The Economic Journal of Nepal, Vol. 17, No. 1, Issue 65, January - March 1994 © DOE-TU

Relationship Between Population Growth and Agricultural Change in Nepal: A Regional Analysis

Uma Kant Silwal*

INTRODUCTION

The problems of growing population and of the pressure exerted on already scarce land have been a recurrent concern in the developing countries like Nepal. In fact, agriculture remains at the centre of population-development scenario because of its predominant position in the economic structure and demographic processes. In Nepal, total population at national level is increasing very rapidly. Agriculture being the main occupation of Nepalese people, the proportion of labour force engaged in this sector is considerably high. In addition, the increasing pressure of agricultural population on land has caused a significant deforestation, resultant from the use of marginal land for cultivation, leading to increased landslides, soil erosion and environmental degradation (Eckholm, 1976; Upreti, 1983; Seddon, 1987). The total agricultural production has increased in Nepal due to the expansion of cultivated land, but the yield rate of most of the crops has tended to fall.

Although the pressure of population on agriculture at macro level is interesting to realize the problem, the important phenomenon of this pressure at regional level is meaningful for operational use. Three distinct ecological regions of the country-mountains, hills and tarai plains, comprising five development regions in each belt, have wide variation in population density and availability of cultivable land.

It has been, therefore, suggested that the population growth and resource utilization process in the land scarce subsistence economy of Nepal is going in an unbalanced way. The resource base and utilization process, and impact of population pressure on agricultural change differ widely in various agricultural regions. In such a country with diverge resource base, agro-climatic condition and differential rates of population growth, the problem must not, however, be understood in terms of relationship between totalities or micro findings, although it provides starting point to investigate regional variations. In the past studies, no systematic effort has been made to analyse and measure the magnitude of interrelationships between population growth and agricultural changes on spatial-temporal basis. To what extent the population pressure is associated with natural resource development in terms of expansion of land,

* *Dr. Silwal is Lecturer at Tri-chandra Multiple Campus, Kathmandu, Nepal.*

agricultural output and crop productivity in different regions remains unclear. Thus, the present state of knowledge in this issue can not provide planners and policy makers with clear-cut picture.

OBJECTIVES OF THE STUDY

The purpose of this study is to explore the nature and magnitude of changes in agriculture in response to changes in population over time so that a more analytical and empirical basis can be developed to make policy decisions and regional planning more realistic. Specifically, the study will try to examine the spatial-temporal pattern of changes in population, cultivated area, agricultural output, productivity, and find the interrelationships between these variables.

DATA AND METHODOLOGY

Since there are variations in agro-eco-climatic conditions and population growth and distribution in different regions of the country, the present study has followed regional analysis approach. In our regional analysis, the country as a whole is taken as the study area. As the country can be divided into three main geographic regions - mountains, hills and tarai plains, each of these regions is further divided into five development planning regions, which ultimately come to 15 geographic, planning subregions. These regions are taken as the units for spatial-temporal analysis.

The study is primarily based on the secondary sources of data. For agriculture, the area and production data for major nine food and cash crops are obtained from the publications and official records of the Department of Food and Agricultural Marketing Services (DFAMS) of HMG. The data for chemical fertilizer and improved seeds supply are obtained from the publications and official records of the Agricultural Inputs Corporation (AIC) and rainfall from Department of Hydrology and Meteorology of HMG. For population, the major sources of data are various reports of population censuses. Various reports of demographic surveys and estimates produced by government and non-government organizations were also consulted. Since the detailed result of 1991 population census has yet to be come, the agricultural labour force for 1991 has to be estimated merely through using the activity rate and ratio of agricultural labour force to the total active labour for 1981 in the corresponding regions.

Despite the agricultural implements and pesticides being important inputs in agricultural production, the available data for these items did not meet our purpose. The incomplete sales figures of these inputs are in the AIC, while there is higher quantity of selling in private sector that have no recorded data.

LIMITATIONS

Since this study is heavily based on the secondary sources of data, various types of errors might have occurred in the data collection processes. The quality of data for area and production of agricultural crops has always been a problem for a study of this kind. Similarly, the unavailability of quality data for net cultivated land, irrigated area and modern inputs have narrowed the detailed analysis of this study. Being food crops as major crops occupying about 90 percent area and output in agriculture, our regression analysis has been made only with these crops.

POPULATION CHANGE PATTERNS

The population of Nepal has increased very rapidly since 1952/54 census, but with the irregular growth rate in different periods. The high growth in total population is observed due to the drastic decline in death rate without corresponding decline in birth rate and partly also by the immigration of people. Owing to the distinct geographical dichotomy in the country, a wide inter-regional variation in the population growth is the chief characteristic. The average annual growth rate between the regions is remarkably different, varying from -0.13 to 4.74 percent during 1981-91 decade. Moreover, the growth rate ranged from -5.30 to 8.00 percent per annum during the decade of 1971-81 (Table 2). All the tarai regions had higher population growth rate than the national average in both decades of 1970s and 1980s, while all hill and mountain regions, except central hill during 1980s, had lower growth rate. But the far-west and mid-west tarai regions stood with the highest growth rate, while the western mountain belt was the exception with the decline in total population during the study period, 1971-1991.

These wide differentials in population growth among the regions were caused not only by natural increase but mainly by immigration. There was phenomenal increase in migration of people to the tarai plains since 1960s. After the eradication of malaria in late 1950s and government incentives through resettlement programmes in the tarai districts, the influx of emigration occurred from the hill and mountain regions as well as from adjoining districts of India. Due to the increasing population pressure and declining cultivated land size in the hill and mountain regions, the people from these regions were forced to migrate to the southern plains in order to find the cultivable land for their livelihood. During 1971-81, the composite tarai alone received 74.4 percent of the total in-migrants in the country, and the Eastern tarai alone did 29 percent. On the other hand, 61.3 percent of the total out-migrants were originated from the hills and 30.3 percent from the mountains. Among the 15 regions, the Eastern hill and Eastern mountain sent out 25.5 and 22.7 percent of total out-migrants respectively in the same period (Gurung,1989).

Table 1

Distribution of Population and Land, by Region
1971 - 1991

Regions	Total Land Area (in sq.km)	Total Population			Percentage of Land	Percentage of Population		
		1971	1981	1991*		1971	1981	1991
Mountain								
Eastern	10438	304352	338439	359096	7.09	2.63	2.25	1.95
Central	6277	353923	413143	471576	4.26	3.06	2.75	2.55
Western	5819	34380	19951	19688	3.95	0.30	0.13	0.11
Mid-Western	21351	207122	242486	261246	14.51	1.79	1.61	1.42
Far-Western	7932	238833	288877	332875	5.39	2.07	1.92	1.80
Total	51817	1138610	1302896	1444481	35.21	9.85	8.67	7.82
Hill								
Eastern	10749	1105590	1257042	1429372	7.30	9.57	8.37	7.74
Central	11805	1741594	2108433	2676476	8.02	15.07	14.03	14.50
Western	18319	1816940	2150939	2417084	12.45	15.72	14.32	13.09
Mid-Western	13710	885562	1042365	1218342	9.32	7.66	6.94	6.60
Far-Western	6762	521721	604336	670035	4.59	4.51	4.02	3.63
Total	61345	6071407	7163115	8411309	41.68	52.54	47.68	45.56
Tarai								
Eastern	7269	1387558	2113442	2659906	4.94	12.01	14.07	14.41
Central	9328	1770236	2387781	3026185	6.34	15.32	15.89	16.39
Western	5260	595110	957969	1315150	3.57	5.15	6.38	7.12
Mid-Western	7317	395322	670760	926507	4.97	3.42	4.46	5.02
Far-Western	4845	197740	426876	678543	3.29	1.71	2.84	3.68
Total	34019	4345966	6556828	8606291	23.11	37.61	43.65	46.62
Nepal	147181	11555983	15022839	18462081	100	100	100	100

Source: Central Bureau of Statistics, *Population Monograph of Nepal 1987* Kathmandu, and Preliminary result of Population Census 1991.

This phenomenon led to the redistribution of population in the different regions of the country. As a result, the percentage of total population residing in the composite tarai regions alone reached up to 46.6 percent in 1991 from 37.6 percent in 1971. While in the composite hill regions, the share declined from 52.5 percent in 1971 to 45.6 percent in 1991. Similarly, the percentage of the composite mountain regions dropped

from 9.9 to 7.8 percent in twenty years period (Table 1 & 2). This in turn, the density of population increased very sharply in the tarai regions, which was followed by the hills. In the composite tarai regions, the density of population became nearly double, from 128 persons in 1971 to 253 per square kilometre in 1991. In the far-west tarai, the density increased to more than three fold. The number of population residing per square kilometre was 99 in 1971, and it increased to 137 in the composite hill regions. The highest increase in the density among the hill regions was experienced in the central hill. Due to perceptive increase in population density in the tarai regions, the net cultivated land per worker in these regions should have declined as in the mountain and hill regions.

Table 2

Average Annual Growth Rate and Density of Population Over the Years, by Region, 1971 - 1991

Regions	Density Population per sq.km			Growth Rate			Change in Density (1971=100)		
	1971	1981	1991	1971 -81	1981 -91	1971 -91	1971	1981	1991
Eastern Mountain	29.16	32.42	34.40	1.07	0.59	0.83	100	111.20	117.99
Central Mountain	56.38	65.82	75.13	1.56	1.33	1.45	100	116.73	133.24
Western Mountain	5.91	3.43	3.38	-5.30	-0.13	-2.75	100	58.03	57.27
Mid-West Mountain	9.70	11.36	12.24	1.59	0.75	1.17	100	117.07	126.13
Far-West Mountain	30.11	36.42	41.97	1.92	1.43	1.67	100	120.95	139.38
Mountains Total	21.97	25.14	27.88	1.36	1.04	1.20	100	114.43	126.86
Eastern Hill	102.86	116.95	132.98	1.29	1.29	1.29	100	113.70	129.29
Central Hill	147.53	178.61	226.72	1.93	2.41	2.17	100	121.06	153.68
Western Hill	99.18	117.42	131.94	1.70	1.17	1.44	100	118.38	133.03
Mid-West Hill	64.59	76.03	88.87	1.64	1.57	1.61	100	117.71	137.58
Far-West Hill	77.15	89.37	99.09	1.48	1.04	1.26	100	115.84	128.43
Hills Total	98.97	116.77	137.11	1.67	1.62	1.64	100	117.98	138.54
Eastern Tarai	190.89	290.75	365.92	4.30	2.33	3.31	100	152.31	191.70
Central Tarai	189.78	255.98	324.42	3.04	2.40	2.72	100	134.88	170.95
Western Tarai	113.14	182.12	250.03	4.88	3.22	4.04	100	160.97	220.99
Mid-West Tarai	54.03	91.67	126.62	5.43	3.28	4.35	100	169.67	234.37
Far-West Tarai	40.81	88.11	140.05	8.00	4.74	6.36	100	215.88	343.15
Tarai Total	127.75	192.74	252.98	4.20	2.76	3.48	100	150.87	198.03
Nepal	78.52	102.07	125.44	2.66	2.08	2.37	100	130.00	159.76

Source: Table 1

CHANGE IN AGRICULTURE

There is a large variation in the availability of cultivated land and its soil quality in different regions. The cultivated land is less than 6 percent of the total land area in the composite mountain regions, and in the composite hills, it is about 20 percent, while in the composite tarai more than 40 percent of the total land is under cultivation (LRMP,1986). From the analysis of area and production data, it has been suggested that the distribution of gross cropped area and agricultural production is uneven also between the regions. The percentage share of the composite tarai to the gross cropped area is the highest, although it is declining, while the share of the composite hills is increasing, and remaining almost constant in the composite mountains. Similar trend is observed in the distribution of total agricultural production. The major agricultural production in all regions of the country is food crops occupying more than 90 percent of the gross cropped area in most of the regions. Only few the mountain and tarai regions have little bit higher share in the area under cash crop, but less than 20 percent. The substitution of area from food to cash crops, therefore, was negligible during the study period.

The growth of gross cropped area in the initial decade of study was not much high in the regions; even in the three mountain regions and far-west hill, it was negative. In the following decade, however, the annual growth rate in food crop area was strikingly high, especially in the hill regions, which ranged from 3.72 percent to 8.03 percent per annum. In the mountain regions also, the growth rate ranged between 3.89 to 6.66 percent per annum, with exception of the western mountain which had negative growth rate (Table 3). But in the tarai regions, the increase in area was not encouraging.

Similarly, the rate of growth of food crop production was negative in most of the mountain and hill regions, except in the Eastern mountain and mid-west hill in the preceding decade. But in the following decade, there was phenomenal increase in both food and cash crop output. The growth rate in food crop output was more pronounced in the hill regions, which ranged from 4.66 to 8.68 percent per annum (Table 4). The western mountain, however, has experienced declining food crop output in both decades, along with total population.

Regarding the land productivity, it was interesting that the productivity per hectare of food crop output in the initial decade was declined in all the 14 regions under study, except almost zero growth in the eastern mountain (Table 5). The rate of decline in food crop productivity was ranging from 0.16 to 2.68 percent per annum. In the composite mountains, it declined by 1.15 percent and in the composite hills by 1.72 percent per annum. Also in the latter decade, there was the decline of food crop productivity in the 6 out of 10 mountain and hill regions. Only in the tarai regions, during this decade, the productivity was found increasing at the annual rate of 2.08 to

3.99 percent. However, the increase in cash crop productivity was satisfactory in most of the regions in the latter decade.

Table 3

Average Annual Growth Rates and Changes of Cropped Area of Different Crops, by Region, 1969-1971 to 1989-1991

(Growth rates in percent)

Regions	1969-71 to 1979-81			1979-81 to 1989-91			1969-71 to 1989-91		
	Food crops	Cash crops	All crops	Food crops	Cash crops	All crops	Food crops	Cash crops	All crops
Eastern Mountain	3.35	6.02	3.77	4.89	-0.22	4.13	4.12	2.85	3.95
Central Mountain	0.26	1.59	0.42	3.89	7.15	4.36	2.06	4.33	2.37
Western Mountain	-2.08	0.31	-1.80	-0.24	6.04	0.80	-1.16	3.14	-0.51
Mid-West Mountain	-3.04	-1.76	-2.91	5.34	2.41	5.07	1.06	0.31	1.00
Far-West Mountain	-1.60	2.08	-1.40	6.66	3.53	6.48	2.44	2.80	2.46
Mountains Total	-0.12	2.74	0.20	4.90	3.17	4.69	2.36	2.96	2.42
Eastern Hill	2.86	2.43	2.80	5.83	0.41	5.22	4.34	1.41	4.00
Central Hill	0.59	-2.31	0.37	3.72	5.57	3.85	2.14	1.55	2.09
Western Hill	1.78	1.60	1.77	8.03	3.24	7.86	4.86	2.42	4.77
Mid-West Hill	2.03	1.93	2.03	7.95	6.22	7.87	4.95	4.06	4.91
Far-West Hill	-0.19	0.79	-0.15	5.35	5.69	5.37	2.54	3.21	2.57
Hills Total	1.53	0.73	1.47	6.29	3.32	6.09	3.88	2.02	3.75
Eastern Tarai	1.66	4.74	1.80	0.73	0.91	0.74	1.19	2.81	1.27
Central Tarai	0.99	0.57	0.96	0.41	3.18	0.68	0.70	1.87	0.82
Western Tarai	1.33	5.01	1.60	-0.35	0.16	-0.30	0.49	2.55	0.64
Mid-West Tarai	0.17	2.81	0.55	2.25	2.20	2.24	1.21	2.51	1.39
Far-West Tarai	2.96	3.82	3.07	3.46	5.44	3.73	3.21	4.63	3.40
Tarai Total	1.28	2.66	1.40	0.83	2.44	0.98	1.06	2.55	1.19
Nepal	1.29	2.12	1.36	3.03	2.73	3.01	2.15	2.42	2.18

Source: Computed from the data obtained from the Department of Food and Agricultural Marketing Services, Ministry of Agriculture, HMG/N, Kathmandu.

Table 4

Average Annual Growth Rates and Changes in Output of Crops by Region, 1969-1971 to 1989-1991

(Growth rates in percent)

Regions	1969-71 to 1979-81			1979-81 to 1989-91			1969-71 to 1989-91		
	Food crops	Cash crops	All crops	Food crops	Cash crops	All crops	Food crops	Cash crops	All crops
Eastern Mountain	3.37	4.01	3.57	4.01	4.95	4.33	3.69	4.48	3.95
Central Mountain	-2.43	2.85	-0.83	4.85	9.89	6.95	1.15	6.31	2.99
Western Mountain	-3.21	2.72	-1.22	-2.19	6.39	2.14	-2.70	4.54	0.44
Mid-West Mountain	-4.20	-1.12	-3.41	4.45	6.07	4.94	0.03	2.41	0.68
Far-West Mountain	-3.38	0.36	-2.91	6.19	7.67	6.42	1.29	3.95	1.65
Mountains Total	-1.27	2.42	-0.28	4.50	7.20	5.40	1.58	4.78	2.52
Eastern Hill	0.77	2.64	1.26	5.81	2.91	5.07	3.26	2.78	3.14
Central Hill	-0.12	-0.42	-0.16	4.66	10.03	5.55	2.24	4.68	2.66
Western Hill	-0.76	0.91	-0.59	8.68	6.94	8.50	3.85	3.88	3.85
Mid-West Hill	0.06	1.62	0.19	7.22	10.36	7.53	3.58	5.90	3.80
Far-West Hill	-2.10	-0.72	-1.98	5.35	12.35	6.19	1.56	5.61	2.02
Hills Total	-0.22	1.20	-0.02	6.47	6.94	6.55	3.07	4.03	3.21
Eastern Tarai	1.49	5.54	1.79	2.82	9.51	3.60	2.15	7.51	2.69
Central Tarai	0.82	5.49	1.72	3.61	9.20	5.17	2.21	7.33	3.43
Western Tarai	0.60	5.18	1.60	3.20	10.06	5.42	1.89	7.59	3.49
Mid-West Tarai	-0.30	3.54	0.08	4.95	3.25	4.76	2.29	3.40	2.40
Far-West Tarai	1.29	3.66	1.48	7.59	18.83	9.10	4.39	10.99	5.22
Tarai Total	0.90	5.22	1.53	3.75	9.57	5.02	2.31	7.37	3.26
Nepal	0.43	3.72	0.94	4.70	8.72	5.52	2.54	6.19	3.21

Source: Computed from the data obtained from the Department of Food and Agriculture Marketing Services, Ministry of Agriculture, HMG/N Kathmandu.

Table 5

Yield Rates of Per Hectare Agricultural Crop Production by Region, 1969-1971 to 1989-1991

(M.ton/ha.)

Regions	1969-1971		1989-1981		1989-1991	
	Food crops	Cash crops	Food crops	Cash crops	Food crops	Cash crops
Eastern Mountain	1.71	4.57	1.71	3.78	1.57	6.25
Central Mountain	1.81	4.81	1.38	5.44	1.52	7.00
Western Mountain	1.51	4.97	1.34	6.30	1.10	6.51
Mid-West Mountain	1.43	4.23	1.27	4.51	1.17	6.41
Far-West Mountain	1.55	3.76	1.29	3.17	1.23	4.70
Mountains Total	1.62	4.51	1.45	4.37	1.39	6.42
Eastern Hill	1.91	3.74	1.56	3.82	1.55	4.89
Central Hill	2.00	3.39	1.86	4.10	2.04	6.21
Western Hill	1.90	4.09	1.47	3.82	1.56	5.44
Mid-West Hill	1.77	2.55	1.46	2.47	1.36	3.62
Far-West Hill	1.62	2.94	1.34	2.53	1.34	4.66
Hills Total	1.89	3.52	1.59	3.69	1.62	5.21
Eastern Tarai	1.74	2.86	1.71	3.09	2.11	7.00
Central Tarai	1.67	3.19	1.64	5.14	2.25	9.06
Western Tarai	1.59	5.49	1.48	5.58	2.10	14.32
Mid-West Tarai	1.65	1.03	1.58	1.11	2.04	1.23
Far-West Tarai	1.64	0.93	1.39	0.91	2.06	3.02
Tarai Total	1.67	2.79	1.61	3.57	2.14	7.00
Nepal	1.74	3.13	1.60	3.66	1.87	6.45

Source: Computed from the data obtained from the Department of Food and Agricultural Marketing Services, Ministry of Agriculture, HMG/N, Kathmandu.

Because of the increasing population pressure in the hill and mountain regions, the cultivable land has already been exhausted (Seddon,1987:50). So, the farmers are being forced to cultivate low quality steep land to meet the food requirement of the growing population. From the traditional method of agriculture in such a steep terrain, the soil erosion problem is leading to declined crop productivity (Winrock International, 1991). There are numerous other factors which have hindered the rise in productivity per hectare. Due to endemic poverty of Nepalese farmers and the steep topographic condition, the use of modern inputs is very low.

Although the use of chemical fertilizer is increasing, its rate of use per hectare is very low. The use of improved variety seeds is almost nil in most of the regions (Table 6). But the use of modern tools is not feasible in the Nepalese hill farms owing to the terraced topography. The year round irrigation facility is available in very insignificant percent of cultivated land. This facility is rather low in the hill and mountain regions. Therefore, whatever the total agricultural production has increased, it is due to the expansion of cultivated area rather than the increased productivity per hectare.

Table 6

Use of Fertilizer and Improved Seeds Per Hectare of Gross Cropped Area, by Region, 1971 - 1991

(In kg.)

Regions	Fertilizer Use		Improved Seeds Use	Regions		
	1971	1981	1991	1971	1981	1991
Eastern Mountain	0.22	2.86	11.80	0.08	0.48	0.59
Central Mountain	7.03	62.48	65.74	0.34	0.42	0.09
Western Mountain	0.00	4.49	7.66	0.00	2.42	0.80
Mid-West Mountain	0.19	0.44	1.20	0.11	0.14	0.45
Far-West Mountain	0.24	0.44	4.79	0.04	0.61	0.25
Mountains Total	1.96	17.77	22.05	0.14	0.53	0.37
Eastern Hill	2.67	5.01	78.45	0.43	0.57	0.27
Central Hill	53.80	104.89	142.01	0.64	0.57	1.10
Western Hill	6.98	11.08	17.66	1.57	0.97	0.21
Mid-West Hill	0.76	2.14	6.99	0.28	0.11	0.14
Far-West Hill	1.49	1.85	6.50	0.21	0.22	0.69
Hills Total	19.45	34.04	55.96	0.77	0.59	0.44
Eastern Tarai	5.87	10.53	50.54	1.16	1.33	6.98
Central Tarai	13.95	27.63	83.06	0.74	0.85	1.03
Western Tarai	11.38	9.71	83.12	0.20	0.53	0.95
Mid-West Tarai	2.81	5.55	36.22	0.59	0.38	0.68
Far-West Tarai	2.62	2.18	23.56	0.25	0.19	0.96
Tarai Total	9.18	15.16	62.06	0.71	0.83	2.63
Nepal	11.91	21.13	57.15	0.70	0.74	1.59

Source : Fertilizer data was obtained from the publications and official records of Agricultural Inputs Corporation, Kathmandu and Area data was obtained from the Department of Food and Agricultural Marketing Services, Ministry of Agriculture, HMG/N Kathmandu.

RELATIONSHIPS BETWEEN POPULATION GROWTH AND AGRICULTURAL CHANGE: CORRELATION AND REGRESSION ANALYSIS

In order to gain an insight into the behavioral relationship, an effort is made to make quantitative analysis of leading population and agricultural variables, using time series data from 1971 to 1991. First the analysis is devoted to correlation analysis of the population and agricultural variables, which is followed by a discussion of regression results.

Correlation Analysis

The simple correlation coefficients of agricultural labour and other agricultural variables, such as area, output and productivity of food crops, derived from the time series data for the period from 1971 to 1991 are given in Table 7. The results of our analysis suggest that the correlation between agricultural labour and gross food crop area is very high in most of the regions. A notable exception is observed in the mid-west mountain region where the correlation coefficient is only 0.22. In this region, the growth rate of agricultural labour force was exceptionally erratic during the last two decades. For instance, the average annual growth rate of labour force during the period from 1971 to 1981 was 3.81 percent, whereas it was only 0.74 percent in the decade of 1981 to 1991. Also, a weak association is noted between agricultural labour force and increase in food crop area in the western tarai region, as shown by the correlation value of 0.55.

The correlation coefficient of agricultural labour and food crop area, however, is more than 0.80 in 10 out of 15 regions under study. The highest coefficient of labour with area is found in the central hill and far-west tarai, as 0.95 in each. It must be noted that correlation between agricultural labour and food crop area is higher in the hills and tarai regions than in the mountains. A possible reason for this lower correlation coefficient in the mountains is the limited potential for expansion of food crop area due to the rugged terrain and adverse climatic condition for food crop production.

As observed in Table 7, the correlation between labour force and food crop output is weak in most of the mountain regions. There is a negative correlation between these variables in the mid-west mountain region where the correlation between labour and area is very weak. It is interesting to note that the western mountain region has the highest correlation coefficient of output with respect to labour as its value is 0.91. This region is characterized by a decline in both population and agricultural labour force during the two decades of the 1970s and 1980s. The correlation coefficient

of labour and food crop output in the average mountain regions is not much high, as its value is 0.51.

The correlation between labour and output is higher in the hill regions than that in the mountains. The highest correlation coefficient between these two variables is found in central hill, at 0.88. However, the far-west hill region shows the lowest correlation coefficient between labour and output as 0.34, where the coefficient of correlation between labour and area is 0.78. This region is characterized by dry climatic condition and low soil quality. However, the coefficient of correlation between labour and food output in the average five hill regions is 0.79. The closeness of association between labour and food output in the tarai regions is almost the same as in the hill regions.

Table 7

The Correlation Coefficients of Agricultural Labour with Area, Output and Productivity of Food Crops, by Region, 1971 - 1991

Regions	Area	Output	Productivity
Eastern Mountain	0.808	0.726	0.590
Central Mountain	0.870	0.430	0.665
Western Mountain	0.732	0.910	0.804
Mid-West Mountain	0.224	0.122	-0.782
Far-West Mountain	0.814	0.647	-0.778
Mountains Total	0.742	0.508	-0.811
Eastern Hill	0.899	0.764	-0.770
Central Hill	0.951	0.876	-0.217
Western Hill	0.888	0.760	-0.717
Mid-West Hill	0.805	0.721	-0.803
Far-West Hill	0.781	0.341	-0.802
Hills Total	0.908	0.790	-0.745
Eastern Tarai	0.807	0.679	0.500
Central Tarai	0.801	0.753	0.655
Western Tarai	0.554	0.669	0.514
Mid-West Tarai	0.724	0.615	0.436
Far-West Tarai	0.953	0.801	0.365
Tarai Total	0.902	0.761	0.599
Nepal	0.940	0.790	0.117

It is striking to observe that there is a negative correlation between increase in labour force and food crop productivity per hectare in all mountain and hill regions, except in the western mountain. This indicates that the productivity of food crop per hectare has not increased, despite the increase of agricultural labour in the same farm area. Whatever the total food crop output has increased in these regions, it is due to increase in cropped area. Population pressure has excessively exerted the effect on expansion of crop area to bring marginal land under cultivation and to some extent multiple cropping. These regions have low use of chemical fertilizer and limited possibility for irrigation due to the steep slopes. Although numerous rivers and streams flow through these mountain and hill regions, they run far deeper in the gorges which render the rivers inaccessible for the agriculture farms. On the other hand, the problem of soil erosion is rising every year due to overgrazing of increased livestock, deforestation and steepness of the newly cultivated land (Eckholm,1976; Upreti, 1983; Jodha,1990). In the tarai regions, however, the correlation coefficient of labour with productivity per hectare of food crop output is found positive, although it is still weak (Table 7).

Regarding the association between agricultural labour and cash crop area, it is not much strong. Only the 4 out of 15 regions have correlation coefficients above 0.80. However, in the tarai regions, coefficients of correlation between these two variables are little better than those for the mountain and hill regions. From the observation of time series data, the area devoted to cash crops is increasing consistently in the tarai regions. There are various other factors besides the labour force for this increase in cash crop area. For example, the establishment of agro-based industries such as, cigarettes, sugar and oil processing have encouraged to increase output of cash crop. Beside this, the tarai regions are climatically favorable for these cash crops. One study has also indicated that cash crops are highly price responsive in Nepal (Paudel, 1981). However, the area devoted to cash crops in Nepal is negligible, around 10 percent of the gross cropped area.

The correlation between labour and cash crop output is stronger than that between labour and cash crop area in most of the regions under the study. The association between labour and cash crop productivity is also higher in most of the tarai regions, except the mid-west tarai with a coefficient strikingly low as 0.29. In interpreting the data on output and productivity of cash crop, one should bear in mind that this is affected by the aggregation of cash crop output data.

The correlation matrices for population, labour force and various agriculture related variables are given in Annex 1. One can get an additional information about the relationships between various variables from those matrices.

Table 8

Correlation Coefficient of Labour with Area, Output and Productivity of Cash Crops, by Region, 1971 - 1991

Regions	Area	Output	Productivity
Eastern Mountain	0.358	0.760	0.673
Central Mountain	0.877	0.925	0.791
Western Mountain	-0.342	-0.735	-0.789
Mid-West Mountain	-0.327	0.426	0.778
Far-West Mountain	0.586	0.727	0.721
Mountains Total	0.707	0.863	0.816
Eastern Hill	0.592	0.829	0.724
Central Hill	0.428	0.815	0.845
Western Hill	0.680	0.751	0.613
Mid-West Hill	0.881	0.832	0.613
Far-West Hill	0.545	0.679	0.728
Hills Total	0.741	0.817	0.816
Eastern Tarai	0.686	0.889	0.811
Central Tarai	0.721	0.877	0.811
Western Tarai	0.685	0.865	0.831
Mid-West Tarai	0.918	0.802	0.291
Far-West Tarai	0.903	0.807	0.746
Tarai Total	0.881	0.879	0.855
Nepal	0.863	0.877	0.861

From the correlation analysis of time series data presented here, it has been confirmed that there is a very close association between agricultural labour and food crop area. It is noted also from the correlation analysis that there is wide variation in the relationship among the regions.

While correlation coefficient merely estimates the degree of closeness of linear relationship between the variables in question, the regression line makes it possible to predict the change in the dependent variable due to a change in the independent variables. Thus, the regression techniques have been employed to gain insight into the processes of interactions between population and agriculture related variables.

Regression Analysis

In the regression analysis, effort is concentrated to measure the magnitude of changes in food crop area and output in response to the population pressure. There are various reasons to examine the effects of population pressure on food crop area and output. In the subsistence agricultural economy like that of Nepal, population growth leads first to increased demand for food grain. In Nepal, food grain has remained as the major agricultural production. As has been already discussed, more than 90 percent of the gross cropped area in Nepal is devoted to food crop production. The contribution of cash crop to the total crop production is insignificant.

It should be kept in mind that the ultimate impact of population growth and other agricultural input in a subsistence economy lies on the total food output. This occurs either by increasing gross cropped area (through reclaiming new land and or multiple cropping) or by the increase in productivity per unit of land. Hence, the total food crop output is considered as dependent variable. No doubt, there are more other factors too, such as water, improved variety of seeds, chemical fertilizer and modern implements besides agricultural labour force, which have important effect on the variation of food crop output.

It should be noted that in Nepal, disaggregated time series data on irrigation facility are not available. At the same time, due to very limited area under irrigation, Nepalese agriculture is dependent mostly on rain water. In this condition, rainfall has been playing very crucial role in agricultural production. Due to various factors, the use of improved variety of seeds in agriculture is negligible. On the other hand, the employment of modern implements, such as tractors, is not feasible in the hill and mountain terrain. We have, therefore, included rainfall and supply of chemical fertilizer in addition to agricultural labour force as the explanatory variables to explain the variability in the food crop output.

In the regression analysis, we have taken two steps. At first, an attempt is made to see that to what extent the increased agricultural labour force is responsible for the variation in gross food crop area. In the next step, the food crop output is related to labour, rainfall and fertilizer supply.

Simple Two Variable Regression Model

Table 9 presents the results of log-linear relationship between dependent and independent variables. In all equations, the ordinary least square (OLS) method has been adopted and the time series data included herein range from 1971 to 1991. The coefficients from the table show the elasticity of area increase with respect to increase in agricultural labour force. The figures in parentheses indicate the t-values.

As noticed in Table 9, the regression equations yield significant results in all mountain regions, except in the mid-west mountain. It gives very high coefficients of labour, indicating the elasticity of food crop area with respect to agricultural labour which is greater than unity in the 4 out of 5 mountain regions. Also these coefficients of labour are statistically significant at 1 percent level. The adjusted R^2 as 0.76, 0.63 and 0.62, in the central, western and far-west mountain respectively, are quite reasonable considering the secondary nature of data. But in the mid-west mountain, the labour force shows its inability to explain the food crop area, as the coefficient has not been found statistically significant. Similarly for this region, the adjusted R^2 was only 0.32, indicating that the fit was not good.

Some arguments can be put forward in this context. First, this region has very limited scope for the expansion of cultivated area. Secondly, due to the cold climatic condition, only single crop can be harvested. Thirdly, according to 1981 survey data, round the year irrigation facility in this region is available only for 0.38 percent of the net cultivated land (HMG/DIR, 1989). Therefore, the increase in food crop area either by reclaiming new land or by multiple cropping is least possible. On the other hand, the population and labour force data, when compared with the 1971 and 1981 population census results, are doubtful.

In the case of all five hill regions, the variation in the food crop area is explained significantly by the changes in agricultural labour force. The elasticity for labour is greater than unity in all regions. The coefficients also have high and significant t-values for all regions. In regard to the tarai regions, the variation in food crop area due to the increase in agricultural labour force is comparatively low. As indicated in Table 9, the elasticity coefficients of labour in all the five tarai regions are less than unity, ranging from 0.14 to 0.46. As the results show, a one percent increase in the agricultural labour force leads to increase the area by 0.29, 0.20, 0.14, 0.17 and 0.46 percent respectively in the eastern, central, western, mid-west and far-west tarai. These coefficients, however, are statistically highly significant in all the tarai regions. The over all variance in the equation for the tarai regions is also comparatively lower than that for the hill regions. Only the far-west tarai suggests a high coefficient of determination of 0.89. In other four regions, it ranges from 0.77 to lowest 0.64. However, these can be taken as the high considering of the secondary data collected from crude method, especially on agriculture.

Table 9

Regression Parameters Estimated for Food Crop Area by Region, 1971 - 1991

Dependent variable	Independent variable				N=21
Food crop area	Constant	Labour force	R^2	Adjusted R^2	F
Eastern Mountain	-17.293	2.308	0.823	0.801	61.27
	(4.873)	(7.828)***			
Central Mountain	-10.291	1.687	0.769	0.755	48.72
	(3.476)	(6.980)***			
Western Mountain	0.167	0.900	0.650	0.626	23.22
	(0.095)	(4.818)			
Mid-West Mountain	8.852	0.098	0.340	0.319	5.92
	(2.012)	(0.264)***			
Far-West Mountain	-19.792	2.533	0.648	0.624	23.01
	(3.162)	(4.796)***			
Mountains Total	-8.047	1.475	0.584	0.557	17.82
	(1.718)	(4.221)***			
Eastern Hill	-14.879	2.026	0.893	0.884	96.60
	(5.430)	(9.828)***			
Central Hill	-3.116	1.130	0.909	0.892	144.1
	(2.421)	(12.004)***			
Western Hill	-40.203	3.810	0.869	0.850	86.23
	(7.097)	(9.286)***			
Mid-West Hill	-15.084	2.051	0.766	0.751	45.62
	(3.799)	(6.754)***			
Far-West Hill	-3.754	1.172	0.658	0.637	24.03
	(1.248)	(4.902)***			
Hills Total	-18.554	2.147	0.871	0.862	94.88
	(5.614)	(9.740)***			
Eastern Tarai	9.128	0.286	0.770	0.752	36.55
	(14.446)	(6.046)***			
Central Tarai	10.401	0.200	0.786	0.772	53.07
	(27.866)	(7.285)***			
Western Tarai	10.666	0.135	0.664	0.636	16.42
	(25.119)	(4.052)***			
Mid-West Tarai	9.859	0.172	0.672	0.653	16.30
	(18.637)	(4.036)***			
Far-West Tarai	6.147	0.457	0.891	0.877	147.79
	(13.676)	(12.157)***			
Tarai Total	10.578	0.246	0.856	0.848	112.99
	(31.299)	(10.630)***			
Nepal	1.881	0.820	0.880	0.873	139.19
	(1.733)	(11.800)			

*** = Significant at 1 percent level

N = Number of observations

Multiple Regression Model

To assess the relative significance of labour and other inputs in explaining variation in food crop output, the log-linear regression was fitted, taking time series data for the same period of 21 years from 1971 to 1991, as in the preceding section, for different regions. Because of the deficiency of data as noted above, it has been possible to incorporate only agricultural labour force, rainfall and supply of chemical fertilizer in the equations. In our regression model, the cropped area has not been included in the explanatory variables. There are two reasons for this: firstly, there is a very high multicollinearity between agricultural labour force and food crop area. Secondly, it has been already confirmed from the preceding regression results that there is a strong relationship between cropped area and agricultural labour force.

In the regression results obtained for each region, the food crop output is related to agricultural labour and rainfall (Table 10). A separate equation was also estimated incorporating fertilizer as an additional explanatory variable. Because of the high correlation between labour and fertilizer, the results were found contrary to the expectation. The results obtained through that equation are given in Annex 2.

In the case of mountains, the estimated equations suggest that the increase in food production takes place at a lower rate than the change in agricultural labour force in four out of five mountain regions. The case of the western mountain is an exception with declining population. However, labour coefficients are statistically significant at one percent level for all mountains.

The rainfall was not an important factor in determining the variation of food crop output in the mountain regions. Further for the western mountain, the coefficient was found negative, and it was significant only for Eastern mountain at 5 percent level.

Also in the case of hills, the variation in food crop output is mainly influenced by the agricultural labour force. The elasticity coefficients are highly significant for all the five hill regions. Rainfall is also found as one of the important factors in the hill regions in explaining the variation in food crop output compared to that of the mountains. The R^2 values (adjusted) of the equations are shown as more than 80 percent in three out of five hill regions. However, the equation explains as low as 57 percent in far-west hill.

The regression results, in many cases, are found as contrary to the general expectation. This is particularly true in the case of rainfall variable in the hill and mountain regions. But when one examines very closely the situation prevailing in the hills and mountains, one may find out that the results are not far from the reality. In

Table 10
Regression Parameters Estimated for Food Production by Region, 1971 - 1991

Dependent Variable	Independent Variables			N=21	Adjusted	
Food Production	Constant	Labour	Rainfall	R^2	R^2	
Eastern Mountain	2.107	0.841***	0.074**	0.944	0.938	151.13
	(3.953)	(16.422)	(2.448)			
Central Mountain	4.378	0.616***	0.018	0.442	0.380	7.12
	(2.346)	(3.386)	(0.252)			
Western Mountain	-3.116	1.396***	-0.103**	0.816	0.796	40.03
	(2.134)	(8.277)	(1.987)			
Mid-West Mountain	2.136	0.804***	0.045	0.849	0.832	50.49
	(2.135)	(7.894)	(0.861)			
Far-West Mountain	2.706	0.756***	0.054	0.871	0.857	61.02
	(3.102)	(8.712)	(1.160)			
Mountains Total	3.680	0.714***	0.043	0.822	0.802	41.60
	(3.616)	(8.145)	(1.033)			
Eastern Hill	3.888	0.702***	0.193***	0.932	0.924	115.73
	(6.121)	(13.197)	(4.739)			
Central Hill	2.426	0.851***	0.074**	0.835	0.816	43.16
	(2.056)	(8.864)	(1.742)			
Western Hill	3.307	0.764***	0.088*	0.884	0.871	68.30
	(3.693)	(10.405)	(1.459)			
Mid-West Hill	5.170	0.586***	0.043	0.807	0.785	37.60
	(6.158)	(8.008)	(0.536)			
Far-West Hill	5.642	0.510***	0.043	0.627	0.574	10.02
	(3.425)	(3.347)	(0.609)			
Hills Total	4.276	0.719***	0.048	0.867	0.852	55.50
	(4.211)	(9.532)	(0.958)			
Eastern Tarai	-9.196	1.747***	0.134***	0.855	0.838	50.14
	(3.188)	(7.833)	(4.583)			
Central Tarai	-17.681	2.389***	0.068	0.583	0.515	9.59
	(1.860)	(3.299)	(1.008)			
Western Tarai	-3.899	1.345**	0.200***	0.611	0.546	10.29
	(0.563)	(2.409)	(3.057)			
Mid-West Tarai	-7.669	1.673***	0.157***	0.841	0.823	47.57
	(2.905)	(7.058)	(3.983)			
Far-West Tarai	-2.381	1.234***	0.204***	0.772	0.748	28.81
	(1.042)	(6.234)	(2.618)			
Tarai Total	-12.369	1.905***	0.129***	0.725	0.693	22.43
	(2.397)	(5.229)	(2.933)			
Nepal	-0.549	1.065***	0.133***	0.905	0.895	85.97
	(0.414)	(11.783)	(4.247)			

*** = Significant at 1 percent level
** = Significant at 5 percent level
* = Significant at 10 percent level
N = Number of observations

these regions, the ecological, environmental and soil erosion problems have been an usual and common phenomenon in recent years. This has made very adverse effect on soil fertility and productivity of food output per hectare.

In the tarai plains, the elasticities of agricultural labour force are greater than unity in all the five tarai regions. These are significant at one percent level in all regions, except the western tarai. Unlike in the hill and mountain regions, the rainfall appears as one important variable, explaining the variation in food crop output in the tarai. The coefficients are significant at one percent in four out of five tarai regions. Only in the central tarai region, the coefficient is not statistically significant. Since the irrigation facility in the central tarai region is comparatively better, this might have led to derive the low value. If the available indices are examined, it is found that 59 percent of the total cultivated area has the irrigation facility in this region (LRMP, 1986).

CONCLUSION

The study has confirmed that the population pressure in Nepal first exerts its impact on the greater use of marginal lands for cultivation and shortening the fallow period which, in turn, leads to increase in agricultural production. The variation in population pressure and subsequent impact on area and output is quite large between the different regions. The study, however, could not confirm that there has been an increase in productivity as a result of rising population. Specially, in the mountain and hill regions, no strong positive relationship could be observed. Some of the important factors responsible for this state of affairs are; very low coverage of irrigation facility, the scant use of fertilizer and improved seeds as well as cultivation of low quality marginal lands and environmental degradation as a result of high population pressure, leading to deforestation and poor land use management.

Annex 1

Correlation Matrices for Different Regions, 1971-1991

Eastern Mountain

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.989	0.876	0.370	0.791	0.814	-0.619	0.696	0.045	0.898	0.908
LAB		1.000	0.808	0.358	0.726	0.766	-0.590	0.673	-0.007	0.827	0.881
FCA			1.000	0.421	0.964	0.877	-0.469	0.653	0.261	0.941	0.755
CCA				1.000	0.480	0.527	0.063	-0.126	0.228	0.296	0.185
FCP					1.000	0.793	-0.218	0.503	0.380	0.845	0.611
CCP						1.000	-0.577	0.756	0.112	0.798	0.697
FCY							1.000	-0.742	0.329	-0.650	-0.760
CCY								1.000	-0.124	0.668	0.683
RAIN									1.000	0.192	0.041
FERT										1.000	0.890
SEED											1.000

Central Mountain

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.999	0.865	0.872	0.420	0.921	-0.672	0.790	0.412	0.898	-0.633
LAB		1.000	0.870	0.877	0.430	0.925	-0.665	0.791	0.413	0.896	-0.637
FCA			1.000	0.976	0.727	0.958	-0.420	0.608	0.398	0.676	-0.692
CCA				1.000	0.637	0.947	-0.499	0.557	0.362	0.687	-0.685
FCP					1.000	0.678	0.312	0.391	0.279	0.206	-0.425
CCP						1.000	-0.448	0.782	0.401	0.751	-0.706
FCY							1.000	-0.389	-0.181	-0.702	0.374
CCY								1.000	0.427	0.754	-0.596
RAIN									1.000	0.367	-0.474
FERT										1.000	-0.549
SEED											1.000

Western Mountain

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.999	0.730	-0.337	0.912	-0.739	0.812	-0.804	-0.532	-0.754	-0.543
LAB		1.000	0.732	-0.342	0.909	-0.735	0.804	-0.790	0.522	-0.741	-0.530
FCA			1.000	-0.096	0.860	-0.396	0.483	-0.593	-0.251	-0.619	-0.316
CCA				1.000	-0.303	0.810	-0.417	-0.003	0.365	0.251	-0.002
FCP					1.000	-0.717	0.858	-0.820	-0.439	-0.852	-0.503
CCP						1.000	-0.837	0.581	0.615	0.720	0.398
FCY							1.000	-0.832	-0.510	-0.874	-0.553
CCY								1.000	0.533	0.894	0.693
RAIN									1.000	0.533	0.342
FERT										1.000	0.625
SEED											1.000

Mid-West Mountain

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.989	0.348	-0.209	0.014	0.543	-0.789	0.843	0.166	0.757	0.763
LAB		1.000	0.224	-0.327	-0.122	0.426	-0.782	0.778	0.082	0.687	0.692
FCA			1.000	0.671	0.910	0.806	-0.452	0.539	0.535	0.776	0.645
CCA				1.000	0.819	0.627	0.182	0.063	0.443	0.294	0.093
FCP					1.000	0.739	-0.048	0.348	0.547	0.482	0.394
CCP						1.000	-0.348	0.815	0.465	0.724	0.614
FCY							1.000	-0.575	-0.073	-0.807	-0.705
CCY								1.000	0.287	0.705	0.734
RAIN									1.000	0.421	0.496
FERT										1.000	0.833
SEED											1.000

Far-West Mountain

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.993	0.747	0.540	0.556	0.662	-0.816	0.643	0.395	0.838	0.474
LAB		1.000	0.814	0.586	0.647	0.727	-0.778	0.721	0.439	0.872	0.461
FCA			1.000	0.725	0.945	0.864	-0.519	0.845	0.527	0.878	0.294
CCA				1.000	0.725	0.920	-0.323	0.886	0.362	0.688	0.229
FCP					1.000	0.866	-0.217	0.858	0.548	0.711	0.128
CCP						1.000	-0.323	0.886	0.362	0.688	0.229
FCY							1.000	-0.326	-0.112	-0.754	-0.577
CCY								1.000	0.430	0.731	0.197
RAIN									1.000	0.541	0.102
FERT										1.000	0.456
SEED											1.000

Mountains total

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.996	0.795	0.745	0.577	0.900	-0.795	0.827	0.322	0.946	0.824
LAB		1.000	0.742	0.707	0.508	0.863	-0.811	0.816	0.312	0.946	0.828
FCA			1.000	0.864	0.920	0.934	-0.553	0.659	0.356	0.722	0.629
CCA				1.000	0.798	0.861	-0.456	0.416	0.355	0.604	0.510
FCP					1.000	0.830	-0.185	0.497	0.387	0.494	0.386
CCP						1.000	-0.605	0.811	0.294	0.813	0.689
FCY							1.000	-0.661	-0.039	-0.805	-0.772
CCY								1.000	0.131	0.840	0.723
RAIN									1.000	0.262	0.334
FERT										1.000	0.801
SEED											1.000

Eastern Hill

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.981	0.953	0.610	0.854	0.879	-0.694	0.764	0.089	0.552	0.468
LAB		1.000	0.801	0.592	0.764	0.830	-0.770	0.723	0.015	0.446	0.557
FCA			1.000	0.577	0.939	0.878	-0.579	0.771	0.229	0.498	0.350
CCA				1.000	0.484	0.675	-0.526	-0.239	-0.303	0.398	0.353
FCP					1.000	0.883	-0.272	0.828	0.434	0.482	0.034
CCP						1.000	-0.429	0.875	0.155	0.603	0.185
FCY							1.000	-0.248	0.451	-0.089	-0.912
CCY								1.000	0.384	0.506	0.034
RAIN									1.000	0.111	-0.565
FERT										1.000	-0.104
SEED											1.000

Central Hill

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.999	0.958	0.466	0.891	0.835	0.198	0.844	0.024	0.941	0.207
LAB		1.000	0.951	0.428	0.876	0.815	0.217	0.845	0.011	0.944	0.188
FCA			1.000	0.603	0.889	0.829	0.270	0.753	0.114	0.909	0.124
CCA				1.000	0.684	0.858	0.163	0.332	0.359	0.394	0.399
FCP					1.000	0.955	0.196	0.858	0.259	0.773	0.418
CCP						1.000	0.203	0.864	0.284	0.719	0.531
FCY							1.000	0.145	0.328	0.330	0.544
CCY								1.000	0.184	0.739	0.410
RAIN									1.000	0.019	0.038
FERT										1.000	0.036
SEED											1.000

Western Hill

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.999	0.881	0.773	0.750	0.740	-0.723	0.603	0.357	0.930	-0.629
LAB		1.000	0.888	0.680	0.760	0.751	-0.717	0.613	0.361	0.936	-0.637
FCA			1.000	0.884	0.957	0.931	-0.441	0.699	0.360	0.966	-0.766
CCA				1.000	0.875	0.867	-0.280	0.459	0.095	0.810	-0.684
FCP					1.000	0.949	-0.172	0.723	0.388	0.905	-0.779
CCP						1.000	-0.252	0.838	0.262	0.902	-0.687
FCY							1.000	-0.191	0.044	-0.527	0.179
CCY								1.000	0.362	0.731	-0.458
RAIN									1.000	0.339	-0.283
FERT										1.000	-0.705
SEED											1.000

Mid-West Hill

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.984	0.872	0.914	0.820	0.904	-0.776	0.718	0.329	0.937	0.211
LAB		1.000	0.805	0.881	0.721	0.832	-0.803	0.613	0.311	0.864	0.203
FCA			1.000	0.864	0.858	0.882	-0.774	0.734	0.320	0.920	0.168
CCA				1.000	0.822	0.935	-0.716	0.646	0.456	0.873	0.088
FCP					1.000	0.939	-0.410	0.881	0.319	0.945	0.187
CCP						1.000	-0.587	0.869	0.354	0.959	0.116
FCY							1.000	-0.343	0.108	0.870	0.128
CCY								1.000	0.108	0.870	0.128
RAIN									1.000	0.277	-0.064
FERT										1.000	0.216
SEED											1.000

Far-West Hill

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.931	0.939	0.767	0.623	0.893	-0.677	0.890	0.447	0.964	0.185
LAB		1.000	0.781	0.545	0.341	0.679	-0.802	0.728	0.386	0.869	0.275
FCA			1.000	0.768	0.747	0.920	-0.590	0.954	0.567	0.996	0.139
CCA				1.000	0.774	0.920	-0.206	0.690	0.251	0.768	-0.026
FCP					1.000	0.853	0.089	0.768	0.451	0.571	0.002
CCP						1.000	-0.348	0.914	0.398	0.878	0.024
FCY							1.000	-0.505	-0.290	-0.714	-0.253
CCY								1.000	0.517	0.883	0.110
RAIN									1.000	0.372	-0.004
FERT										1.000	0.129
SEED											1.000

Hills total

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.996	0.939	0.795	0.839	0.859	-0.711	0.839	0.328	0.933	-0.148
LAB		1.000	0.908	0.741	0.790	0.817	-0.745	0.816	0.319	0.905	-0.124
FCA			1.000	0.922	0.931	0.925	-0.611	0.835	0.338	0.923	-0.279
CCA				1.000	0.937	0.922	-0.378	0.742	0.285	0.865	-0.201
FCP					1.000	0.972	-0.292	0.876	0.365	0.912	-0.304
CCP						1.000	-0.360	0.941	0.280	0.933	-0.166
FCY							1.000	-0.364	-0.066	-0.511	-0.026
CCY								1.000	0.255	0.800	-0.110
RAIN									1.000	0.314	-0.561
FERT										1.000	-0.166
SEED											1.000

Eastern Tarai

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.999	0.816	0.689	0.689	0.893	0.508	0.812	0.143	0.886	0.545
LAB		1.000	0.807	0.688	0.679	0.890	0.410	0.811	0.146	0.883	0.542
FCA			1.000	0.568	0.823	0.755	0.607	0.696	0.203	0.713	0.486
CCA				1.000	0.610	0.642	0.538	0.312	0.125	0.623	0.164
FCP					1.000	0.787	0.950	0.637	0.558	0.792	0.383
CCP						1.000	0.669	0.920	0.230	0.954	0.618
FCY							1.000	0.491	0.690	0.699	0.250
CCY								1.000	0.172	0.863	0.711
RAIN									1.000	0.213	-0.025
FERT										1.000	0.618
SEED											1.000

Central Tarai

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.998	0.784	0.753	0.773	0.895	0.682	0.810	-0.231	0.955	0.156
LAB		1.000	0.801	0.721	0.753	0.877	0.655	0.811	-0.212	0.938	0.185
FCA			1.000	0.322	0.606	0.574	0.439	0.617	-0.077	0.683	0.279
CCA				1.000	0.650	0.753	0.656	0.462	-0.290	0.810	-0.138
FCP					1.000	0.703	0.980	0.562	0.094	0.832	-0.303
CCP						1.000	0.656	0.925	-0.323	0.906	0.229
FCY							1.000	0.486	0.131	0.772	-0.405
CCY								1.000	-0.275	0.767	0.443
RAIN									1.000	-0.228	-0.174
FERT										1.000	0.043
SEED											1.000

Western Tarai

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.999	0.532	0.683	0.681	0.875	0.534	0.840	-0.106	0.949	0.456
LAB		1.000	0.554	0.685	0.669	0.865	0.514	0.831	-0.118	0.939	0.472
FCA			1.000	0.556	0.291	0.304	-0.033	0.230	-0.176	0.283	0.580
CCA				1.000	0.414	0.670	0.246	0.458	-0.036	0.584	0.295
FCP					1.000	0.798	0.947	0.947	0.499	0.746	0.052
CCP						1.000	0.651	0.961	0.087	0.918	0.403
FCY							1.000	0.669	0.579	0.686	-0.136
CCY								1.000	0.080	0.907	0.460
RAIN									1.000	1.728	-0.419
FERT										1.000	-0.319
SEED											1.000

Mid-West Tarai

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.998	0.751	0.930	0.648	0.810	0.466	0.289	0.150	0.906	-0.111
LAB		1.000	0.724	0.918	0.615	0.802	0.436	0.291	0.142	0.883	-0.096
FCA			1.000	0.735	0.870	0.744	0.642	0.379	0.288	0.890	-0.066
CCA				1.000	0.734	0.834	0.610	0.246	0.284	0.909	-0.252
FCP					1.000	0.806	0.934	0.511	0.552	0.825	-0.234
CCP						1.000	0.721	0.737	0.458	0.807	-0.393
FCY							1.000	0.530	0.677	0.631	-0.314
CCY								1.000	0.490	0.288	-0.404
RAIN									1.000	0.175	-0.307
FERT										1.000	-0.169
SEED											1.000

Far-West Tarai

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.999	0.964	0.906	0.818	0.826	0.383	0.769	0.199	0.872	0.245
LAB		1.000	0.955	0.903	0.801	0.807	0.365	0.746	0.190	0.854	0.243
FCA			1.000	0.945	0.868	0.885	0.443	0.828	0.263	0.917	0.213
CCA				1.000	0.852	0.886	0.473	0.789	0.268	0.842	0.226
FCP					1.000	0.922	0.822	0.906	0.446	0.868	-0.048
CCP						1.000	0.635	0.978	0.272	0.934	0.093
FCY							1.000	0.674	0.563	0.513	-0.384
CCY								1.000	0.250	0.925	0.013
RAIN									1.000	0.231	-0.327
FERT										1.000	0.234
SEED											1.000

Tarai total

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.999	0.904	0.891	0.777	0.891	0.619	0.863	0.077	0.937	0.486
LAB		1.000	0.902	0.881	0.761	0.879	0.599	0.855	0.068	0.926	0.489
FCA			1.000	0.741	0.781	0.803	0.587	0.807	0.223	0.816	0.518
CCA				1.000	0.758	0.891	0.660	0.788	0.244	0.895	0.337
FCP					1.000	0.831	0.963	0.776	0.508	0.861	0.187
CCP						1.000	0.725	0.976	0.212	0.937	0.526
FCY							1.000	0.652	0.576	0.762	0.011
CCY								1.000	0.155	0.888	0.609
RAIN									1.000	0.129	-0.154
FERT										1.000	0.445
SEED											1.000

Nepal

	POP	LAB	FCA	CCA	FCP	CCP	FCY	CCY	RAIN	FERT	SEED
POP	1.000	0.999	0.955	0.882	0.815	0.895	0.149	0.872	0.067	0.947	0.454
LAB		1.000	0.940	0.863	0.790	0.877	0.117	0.861	0.057	0.932	0.459
FCA			1.000	0.938	0.910	0.944	0.298	0.888	0.167	0.968	0.364
CCA				1.000	0.860	0.910	0.283	0.792	0.135	0.917	0.288
FCP					1.000	0.920	0.663	0.858	0.412	0.911	0.214
CCP						1.000	0.396	0.968	0.128	0.956	0.466
FCY							1.000	0.352	0.691	0.337	-0.215
CCY								1.000	0.089	0.909	0.558
RAIN									1.000	0.117	-0.290
FERT										1.000	0.456
SEED											1.000

Note:

POP	= Number of population
LAB	= Number of agricultural labour force
FCA	= Food crop area
CCA	= Cash crop area
FCP	= Food crop production
CCP	= Cash crop production
FCY	= Food crop yield
CCY	= Cash crop yield
RAIN	= Volume of rainfall
FERT	= Chemical fertilizer
SEED	= Improved variety seed

Annex 2

Regression Parameters Estimated for Food Production by Region, 1971 - 1991

Dependent Variable:	Independent Variables,			N=21	Adjusted		
Food Production	Constant	Labour	Rainfall	Fertilizer	R^2	R^2	F
Eastern Mountain	0.078	1.049 ***	0.049 *	-0.029 **	0.957	0.949	124.73
	(0.076)	(10.094)	(1.669)	(2.233)			
Central Mountain	0.689	1.043 ***	0.035	-0.112 ***	0.786	0.748	20.78
	(0.498)	(7.355)	(0.757)	(5.225)			
Western Mountain	1.089	0.914 ***	-0.004	-0.004 ***	0.931	0.918	76.07
	(0.894)	(6.519)	(0.117)	(5.292)			
Mid-West Mountain	-0.024	1.041 ***	0.052 **	-0.084 ***	0.965	0.959	158.42
	(0.043)	(17.636)	(2.007)	(7.581)			
Far-West Mountain	0.390	0.995 ***	0.074 **	-0.044 ***	0.931	0.919	76.75
	(0.438)	(11.040)	(2.107)	(3.844)			
Mountains Total	1.786	0.911 ***	0.044 *	-0.058 ***	0.934	0.923	80.39
	(2.454)	(13.809)	(1.701)	(5.378)			
Eastern Hill	4.941	0.594 ***	0.204 ***	0.035 **	0.937	0.925	79.36
	(4.517)	(5.583)	(4.934)	(1.176)			
Central Hill	1.521	0.967 ***	0.066 *	-0.052	0.839	0.808	27.720
	(0.754)	(4.210)	(1.430)	(0.560)			
Western Hill	-1.839	1.409 ***	0.055	-0.355 ***	0.947	0.938	102.00
	(1.424)	(9.338)	(1.302)	(4.539)			
Mid-West Hill	4.792	0.626 ***	0.038	-0.015	0.808	0.774	23.77
	(2.668)	(3.436)	(0.445)	(0.240)			
Far-West Hill	-3.589	1.479 ***	-0.109 *	-0.244 ***	0.746	0.701	16.60
	(1.322)	(5.315)	(1.643)	(3.823)			

Hills Total	2.975	*** 0.889	0.049	-0.100	0.873	0.849	36.74
	(1.646)	(4.253)	(0.977)	(0.873)			
Eastern Tarai	-5.509	*** 1.440	*** 0.135	0.033	0.868	0.843	35.08
	(1.349)	(4.381)	(4.706)	(1.255)			
Central Tarai	15.216	-0.295	** 0.116	*** 0.235	0.671	0.613	11.54
	(1.366)	(0.334)	(2.217)	(3.852)			
Western Tarai	8.022	0.278	*** 0.210	*** 0.147	0.771	0.731	19.10
	(1.603)	(0.672)	(5.002)	(5.173)			
Mid-West Tarai	-6.547	*** 1.574	*** 0.160	0.010	0.842	0.814	30.17
	(1.491)	(4.122)	(3.837)	(0.324)			
Far-West Tarai	2.586	0.752	*** 0.225	0.093	0.783	0.742	19.24
	(0.429)	(1.307)	(2.749)	(0.892)			
Tarai Total	9.804	*** 0.229	*** 0.161	0.148	0.835	0.804	26.98
	(1.237)	(0.387)	(4.402)	(3.263)			
NEPAL	-5.673	*** 1.485	*** 0.120	-0.093	0.911	0.896	58.22
	(1.150)	(3.721)	(3.568)	(1.078)			

*** = Significant at 1 percent level
** = Significant at 5 percent level
* = Significant at 10 percent level

SELECTED REFERENCES

Ahmad, A. (1984), *Agricultural Stagnationa Under Population Pressure: The case of Bangladesh*, Vikas Publishing House, Delhi.

Brown, L.R. (1988), "Climatic Change and Food Outlook", *Populi*, Journal of UNFPA, Vol. 15, No. 15, P. 12-20.

Buserup, E. (1965), *Conditions of Agricultural Growth*, Aldine Publishing Co., Chicago.

Central Bureau of Statistics (1975), *Population Census 1971*, Vol. I, Vol. 3 Part I, CBS, Kathmandu.

---------- (1984), *Population Census 1981*, Vol. I, Parts I & V, CBS, Kathmandu.

---------- (1987), *Population Monograph of Nepal*, CBS, Kathmandu.

---------- (1991), *Population Census 1991, Priliminary Result*, CBS, Kathmandu.

Clark, C., (1977), *Population Growth and Land Use*, The MacMillan Press, London.

Dahal, D. R., (1983), *Poverty or Plenty: Innovative Response to Population Pressure in an Eastern Nepalese Hill Country*, Ph. D. Dissertation, University of Hawaii, Hawaii.

Das, K. M., (1973), "Population Pressure and Intensity of Cropping in the Kosi Area, Bihar", *Geographical Review of India*, Vol. 35 No. 4, P. 309-324.

Das, M. M., (1979), "Population Pressure and Intensity of Cropping in Assam (India)" *Geographical Review of India*, Vol. 41, No. 2, P. 105-114.

Economic and Social Commission for Asia and the Pacific, (1975 C), *Comparative Study of Population Growth and Agricultural Change, Case Study of India*, Asian Population Studies Series No. 23, ESCAP, Bangkok.

---------- (1975 D), *A Comparative Study of Population Growth and Agricultural Change, Case Study of Sri Lanka*, Asian Population Studies Series No. 23, ESCAP, Bangkok.

Eckhlom, E. P., (1976), *Losing Ground: Environmental Stress and World Food Prospect*, W. W. Norton and Company, New York.

Gill, G. J., (1991), *Towards the Development of Perspective Plan for Nepalese Agriculture*, HMG, Ministry of Agriculture/Winrock International, Kathmandu.

Grigg, D. B., (1981), *Population Growth and Agrarian Change*, Cambridge University Press, Cambridge.

Gurung, H., (1989), *Regional Patterns of Migration in Nepal*, Papers of the East-West Population Institute, No. 113, East-West Center, Hawaii.

Heady, E. O. and Dillon, J. L., (1961), *Agricultural Production Function*, Kalyani Publishers, Ludhiana.

HMG/DIR (1989), *Master Plan for Irrigation Development in Nepal*, Department of Irrigation, HMG, Nepal.

Huda, K. S., (1987), "Feeding Asia's Millions" *Populi*, Journal of UNFPA, Vol. 14, No. 3, P. 22-31.

Jodha, N.S., (1990), *Mountain Agriculture: Search for Sustainability*, Mountain Farming Series No. 2, ICIMOD, Kathmandu.

Land Resource Mapping Project, (1986), *Economic Report*, LRMP/HMG, Nepal.

Macfarlane, A., (1976), *Resource and Population, A Study of the Gurungs of Nepal*, Cambridge University Press, London.

Ministry of Agriculture, (1981), *Nepal's Experience in Hill Agricultural Development*, seminar proceedings, MOA, Kathmandu.

National Commission on Population, (1988), *Population and Development in Nepal*, NCP, Kathmandu.

National Planning Commission, (1977), *A Survey of Employment, Income Distribution and Consumption Patterns in Nepal*, NPC, Kathmandu.

Paudel, D.P., (1981), *Supply Response in Nepalese Agriculture*, Unpublished Master's Degree Thesis, T.U., Kathmandu.

Pingali, P. and Binswanger, H. P., (1988), "Population Density and Farming Systems: The Changing Locus of Innovations and Technical Change", Lee et al. (eds), *Population, Food and Rural Development*, Clarendon Press, Oxford.

Seddon, D., (1987), *Nepal: A State of Poverty*, Vikash Publishing House, Delhi.

United Nations, (1971), *Methods of Projecting the Economically Active Population*, Manual V, New York.

Upreti, B. P., (1983), *Disequilibrium of Mountain Ecosystem: The Case of Nepal*, paper presented on International Symposium on Mountain Population Pressure, Kathmandu.

Winrock International Institute for Agricultural Development, (1991), *Nepal Agricultural Research Study*, Winrock International, Kathmandu.