CONTRIBUTION OF INFRASTRUCTURES TO AGRICULTURAL GROWTH IN NEPAL

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INTRODUCTION

Issues

The relationship between the development of social and physical infrastructures and the rate of growth of agricultural production (Agri-GDP) is of great interest to decision makers and researchers. A knowledge of this relationship would help us to formulate a rational policy for the development of infrastructures and their spatial distribution with the objective of modernising the agricultural sector in Nepal. Since more than two thirds of the people in the remote and rural areas live in abject poverty, the results of this study will also provide appreciation of the larger contribution of the infrastructures in the over all socioeconomic development.

Planned Development Efforts

The past development plans have consistently accorded high priority to the development of infrastructures and the creation of institutions that would support economic expansion. First, the 1956-70 plans laid emphasis on (1) transport and communication and (2) industry. Second, during 1970-80 plans accorded priority to (1) agriculture and regional development and (2) transport and communication. Lastly, the 1980-97 plans returned to "basic needs" such as (1) agriculture and poverty alleviation and (2) social services. The above investment patterns by economic sectors, its regional allocation and building of institutions have in some way affected the process of growth of the agricultural output and its productivity. As a corollary, the infrastructures would redistribute the benefits of agricultural growth among the regions, districts and households.

Hypotheses and Objectives

The rates of agricultural growth are hypothesized to be high in those areas where the public investment on infrastructures is high. So, a decision to develop an area or leave it backward will be operational by

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discriminatory allocation of resources to develop the social-overhead capital. The specific objectives of the study have been to (1) estimate the trend growth rate of the agri-GDP, cultivated area and land productivity by district and (2) examine the relationship between the rates of agricultural growth and development of the social and physical infrastructures.

METHODOLOGY AND DATA

Growth Curves

The rate of growth of agri–GDP has been estimated by applying the geometric exponential function. This function gives discrete and compound growth rates, which are constant.

Growth Rate-Production Functions

The cause-effect relationship between the agricultural growth rates and the indices of infrastructures in some "q" function as specified below:

$$(G_1, G_2, G_3, P_1, P_2) = q\,(Z_1, Z_2, Z_3, Z_4, Z_5, Z_6, D_1, D_2)$$

Where,

G_1 = rate of growth of total agri. productivity, 1967/68-90/91
G_2 = rate of growth of total agri. productivity, 1985/86-90/91
G_3 = rate of growth of agri. GDP, during 1985/86-90/91
P_1 = agri. GDP per cultivated hectare, average of 1988/89–90/91
p_2 = agri. GDP per economically active rural labourer, 1988/89–90/91
Z_1 = irrigated area as percent of the cultivated area in 1988
Z_2 = agri. research and extension work force per 1,000 ha in 1990
Z_3 = educated labour force as percent of agri. labourer in 1981
Z_4 = motorable road length per 100 sq. km of the area in 1989
Z_5 = transport and communication scores in 1976/77
Z_6 = industrial capital formation per capita in 1986/87
D_1 = "1" if cropped area *growth* rate is 5% or more; otherwise, "O"
D_2 = "1" if cropped area *declined* by 1% or more; otherwise, "O".

DATA

Agricultural Production and Productivity

The Central Bureau of Statistics' estimates of producers' national average farm gate prices at 1976/77 levels were used to aggregate the agricultural commodities by districts (CBS 1984). From 1967/68 onwards, the then Department of Food and Agricultural Marketing Services (DFAMS) published the district-wise estimates of area, yield and production of food grains (paddy, maize, wheat, millet, barley), cash crops (potato, mustard, jute, sugarcane and tobacco). Also included were the data on the production of

the following commodities for the 1985/86-90/91 period: (1) meat (buffalo, goat, ship, chicken, duck and pork), milk (buffalo, cow and goat), eggs (hen and duck) and wool; (2) fish (extrapolated backward on a prorate basis for 1985/ 86 and 1986/87); (3) pulses (lentil, chick pea, pigeon pea, black gram, grass pea, horse gram and soyabean); (4) tea; and (5) cotton. Finally, production of the fruits and vegetables for 1989/90 are from the Horticultural Master Plan. Production of ginger for 1989/90 was obtained from the project office.

The ratio of the DFAMS's cropped area to the NPC's cultivated area (for 1990) gives an estimate of the aggregate cropping intensity, and the level of productivity (NRs/hectare) or the rate of its growth refers to the ratio of agri-GDP per unit of cropped area.

Infrastructures

Irrigation, the agricultural research/extension network and the educated labour force increase agriculture's supply capacity. Industrial capital formation, road density and the transport/communication network increase the farm products' demand, which in turn contributes to increasing the rate of growth in agri-GDP. Construction of indices of growth of infrastructures is a complicated work. First, comparable time-series data on the physical and social infrastructures at the district level do not exist. Second, infrastructure variables are too heterogenous to make a single composite index. Nevertheless, we attempted to construct the following sector-specific six indices of infrastructures.

Irrigated Area (IRA)

The government has been spending over one-half of the agricultural sector's total budget allocation to develop irrigation facilities. Data on development of irrigation for 1988 are based on the Irrigation Master Plan (HMG/UNDP/IBRD:1990). Irrigated area as percent of cultivated area in 1990 gives a physical measure of capability to harness water resources to increase the productivity of land and labour.

Research and Extension Manpower (REMP)

The agricultural extension network by districts as of 1990 is represented by the total number of extension officers (EXO), Junior Technicians (JT) and Junior Technical Assistant (JTA) who deal with crops, horticulture, livestock, fishery, jute, cotton and tea.

For quantifying a combined index of the agricultural research and development (R & D) net-work by district, we first apportioned the class-3 and some class-2 agricultural research officers of the R & D farms as the

research manpower stationed in the district where the particular R & D farm is situated. This accounts for about fifty percent of the R & D manpower in the agricultural farms and stations. Second, the "district level" R & D manpower in one district also has "externality or spill-over" benefits to the adjoining districts. We hopefully internalized this effect in other district(s) by reallocating some district level R & D manpower to the neighbouring district (s) in proportion to the R & D programmes launched by any R & D farm to the other districts.

The relative importance of different levels of technical manpower for the growth of agriculture is assumed to have a linear relationship with their educational levels. Therefore, we took a five-year graduate (e.g., B.Sc., B.V.Sc. or B. Tech.) as a common denominator, and synthesized a weighted REMP as follows:

REMP = 0.7 * JTA + 0.8 * JT + 1.07 * EXM + 1.13 * ROM

REMP per 1,000 cultivated hectare by district gives a measure of the intensity of agricultural research and extension infrastructure that would boost up the rate of growth of agriculture.

Educated Labour Force (ELF)

Education embodies certain skills that contribute to productive tasks. The government spends around 4.79 percent of its annual budget in education, and in addition, people spend around 2.04 percent of household expenditures for education.

Population Census-1981 provides information about the educated manpower in agriculture in six categories: (1) educated without schooling (WS); (2) below secondary (BS); (3) SLC or equivalent; (4) intermediate (IM); (5) graduate (G); and (6) post-graduate (PG). To construct a weighted sum of educated labour force (ELF) in agriculture, we assigned a unit weight to the secondary level of education and then adopted a system of weight proportional to the number of years of schooling as follows:

ELF = 1.6*PG + 1.4+G + 1.+IM + 1.0*SLC + 0.5*BS + 0.25*WS

A rise in the ratio of ELF to the economically active population in the agricultural sector (which is roughly equivalent to the rural sector) would contribute to higher levels of productivity and a faster rate of economic growth.

Roads Density Index (RDI):

The extent of the road network reflects the degree of spatial integration of an economy. The Department of Roads published statistics on the length of blacktop road (BR), gravelled road (GR) and earthen road (ER) as of mid-1989 by district for the first time in 1991. We made a weighed road density index

(RDI) as follows:

RDI = Sum (1.0 * BTR + 0.3 * GR + 0.1 * ER)/ Area by District.

The higher weights for the better roads reflect their effectiveness and durability. As of mid-1989 a motorable road of some kind had touched 53 out of 75 districts.

Transport and Communication Score (TCS)

In order to develop a measure of the mobility of goods and people and the interaction of ideas and exchange of messages among the people, the National Council for Science and Technology (NCST) had prepared transportation scores for 48 districts and communication scores for all 75 districts in 1976/77. The transportation score (TS) reflected (1) domestic air passenger movement and (2) road accessibility. The communication score (CS) represented (1) money orders and (2) various postal parameters (e.g. density by population and area and the volume of mail and like). NCST had included more variable in computing the CS than the TS. Thus the CS was 2.25 times more inflated than the TS. To obtain a weighted TCI, we assigned here a higher weight to the TS than the CS. This had two objectives, namely: (a) to deflate the already overblown CS, and (b) to accord higher weight to TS as:

TCS = 0.9 * TS + 0.1 * CS

The higher weight assigned to the transportation scores and lower weight to the communication scores reflect the higher importance of transportation for the Nepalese agriculture which is of high-weight-low-value-type.

Industrial Capital Accumulation (ICA)

Industry contributes to agricultural growth through the inter-industry input-output linkage as well as by providing an urban market for the farm products. Based on the 1986/87 Manufacturing Census by districts conducted by CBS, we have:

ICA/Capita = Manufacturing & grain-mills assets/Population

RESULTS

Trend of National Income and Trend of Agri-GDP per Capita

Rates of growth of GDP, non-agri-GDP and agri-GDP during the 1964/65-90/91 have been accelerating. Since the non-agri-GDP also depends on agri-GDP, the performance of the farming sector and the latter's determinants will have propound economic and social welfare effects in different regions and to different people. The pattern of agricultural growth shows that (1) the productivity of the food grains and cash crops is declining in the mountains and hills; and (2) even after we lumped together the food grains and cash

crops, livestock products, fishery, fruits, vegetables, pulses, tea, cardamom and cotton, it is found that the growth rate of agricultural productivity in the mountains and hills is barely half of that in the Terai (Table 1 & 2).

Table 1: Compound Rates of Growth of GDP, Sectoral-GDPs, Population and Income per Capita by Economic Stages, 1964/65-90/91

Sector & Stage	Growth Rate (%/year)	R^2
Population	2.38	0.99
GDP	3.66	0.98
o/w NAGDP	4.60	0.96
AGDP	3.12	0.95
GDP Growth:		
1964/65–73/74	1.84	0.90
1974/75–82/83	2.75	0.92
1983/84–90/91	4.74	0.99
Agri-GDP Growth:		
1964/65–73/74	1.63	0.78
1974/75–82/83	1.17	0.39
1983/84–90/91	5.17	0.97

Table 2: Rate of Growth of Agri. GDP (Q), Farm Productivity (P) and Population by Development Blocks in two Phases 1967/68–90/91.

	Agri-GDP (Q) and Productivity (P)				Population Growth	
	1967/68–90/91		1985/86–90/91		1971–91	1981–91
Region	Q	P	Q	p	I	II
Mountain	1.95	–0.25	5.77	1.70	1.20	1.04
Hill	2.68	–0.94	7.84	2.90	1.64	1.62
Terai	2.16	1.13	7.31	4.16	3.48	2.76
Nepal	2.35	0.32	7.42	3.73	2.37	2.08

2. Inter-Correlation among Infrastructures

The correlation between the agricultural research cum extension and industrialisation is highest (0.53), followed by the correlation between education and transportation cum communication, (0.50) and the correlation between roads and irrigation (0.46) (refer table 3). Surprisingly, agricultural research cum extension and irrigation do not go hand in hand. As noted later,

the multiple correlation between the rates of agricultural growth and the explanatory variables is more than the inter-correlation among the latter.

Table 3: Correlation Matrix Among Infrastructure Variable

Variable	Irrigation	Education	Research/ Extn	Roads	Industry	Comntn & Transptn
Irrigation	1.00	0.38	–0.10	0.26	0.38	0.60
Education		1.00	0.09	0.46	0.37	0.50
Research & Extn.			1.00	0.17	0.53	–0.00
Road				1.00	0.31	0.40
Industrialization					1.00	0.39
Communication & Transportation						1.00

District-wise Rates of Growth of Agri-GDP and Productivity

The rate of growth of the combined productivity of food grains and cash crops is the main dependent variable. The results show that in 50 out of 75 districts, the rates of growth of the food grains and cash crops are negative or nil (Table 4 and 5).

Table 4: Relativ Distribution of Rates of Cereals and Cash Crops Productivity, 1967/68-90/91

Range of Growth Rate	No. of Districts	Percentage
Below –2.0	2	2.7
–2.0 to –1.5	5	6.7
–1.5 to –1.0	20	26.7
–1.0 to –0.5	14	18.7
–0.5 to 0.0	3	4.0
0.0 to 0.5	10	13.0
0.5 to 1.0	10	13.3
1.0 to 1.5	3	4.0
1.5 to 2.0	4	5.3
2.0 to 2.5	3	4.0
above 2.5	1	1.3
Total	75	100.0

The data on the agricultural production for 1967/68–90/91 cover 10-crops: paddy, maize, wheat, millet, barley, sugarcane, jute, tobacco, oil seeds and potato. If we subtract the productivity growth rates from the corresponding rates of growth of the total agricultural outputs by district, we can obtain the rates of growth of the cropped area by district (not shown here). Further, if we subtract the rates of the growth of population by district during the 1971 to 1991 period (which are published by the Central Bureau of Statistics) from the total agricultural output growth, we can also obtain the rates of growth of agricultural income per capital by district. Such data will be very useful for district level planning purposes.

The agricultural growth rates for 1967/68–90/91 cannot be used as the dependent variable in the regression analysis because (1) many revisions in the cultivated area during the past twenty-five years make it difficult to isolate the systematic relationship between the, variations in the agricultural growth rates and the variation in the indices of the infrastructure variables; and (2) the data about the area under production and production of the cereals and cash crops alone are available at the district level from 1967/68 onwards.

The agricultural GDP for 1985/86–90/91 covers 18 products: five cereals and five cash crops (mentioned in the preceding paragraphs), pulses, meat, milk, egg, wool, fish, tea and cotton.

Relationship between Agri. Growth and Infrastructure Network
Productivity Growth-Production Function in the Long-run

Under a simple linear model, infrastructure variables explained as much as 62.9 percent of variations in the combined rate of growth of food grains and cash crops (Table 6). The coefficient of determination (R^2) is much greater than any of the partial inter-correlations among the explanatory variables (table 3). The Cobb-Douglas production function gave a little lower but good R^2 equal to 0.5243. That is, the relationship between the rate of growth of agricultural productivity and the level of development of the infrastructure net-works is straightforward, linear and significant.

Infrastructures that increase the rates of the growth of agricultural productivity in the long term are (a) agricultural research and extension manpower, (b) road density, and (c) irrigated area. This relation underlines the priority with which to develop such facilities in those areas where the agricultural productivity is declining and the food security is at risk.

Agricultural productivity has, unfortunately, a negative relation with the stock of educated labour force (i.e., human capital) irrespective of whether we consider mass education as percentage of the agricultural labour force or on a per hectare basis. This might be a reflection of a historical syndrome characterized by the following:

(1) Most people do not regard agriculture as an enterprise, though it is a way of life of the "low class" people and a source of rent for the absentee landlords.
(2) Education itself might have very little skill content in it.

Table 5: Rates of Growth of Agri–GDP, Productivity and Area by District and Region in Two Stages During 1967/68–90/91 (**)

	District	1967/68-90/91		1985/86-90/91	
		Agri – GDP	Yield	Agri– GDP	1985/86-90/91 Yield
1.	Taplejung	1.53	–0.69	11.26	–1.32#
2.	Shankuwasawa	5.66	–0.19	7.10	3.06
3.	Solukhumbu	0.58	0.32	11.65	–0.46#
4.	Panchthar	4.50	–0.77	2.86	1.37
5.	Ilam	3.56	–0.91	8.96	8.85
6.	Tehrathum	3.23	–1.48	2.57#	4.04
7.	Dhankuta	3.49	–1.46	2.88	3.70
8.	Bhojpur	2.00	–1.16	8.51	1.52#
9.	Khotang	3.87	–2.06	14.74	–5.50#
10.	OkhaIdhunga	0.37	–1.23	5.11	–1.66
11.	Udyapur	0.07	–0.59	5.35	3.44
12.	Jhapa	1.48	0.47	10.80	10.07
13.	Morang	1.51#	1.18	5.55	4.34
14.	Sunsari	2.83	1.79	6.22	3.32
15.	Saptari	1.13	0.23#	5.3#	5.71
16.	Siraha	1.41	0.55	7.74	6.43
17.	Dolakha	2.78	–0.65	3.00	2.76
18.	Sindhupalchok	1.41	0.06#	7.03	5.00
19.	Rasuwa	6.34	2.01	6.10	1.42#
21.	Ramechhap	2.16	–1.47	4.48	4.67
22.	Sindhuli	2.49	–0.15#	10.28	3.45
23.	Kavre	4.21	–0.08#	13.24	11.32
24.	Bhaktapur	1.27	2.07	4.57	6.46
25.	Lalitpur	–1.03	0.63	7.59	8.25
26.	Kathmandu	–0.05	1.20	5.20	9.72
27.	Nuwakot	4.40	–0.27	6.98	1.97
28.	Dhading	4.76	–0.83	4.80	–5.27#
29.	Makwanpur	1.72	0.32#	8.65	5.81

30.	Dhanusha	1.16	0.98	7.17	6.60
31.	Mahotari	0.67	0.95	7.02	6.92
32.	Sarlahi	3.92	1.61	4.32	5.56
33.	Rautahat	0.16	0.58	3.57	6.08
34.	Bara	4.83	3.10	6.64	5.26
35.	Parsa	4.71	2.43	1.26#	–0.41#
35.	Chitwan	1.25	0.45	5.38	5.24
36.	Manag	0.23	1.80	0.65#	2.18#
38.	Mustang	0.12	0.18#	3.72	3.46
39.	Gorkha	4.74	–1.30	7.46	3.66
40.	Lamjung	3.49	–1.21	8.75	2.39
41.	Tanahu	3.80	–1.14	6.34	5.63
42.	Kaski	2.24	–1.10	7.04	4.67
43.	Parbat	3.37	–1.16	14.64	–5.01
44.	Syangja	4.11	–0.99	12.02	–3.99
45.	Palpa	3.63	–1.17	2.55#	4.59
46.	Myagdi	0.93#	–1.12	9.83	5.69
47.	Baglung	2.52	–1.09	7.03	0.81#
48.	Gulmi	1.72	–2.42	6.61	0.87#
49.	Arghakhanchi	1.98	–1.34	8.58	–3.71
50.	Nawalparasi	2.66#	1.90	5.26	3.21
51.	Rupandehi	1.86	1.21	3.26	3.47
52.	Kapilvastu	1.23	0.33#	2.63#	3.66#
53.	Dolpa	–0.41	–1.78	0.63	–7.71
54.	Mugu	0.18	–1.23	2.20	0.67#
55.	Humla	–0.64	0.64	2.24#	5.49
56.	Jumla	0.09	–0.71	3.61	3.91
57.	Kalikot	0.28	–0.86	6.58	–0.46#
58.	Rukum	5.88	–0.91#	29.62	9.15
59.	Rolpa	4.62	–1.15	8.50	–2.37
60.	Pyuthan	1.37	–1.57	6.49	6.16
61.	Salyan	2.99	–1.98	8.09	–0.45#
62.	Jajarkot	0.86	–1.87	6.79	2.25
63.	Dailekh	1.39	–1.31	8.02	–0.05#
64.	Surkhet	5.63	–1.29	6.72	4.50

65.	Dang	2.78	–0.35	6.04	3.88
66.	Banke	1.13#	0.81	12.21	8.00
67.	Bardiya	1.20	0.91	8.37	0.86#
68.	Bajura	0.09	–0.90	–0.69#	–4.37#
69.	Bajhang	0.09	–0.94	8.61	0.27#
70.	Darchula	3.16	–1.24	2.56	2.93
71.	Achham	1.30	–0.82	7.51	0.76#
72.	Doti	0.83	–1.58	3.03	3.13
73.	Baitadi	1.00	1.21	8.01	–1.07#
74.	Dadeldhura	2.09	–0.89	8.34	7.15
75.	Kailali	2.61	0.64	10.58	5.03
76.	Kanchanpur	6.27#	0.85	9.04	3.35#

Note: # is equivalent to Zero at 90 percent level of confidence.

Table 6: Infrastructure Variables as the Determinants of the Rates of Growth of Total Productivity of Food Grains and Cash Crops (1967/68–90/91)

Variable (*)	Linear Equation		Log-linear Equation	
	Coefficient	T-Static	Coefficient	T-Static
Communication	0.00278	0.945	0.00250	1.933
Research & Extn.	0.05813	2.846	0.00361	2.815
Road	0.02822	3.446	0.00031	1.682
Educated Labour	–0.13439	–3.658	–0.01060	–3.107
Irrigation	0.04064	7.079	0.00813	4.999
Industrialization	–0.00011	–0.364	0.00045	1.433
Constant	–0.76157	–2.594	–0.00757	–2.130
R Square	0.62902		0.52428	
Standard Error	0.77161		0.00379	
F - Statistics	19.21637		12.49042	

* Capital assets in the manufacturing and grain mill sub-sectors as separate variables did not turn significant in the model.

(3) Educated people might be lacking a work ethic or respect for dignity of work.

(4) Educated labourers and managers might be in over-supply in relation to other factors of production, which leads to an appropriate input-mix.

Likewise, the farm productivity growth rates do not show any relationship with the accumulation of capital in the manufacturing and the grain mill sub-sectors taken together or separately.

Output and Productivity Growth-Production Function in Short-run Output

The predicted intercept of the 1985/86-90/91 agri-GDP annual-growth-rate-production curve is 5.06 percent for the year 1985/86, which will be shifted upwards by the land-augmenting technologies or scaled downwards by the land-consuming developments (table 7). A strategy to augment cropping intensity will pay off by increasing the annual rate of growth of farm output. For example,the dummy variable for the growth of cropped area can boost the farm output growth rate by 2.09 percent points; the annual rate of growth of agri-GDP will be 5.06 percent *plus* 2.09 percent equals 7.15 percent.

Conversely, the expansion of urban settlement into the farming area would prune the rate of growth of output by 3.28 points; the intercept of the output growth curve will be 5.06 *minus* 3.28 equals 1.78 percent per year. Capital accumulation in the manufacturing and grain mills sectors contributes to the rate of growth of agri-GDP, but ironically the agricultural research and extension manpower do not show a significant relationship with it.

Table 7: Results of Regression of Agri. GDP Growth Rates (1985/86-90/91) against the Infrastructure Variables

Variable	Log-linear Equation		Linear Equation	
	Coefficient	T-Static	Coefficient	T-Static
Urban Expansion	–0.01176	–2.078	–3.27952	–1.970
Research & Extn.	–0.00462	–0.873	–0.14851	–1.428
Industrialization	0.00256	2.093	0.00126	0.851
Cropped Area Growth	0.01255	2.932	2.89014	2.716
Communication/Trnsp.	0.00375	0.752	0.01402	0.951
Education	0.00280	0.210	0.12775	0.691
Irrigation	–0.00072	–0.109	–0.01792	–0.598
Roads	–0.00047	–0.635	0.00968	0.211
Constant	0.01541	1.102	5.05841	3.242
R Square	0.29933	0.24452		
Standard Error	0.01454	3.85165		
F Statics	3.52452	2.67026		

Productivity

Road and irrigation profoundly increase the annual rates of growth of productivity, even during the short run (table 8). The stock of capital assets in the manufacturing and grain-mill sub-sectors increased the agri-GDP growth rate, but it did not contribute to the growth of productivity. Industry might have led to growth in the extensive farming but not intensive one.

Land and Labour Productivity Functions

Higher levels of agri-GDP per hectare and agri-GDP per labourer at a particular point may contribute to higher rates of growth of productivity, at least over the medium period. Agricultural research and extension, educated labour force, irrigated area, industrial development and motorable road density increase the productivity of land (table 9). Industry and roads also increase the productivity of farm labour.

Table 8: Determinants of Productivity Growth Rates 1985/86-90/91

Variable	Coefficient	T-Static
Communication & transp.	0.01314	0.956
Research & Extn.	0.06945	0.738
Roads	0.03925	1.038
Education	0.10424	0.617
Irrigation	0.04493	1.700
Industrialization	0.000002	0.166
Constant	–0.36656	–0.270
R Square	0.23702	
Standard Error	3.55073	
F - Statistics	3.46891	

Table 9: Regression of the Agri-GDP per Hectare and Agri–GDP per Labourer (1988/89-90/91 Average) (Cobb-Douglas production function)

Variable	Agri–GDP per Hectare		Agri– GDP per Labourer	
	Coefficient	T-Value	Coefficient	T–Value
Comnctn/Transp.	–0.02477	–0.412	0.04348	0.668
Research & Extn.	0.24135	4.050	–0.04888	–0.758
Roads	0.01527	1.758	0.01619	1.723
Education	0.18116	1.143	0.10446	1.609
Irrigation	0.12615	1.669	0.13907	1.701
Industry	0.02543	1.740	0.02188	1.385
Constant	3.35505	20.300	–0.04824	–0.270
R Square	0.38297		0.37304	
Standard Error	0.17615		0.19051	
F - Statistics	7.03425		6.74334	

Human capital such as the educated labour force and agricultural research and extension manpower are found more effective in increasing the land productivity. The Increased income from such sources may largely follow the distribution of land. Irrigation and industrialization are found to be more effective in increasing the labour productivity. The latter might make direct contribution to the wage earners' welfare.

Summary and Conclusion

The present study examined the agricultural growth by region and district and the contribution of infrastructures in increasing the rate of growth of agriculture.

The study concludes that a mismatched public investment in infrastructures is a key factor behind the lopsided agricultural growth. First, agricultural development is "dualistic". Agricultural growth in the prosperous regions and districts (producing cash crops and fine food grains) is high, whereas the agricultural situation in the backward districts (which have predominantly subsistence farming) is stagnant or declining. Obviously, this will exacerbate the inequitable growth of income of purchasing power, undermine food security, exacerbate regional disparity and discourage investment in the rural economy.

Second, the share of productivity in the 1967/68-90/91 rate of growth of food grains and cash crops in the Terai is 52 percent, but the decline in

productivity reduced the growth rates of food grains and cash crops by –12.8 percent in the mountains and by –35.1 percent in the hills.

Third, infrastructure variables (both social and physical) explain as much as 62.9 percent of variations in the rate of growth of agricultural productivity at the district level. Agricultural research and extension manpower, road density and irrigated area have increased the long-term (1967/68-90/91) agricultural productivity. Further development of these facilities, especially where productivity is declining, deserves priority.

Fourth. for the 1985/86-90/91 rate of growth of agri-GDP (which covers cereals, cash crops, pulses, livestock products and fish), the predicted intercept of the annual-output-growth-rate-curve is 5.06 percent. The dummy variable for cropped area growth rate has shifted up this intercept by 2.09 percentage points, while that for expansion of urban area has shifted-down the farm outputs' average growth rate by 3.28 percentage points. That is, any strategy to increase the cropping intensity will pay off by rapidly increasing the annual farm output growth rate, but the current unfolding of urban area in the fertile farm land is a self-defeating practice. Manufacturing and agro-processing mills contributed to increase the rate of growth of agri-GDP.

Fifth, agricultural research and extension, educated labour force, irrigated area, industrial development and roads increased the level of land productivity. Irrigation, industry and roads have increased the productivity of labour.

The Eighth Plan needs to strengthen the interrelationships among sub-sectors such as irrigation, roads, agricultural research/extension, education or manpower development as inputs for agricultural and rural development. The Plan concedes that the objective of irrigation is "to enhance the credibility of irrigation systems through improvement in management."

However, the Plan fails to specify that the irrigation supply bureaucracy would be efficient only if it is made accountable to the demand side, that is, the Department of Agriculture Development (DAD) and the farmers' cooperatives. Moreover, the Department of Irrigation (DOI) alone spends over one-half of the agricultural sector's total development budget, but the institution is held responsible to develop only 54.8 percent of the target of 293,895 hectares of irrigation (Which is very inefficient compared to the performance of the Agricultural Development Bank and non-governmental organisations (NGOs), which could develop nearly half of the irrigation facility at lesser cost per hectare). DOI's few large projects spread over a half dozen districts in the Terai to make up 67.3 percent of its irrigation targets! This approach will lead to development of a few pockets at high cost.

The plan also fails to bring up-front an integrated irrigation, energy and agriculture plan for implementation.

The Eighth Plan's road sector has good objectives of "promoting the complimentary relationship between various geographical and socio-economic sectors" and "linking farms with markets". However, the road sector programmes are biased towards the Terai and towns, and they lack emphasis on the regional growth axises, hinterland development and the life-support approaches for people in the remote areas.

On the supply of human capital, the Eighth Plan has accurately identified the education sector's objectives as "to make citizens aware, capable and productive" and "increase the internal efficiency of education sector and to raise the quality of education". However, a just and efficient education programme remains to be articulated. On the demand side, the socio economic institutions and planning methods are unable to employ the 650,000 jobless, make the 1,000,000 under-employed more productive, and use the additional 200,000 labour force added every year. Out of this nearly 2,600,000 work force in search of jobs, the planners aim to employ 1,400,000 work force.

Against the above prospects, the agricultural/rural research and development programmes need to concentrate on how the creative power of the 2.6 million extra workforce can be streamlined to develop agriculture, agro-forestry, agro-industry and rural infrastructures. Industry and trade sectors need to do more to strengthen their backward linkages with farming, energy and water resources development and forestry. To conclude, the physical and social infrastructures should be developed by according priority to the requirements of agriculture, and within it, the needs of the backward districts and backward sub-sectors.

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