of New Methods: A Nepalese Case Study," Research Paper Series No. 15, A/D/C-APROSC, May, Kathmandu.

Sharma, Ram Krishna (1983), "The Role of Institutional Credit in Nepalese Food Production," Unpublished Master Degree Thesis submitted to University of New England, Australia.

Sharma, Ramesh Prasad (1981), "Agricultural Research Resource Allocation in Nepal", APROSC, Kathmandu, Nepal.

Thapa, G.B. and J.A. Roumasset (1980), "The Economics of Tractor Ownership and Use in Nepal Tarai", Research Paper Series No. 13, A/D/C-APROSC, December, Kathmandu, Nepal.

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4. Prakash Raj Sapkota, "Crop Productivity in Nepal: Spatial and Temporal Dimensions," November 1986.

5. Tilak Rawal, "Transport Cost Minimization for Nepal's Subsidized Foodgrain Program: A Proposed Model," November 1986.

6. Michael B. Wallace, "Fertilizer Price Policy in Nepal," November 1986.