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Productivity Trends in Nepalese Agriculture (1965/66 — 1986/87)

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INTRODUCTION

Agriculture still plays a leading role in the Nepalese economy in spite of a decline in its share in Gross Domestic Product from 69.7 percent in 1974/75 to 58.0 percent in 1987/88. This sector provides employment opportunity to 91.0 percent of total economically active population, and supplies about 80.0 percent of overall industrial raw materials. Realizing such important contributions of agriculture to the economy, the government of Nepal has been paying due attention to its development since the inception of planned development effort in 1956/57. Also, the current Seventh Plan (1985-90) has accorded overall priority to the development of this sector for the fulfilment of its three long term basic objectives: increase in production, increase in productive employment, and fulfilment of the minimum basic needs of the people. Thus, the national goal underlying the economic development of Nepal is still the agricultural development which could be materialized if there is large enough increase in agricultural productivity. Therefore, a study of productivity trends in the Nepalese agriculture seems relevant. The major thrust of this study is to examine the trends in productivity of principal food and cash crops for which long time series data are available.

The principal food crops are paddy, maize, wheat, millet and barley. Similarly, sugarcane, oilseeds, tobacco, jute and potato are regarded as the principal cash crops of Nepal. Based on the 1976/77 Gross Domestic Product, the Central Bureau of Statistics (CBS) of His Majesty's Government of Nepal (HMG/N) has determined the weight of these ten crops in the overall index of agricultural production. According to this estimate paddy is the most dominant crop among food crops. It accounts for 21.09 percent in the overall index. Paddy is followed by maize which contributes 10.25 percent. The shares of the rest three food crops, viz., wheat, millet and barley are 5.70, 3.42 and 0.57 percent respectively. Similarly, among the five cash crops, potato is the most dominant one which shares 3.42 percent. It is followed by oilseeds (2.28 percent) and then comes jute whose weight is half as much as that of oilseeds. The other two cash crops are sugarcane and tobacco; each of them contributes 0.57 percent in the overall index of agricultural production. On the whole, both the food and cash crops contribute 49.01 (41.03 + 7.98) percent in the total agricultural production. Thus, a study of productivity trends of these crops is of much significance.

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DATA AND METHODOLOGY

The Data

In trying to estimate the productivity trend one has to confront to following two methodological questions:

i) How productivity has been measured at different time points ?

ii) How to compute the productivity trend ?

The problem (ii) is discussed in the ensuing subsection. Besides, the problem (i) is essentially the same as the problem that occurs whenever one tries to have a single measure, comparable over time, for a collection of economic objects which do not lend themselves to measurement in any common physical unit. In economic statistics the problem belongs to the areas of aggregation and index numbering. Partly due to this fact and partly due to the unavailability of the data, the physical productivity of ten individual crops mentioned already has been taken into account. The physical productivity of these crops refers to their land productivity or yield per hectare.

Indeed, productivity trend can also be observed by the analysis of output of the crops. However, the use of productivity is justifiable for two reasons:

i) Generally crop output is derived from productivity (average yield per hectare) by multiplying the latter with total cultivated area under a crop in a specific year.

ii) Theoretically, productivity trend is amenable to linear or log-linear estimation, whereas the production trend is more properly depicted with simple or square root quadratic polynomials and other non-linear equations which are relatively difficult to compute as well as interpret.

The data required for this study is time series data. It is not possible to collect primary data with reasonable accuracy from the farmers directly for so many years past. Moreover, there will be serious underestimation in productivity data if it is collected by a private researcher. Therefore, one has to depend on the secondary data. The main source of agricultural production or productivity statistics in Nepal is estimates of area, production, and productivity of principal crops estimated yearly by the Department of Food and Agricultural Marketing Services (DFAMS), Ministry of Agriculture (MOA) of His Majesty's Government of Nepal (HMG/N). The methods by which these estimates are arrived at can be subjected to severe criticism. However, keeping aside this aspect of the problem as there is not any alternative, we have used its data for the period from 1965/66 to 1986/87. Besides the publications of DFAMS, the productivity data are also available in the publications of Central Bureau of Statistics (CBS), Ministry of Finance (MOF), and Nepal Rastra Bank (NRB), of His Majesty's Government of Nepal. But there are inconsistencies, largely due to printing mistakes, in the data published by these

agencies. Due to this problem, no attempt is made to tally the data of different publications. Thus, the productivity data of the ten principal food and cash crops for the period 1965/66 - 1981/82 have been extracted from the Agricultural Statistics of Nepal, 1983 published by DFAMS, and those for the rest period 1982/83 - 1986/87, which are not yet published by DFAMS, from the Economic Survey, 1988 published by MOF.

Method of Analysis

There are different methods/tools used for determining the trend of a time series. The most important ones are: (a) graph, (b) semi-average, (c) moving average, (d) measures of central tendency, and (e) trend equation. The former three methods actually indicate the nature or direction of the trend, but they do not specify the extent of the trend. Therefore, most research workers fit some forms of trend equation -- generally linear or loglinear -- and/or compute average of year-to-year change in time series neglecting the former three methods. Such a naive behaviour of research workers shows their unawareness about the wrong inference that could be inferred from the data. Indeed, graphs or averages of time series serve as a prelude to the choice and estimation of a mathematical trend equation(s). The use of a trend equation calls for a careful examination of the following questions:

i) Whether there is a trend that can be represented by a smooth mathematical function.

ii) How to devise a mathematical trend function in the presence of cyclical and/or seasonal movements in the time series.

iii) How to judge which function best represents the trend.

iv) How to decide if there is a break in the trend calling for fitting of two curves meeting at the point of break.

Keeping in view of the above observations, it seems that all of the methods mentioned above for determining trends are complementary to each other.

In this study major emphasis has been given on the estimation of the trend equation. Linear and semi-log models have been fitted at different stages of analysis. These two equations were chosen after a thorough scrutiny of the data by plotting them and by computing indices and moving averages. Ordinary least squares method has been applied to estimate the trend equations by assuming that the residuals, u'S, have a zero expectation, constant variance, and are uncorrelated. The additional assumption of normal distribution of residual is assumed for the purpose of statistical inference. To test the statistical significance of the trend coefficients of the equations, a two-tail t-test has been performed at 1 and 5 percent conventional levels of significance.

PRODUCTIVITY TRENDS

As an initial step of analysis of the productivity trends, productivity indices have been constructed based on fixed base method. The indices are calculated for each of ten crops and are separately presented for food crops and cash crops in Tables 1 and 2 respectively. These indices are based on the productivity data put in Appendix Tables A.1 and A.2. Moreover, these indices have also been plotted into graph, but the graphs are not put here to save the space.

The striking characteristic of the indices of food crops is that the base year index is larger than that of all other years for maize, millet and barley (Table 1). Thus, they at least do not indicate any possibility of upward trend in their productivity. In the rest two food crops, paddy productivity is higher in three years and that of wheat in five years compared to that of base year.

Table 1
Productivity Indices for Food Crops
(1965/66 = 100)

Year	Paddy	Maize	Wheat	Millet	Barley
1965/66	100.00	100.00	100.00	100.00	100.00
1966/67	91.96	96.32	101.60	100.00	100.00
1967/68	92.46	95.26	85.60	92.50	86.67
1968/69	93.97	95.26	89.60	93.33	86.67
1969/70	95.98	96.84	93.60	92.50	88.57
1970/71	97.99	98.42	68.00	94.17	87.62
1971/72	97.99	91.05	74.40	94.17	88.57
1972/73	88.44	97.37	96.00	92.50	87.62
1973/74	98.99	94.74	90.40	94.17	88.57
1974/75	99.50	95.26	91.20	93.33	88.57
1975/76	104.02	86.84	94.40	95.00	88.57
1976/77	94.97	94.21	83.20	94.17	79.05
1977/78	90.95	87.37	89.60	89.17	83.81
1978/79	92.96	86.32	93.60	90.00	82.86
1979/80	82.41	67.37	96.00	80.83	85.71
1980/81	96.98	85.79	97.60	83.33	81.90
1981/82	99.50	83.16	105.60	83.33	81.90
1982/83	72.86	74.21	108.80	78.33	83.81
1983/84	104.02	79.47	107.20	77.50	83.81
1984/85	98.99	74.74	94.40	77.50	81.90
1985/86	101.51	74.74	99.20	75.83	75.24
1986/87	89.45	72.63	104.80	75.83	81.90

Table 2
Productivity Indices for Cash Crops
(1965/66 = 100)

Year	Sugarcane	Oilseeds	Tobacco	Jute	Potato
1965/66	100.00	100.00	100.00	100.00	100.00
1966/67	100.72	105.56	61.06	99.17	104.49
1967/68	100.20	98.15	66.37	80.99	85.93
1968/69	100.20	98.15	67.26	77.69	86.38
1969/70	104.10	101.85	67.26	79.34	86.38
1970/71	106.64	96.30	67.26	79.34	83.83
1971/72	105.47	96.30	67.26	82.64	86.23
1972/73	107.42	98.15	67.26	84.30	85.48
1973/74	108.85	103.70	61.06	100.00	85.78
1974/75	107.68	107.41	62.83	100.00	85.63
1975/76	109.18	112.96	63.72	102.48	88.02
1976/77	112.63	105.56	65.49	92.56	77.10
1977/78	110.09	109.26	67.26	98.35	80.69
1978/79	109.51	118.52	63.72	120.66	82.34
1979/80	111.85	96.30	64.60	98.35	81.14
1980/81	130.34	116.67	67.26	94.21	84.73
1981/82	152.60	129.63	62.83	100.00	92.07
1982/83	157.88	116.67	69.03	105.79	94.31
1983/84	145.77	122.22	69.03	87.60	97.46
1984/85	152.08	122.22	66.37	100.83	95.96
1985/86	158.01	105.56	47.79	106.61	76.35
1986/87	160.68	107.41	49.56	97.52	79.94

The indices of cash crops are presented in Table 2. Sugarcane shows a clear upward trend, but the rest other crops do not yield a clear trend.

The indices presented above do not reflect the nature of the productivity trend of most of the crops. It, thus, indicates high variability in the productivity of the crops. Such a high variability is mainly attributed to uncertain monsoon. Since the monsoon is not uniform every year, there must be some seasonal (periodic) variations in the productivity. In order to make the secular movements more readily discernible, one should, therefore, minimize the consequences of seasonal changes or smooth out the seasonal fluctuations. Therefore, three-year moving averages have been taken to deseasonalize the time series data given in the Appendix A. These moving averages are presented in Tables 3 and 4 for food crops and cash crops respectively.

A Thorough perusal of Table 3 clearly indicates a downward trend in the productivity of maize, millet and barley. But the trend is not much discernible for paddy and wheat. As earlier sugarcane shows a clear upward trend among cash crops (Table 4). Besides, oilseeds and jute productivity indices express somewhat upward trend. But the index on tobacco produces a downward trend.

Table 3
Three-Year Moving Averages of Productivity of Food Crops
(Metric Tons)

Year	Paddy	Maize	Wheat	Millets	Barley
1966/67	1.89	1.85	1.20	1.17	1.00
1967/68	1.85	1.82	1.15	1.14	0.96
1968/69	1.87	1.82	1.12	1.11	0.92
1969/70	1.91	1.84	1.05	1.12	0.92
1970/71	1.94	1.81	0.98	1.12	0.93
1971/72	1.89	1.82	0.99	1.12	0.92
1972/73	1.89	1.79	1.09	1.12	0.93
1973/74	1.90	1.82	1.16	1.12	0.93
1974/75	2.01	1.75	1.15	1.13	0.93
1975/76	1.98	1.75	1.12	1.13	0.90
1976/77	1.92	1.70	1.11	1.11	0.88
1977/78	1.85	1.70	1.11	1.09	0.86
1978/79	1.77	1.53	1.16	1.04	0.88
1979/80	1.81	1.52	1.20	1.02	0.88
1980/81	1.85	1.50	1.25	0.99	0.87
1981/82	1.79	1.54	1.30	0.98	0.87
1982/83	1.83	1.50	1.34	0.96	0.87
1983/84	1.83	1.45	1.29	0.93	0.87
1984/85	2.02	1.45	1.25	0.92	0.84
1985/86	1.92	1.41	1.24	0.92	0.84

Table 4
Three-Year Moving Averages of Productivity of Cash Crops
(Metric Tons)

Year	Sugarcane	Oilseeds	Tobacco	Jute	Potato
1966/67	15.41	0.55	0.86	1.13	6.47
1967/68	15.42	0.54	0.73	1.04	6.16
1968/69	15.59	0.54	0.76	0.96	5.76
1969/70	15.92	0.53	0.76	0.95	5.71
1970/71	16.19	0.53	0.76	0.97	5.71
1971/72	16.36	0.52	0.76	0.99	5.69
1972/73	16.47	0.54	0.74	1.08	5.73
1973/74	16.59	0.56	0.72	1.15	5.72
1974/75	16.68	0.58	0.71	1.22	5.78
1975/76	16.87	0.59	0.72	1.19	5.58
1976/77	16.99	0.59	0.74	1.18	5.47
1977/78	17.01	0.60	0.74	1.26	5.35
1978/79	16.97	0.58	0.74	1.28	5.44
1979/80	18.01	0.60	0.74	1.26	5.53
1980/81	20.21	0.62	0.73	1.18	5.74
1981/82	22.57	0.65	0.75	1.21	6.04
1982/83	23.36	0.66	0.76	1.18	6.32
1983/84	23.33	0.65	0.77	1.19	6.41
1984/85	23.34	0.63	0.69	1.19	6.01
1985/86	24.10	0.60	0.62	1.23	5.62

Tables 1-4 give some hints on the nature of the different trends, but they do not specify the extent of the trends. With a view to knowing the extent of the productivity changes during the reference period (1965/66 - 1986/87) the following two, linear and semilog, trend equations have been estimated.

$$Y = A + Bt + u$$
$$\ln Y = a + bt + u$$

where,

y = crop yield per hectare (metric ton)
t = year (1965/66 as 1).

In the above equations the trend coefficient, B, of linear equation shows the annual change in productivity, but that of semilog equation, b, explains the annual change in natural log value of productivity. Thus, the latter one indicates a relative change in productivity with respect to an absolute change in the time period (year). Therefore, while the parameter B shows the amount of change in productivity, the parameter b shows the percentage change or growth rate of productivity.

Initially, these two trend equations have been run on unaveraged productivity data given in Appendix A. In Tables 5 and 6 are presented the results of the fits of the two curves for food crops. It is seen from both tables that there is very little to choose between the two functional forms if one were to go by goodness of fit indicated by the coefficient of determination, R^2. However, a comparison of the R^2's of the two tables shows that while linear equation fits better to maize, wheat and millet, the semilog equation fits to paddy and barley. But such a comparison is not beyond the doubt of exacting statisticians since the productivity data used for the two equations are measured on different scales. Thus, so long as the data stands on different footing for different equations, the choice of one functional form based solely on R^2 is not a judicious task. Moreover, there is not any great difference between the estimated corresponding results of the two equations. Except for paddy, the estimates of the trend coefficient of both equations are statistically significant for all food crops (Tables 5 and 6). They indicate a downward trend in the productivity of maize, millet and barley, but an upward trend for wheat. Thus, the linear equation for maize explains that the maize productivity has been decreasing by 25.2 kg. annually, whereas its corresponding semilog equation signifies that the productivity has been decreasing by 1.55 percent annually. The corresponding figures for millet and barley are 13.4 kg. and 7.3 kg. or 1.29 percent and 0.79 percent respectively. Thus, among the three food crops the largest decrease in productivity has been noticed for maize which occupies the second place among the food crops. On the other hand, wheat productivity tends to increase annually by 9.1 kg. (Table 5) or by 0.80 percent (Table 6).

Table 5
Estimated Linear Productivity Trend Equation for Food Crops
(1965/66 - 1986/87)

Food Crops	Estimated Equation	R^2
Paddy	Y = 1.9099 - 0.0020t (- 0.4088)	0.0083
Maize	Y = 1.9543 - 0.0252t (- 7.9865) *	0.7613
Wheat	Y = 1.0686 + 0.0091t (2.4029) **	0.2240
Millet	Y = 1.2162 - 0.0134t (- 10.2739) *	0.8407
Barley	Y = 0.9871 - 0.0073t (- 5.6728) *	0.6167

Figures in parentheses are t-value.
*Significant at or below 1 percent level.
**Significant at 5 percent level.

Table 6
Estimate Semilog Productivity Trend Equation for Food Crops
(1965/66 - 1986/87)

Food Crops	Estimated Equation	R^2
Paddy	ln Y = 0.6479 - 0.0014t (- 0.5024)	0.0125
Maize	ln Y = 0.6814 - 0.0155t (- 7.4485) *	0.7350
Wheat	ln Y = 0.0622 + 0.0080t (2.3049) **	0.2099
Millet	ln Y = 0.2044 - 0.0129t (-10.1254) *	0.8368
Barley	ln Y =-0.0125 - 0.0079t (- 5.7681) *	0.6246

Figures in parentheses are t-value.
* Significant at or below 1 percent level.
**Significant at 5 percent level.

Tables 7 and 8 come up with the results relating to five cash crops. As earlier, there is very little difference between the corresponding R^2's of the estimated two curves. On the whole, a careful scrutiny of the R^2's of the two curves presented in Tables 5 to 8 indicates that while linear curve fits better to food crops, semilog curve fits better to cash crops.

Among the five curves estimated for five cash crops, four curves have been found statistically significant both in case of linear and semilog models. The rest one for potato does not exhibit a statistically significant secular trend. Compared to food crops, the productivity trends for cash crops are found satisfactory. Sugarcane, oilseeds and jute demonstrate a statistically significant positive trend, but tobacco shows a negative trend. The per annum decrease in tobacco productivity is observed 8.3 kg. (Table 7) or 1.09 percent (Table 8). Among the three cash crops whose productivity is found to be significantly increasing, more spectacular has been the increase in sugarcane productivity (468.5 kg.). It exhibits 2.42 percent increase and the other two crops, viz., oilseeds and jute, show up with an increase of 0.89 percent (Table 8).

Table 7
Estimated Linear Productivity Trend Equation for Cash Crops
(1965/66 - 1986/87)

Cash Crops	Estimated Equation	R^2
Sugarcane	$Y = 13.1271 + 0.4685t$ (8.5930) *	0.7869
Oilseeds	$Y = 0.5208 + 0.0053t$ (3.8200) *	0.4218
Tobacco	$Y = 0.8373 - 0.0083t$ (-2.6232) **	0.2560
Jute	$Y = 1.0357 + 0.0098t$ (2.4924) **	0.2370
Potato	$Y = 6.0527 - 0.0193t$ (-1.1886)	0.0660

Figures in parentheses are t-value.
* Significant at or below 1 percent level.
**Significant at 5 percent level.

Table 8
Estimated Semilog Productivity Trend Equation for Cash Crops

Cash Crops	Estimated Equation	R^2
Sugarcane	$\ln Y = 2.6248 + 0.0242t$ (9.3247) *	0.8130
Oilseeds	$\ln Y = -0.6488 + 0.0089t$ (3.8592) *	0.4268
Tobacco	$\ln Y = -0.1825 - 0.0109t$ (- 2.7532) **	0.2748
Jute	$\ln Y = 0.0303 + 0.0089t$ (2.5880) **	0.2509
Potato	$\ln Y = 1.7978 - 0.0033t$ (- 1.2119)	0.0684

Figures in parentheses are t-value.
* Significant at or below 1 percent level.
**Significant at 5 percent level.

In order to obtain a more discernible secular trend in the crop productivity, the above least square linear and semilog trend lines have also been worked out on the three-year moving averages of the productivity already given in Tables 3 and 4. The results for food crops have been presented in Tables 9 and 10 and those for cash crops in Tables 11 and 12.

With regard to food crops, a comparison of the R^2 of Tables 9 and 10 with the corresponding R^2 of Tables 5 and 6, based on unaverage data, shows that the value of R^2 has been increased in all of the five food crops, but the significant improvement is notice only in maize, wheat and barley. Similarly, the R^2's of latter batch of equations have been improved for all cash crops except for potato (Tables 11 and 12 cf. Tables 7 and 8). The more noticeable ones are those of oilseeds and jute (Table 11 and 12). Moreover, the results presented in Tables 9-12 confirm the earlier results based on the unaveraged data (Tables 5-8).

Table 9
Estimated Linear Trend Equation for the Moving Averages of Productivity of Food Crops

Food Crops	Estimated Equation	R^2
Paddy	Y = 1.9013 - 0.0015t (- 0.5452)	0.0162
Maize	Y = 1.9370 - 0.0256t (-13.0143) *	0.9039
Wheat	Y = 1.0424 + 0.0115t (4.1119) *	0.4843
Millet	Y = 1.1979 - 0.0129t (-10.0057) *	0.8476
Barley	Y = 0.9665 - 0.0063t (- 9.4720) *	0.8329

Figures in parentheses are t-value.
*Significant at or below 1 percent level.

Table 10
Estimated Semilog Trend Equation for the Moving Averages of Productivity of Food Crops

Food Crops	Estimated Equation	R^2
Paddy	ln Y = 0.6425 - 0.0008t (- 0.5874)	0.0188
Maize	ln Y = 0.6712 - 0.0156t (-12.6176) *	0.8984
Wheat	ln Y = 0.0442 + 0.0098t (4.0050) *	0.4712
Millet	ln Y = 0.1882 - 0.0125t (-9.7756) *	0.8415
Barley	ln Y =-0.0329 - 0.0070t (-9.7590) *	0.8410

Figures in parentheses are t-value.
*Significant at or below 1 percent level.

Table 11
Estimated Linear Trend Equation for the Moving Averages of Productivity of Cash Crops

Cash Crops	Estimated Equation	R^2
Sugarcane	$Y = 13.3684 + 0.4746t$ (8.6535) *	0.8062
Oilseeds	$Y = 0.5149 + 0.0065t$ (7.7899) *	0.7712
Tobacco	$Y = 0.7815 - 0.0040t$ (-2.6939) **	0.2873
Jute	$Y = 1.0057 + 0.0130t$ (4.4517) *	0.5240
Potato	$Y = 5.8210 - 0.0009t$ (-0.0670)	0.0002

Figures in parentheses are t-value.
* Significant at or below 1 percent.
**Significant at 5 percent level.

Table 12
Estimated Semilog Trend Equation for the Moving Averages of Productivity of Cash Crops

Cash Crops	Estimated Equation	R^2
Sugarcane	$\ln Y = 2.6379 + 0.0248t$ (9.4478) *	0.8322
Oilseeds	$\ln Y = -0.6587 + 0.0111t$ (7.8943) *	0.7759
Tobacco	$\ln Y = -0.2459 - 0.0054t$ (- 2.6987) **	0.2881
Jute	$\ln Y = 0.0049 + 0.0118t$ (4.4320) *	0.5218
Potato	$\ln Y = 1.7603 - 0.0002t$ (- 0.0787)	0.0003

Figures in parentheses are t-value.
* Significant at or below 1 percent level.
**Significant at 5 percent level.

A comparison of the results of trend equations based on averaged and unaveraged data has shown a high variability in the productivity of some crops. For ascertaining whether the trends themselves have been changing, we have estimated, to begin with, trend rate of growth for whole period and later for shorter periods omitting every time two years from the previous series. Such calculations of trend rate of growth are based on the estimation of semilog model on the moving averages of productivity given in Tables 3 and 4.

Table 13 embodies the growth rate for food crops. A simple eye observation reveals that the absolute value of growth rate is increasing in the majority of food crops in later years. For example, when the base is shifted from 1966/67 to 1968/69 the annual trend rate of growth works out to - 1.73 percent for maize, 1.41 percent for wheat, and - 1.35 percent for millet. Moreover, the absolute value of insignificant rate of growth of paddy has also been increasing. But the growth rate of barley does not show such a consistent trend. A still further shift in the base year to 1970/71 shows that the productivity of maize and millet has decreased and that of wheat increased in the remaining period. Thus, by and large, towards the later years the rate of decrease was faster for paddy (but insignificant), maize, millet and barley (excluding the case for entire period). Similarly, the rate of increase was faster in case of wheat (excluding the period 1972/73 - 1985/86). Such a change in trend necessitates an investigation into the pattern of output of various crops.

Table 13
Semilog Trend Rate of Growth of Moving Averages of Productivity of Food Crops for Different Periods

Food Crops	Trend Rate of Growth during			
	1966/67 to 1985/86	1968/69 to 1985/86	1970/71 to 1985/86	1972/73 to 1985/86
Paddy	- 0.08	- 0.14	- 0.20	- 0.19
	(- 0.59)	(- 0.84)	(- 0.92)	(- 0.65)
Maize	- 1.56	- 1.73	- 1.89	- 2.03
	(-12.62)	(-13.23)	(-13.17)	(-11.72)
	*	*	*	*
Wheat	0.98	1.41	1.68	1.31
	(4.01)	(6.29)	(6.86)	(4.95)
	*	*	*	*
Millet	- 1.25	- 1.35	- 1.60	- 1.88
	(- 9.78)	(- 9.01)	(-10.98)	(-14.06)
	*	*	*	*
Barley	- 0.70	- 0.60	- 0.68	- 0.73
	(- 9.76)	(- 8.44)	(- 8.44)	(- 6.91)
	*	*	*	*

Figures in parentheses are t-value.
*Significant at or below 1 percent level.

Compared to food crops the results for cash crops are not so consistent (Table 14). It was earlier observed that there was statistically significant positive growth in the productivity of sugarcane, oilseeds and jute for the whole period (1966/67 - 1985/86). Among these three crops, sugarcane, and oilseeds (except for 1972/73 base) yield a higher positive growth rate in the later years. But for jute the positive growth rate increased when the base is shifted from 1966/67 to 1968/69 and then decreased with further shifts in the base period. Tobacco has shown a negative growth rate during the entire period and it has been decreasing in the later years. The more surprising result is for potato which shows a negative but insignificant growth for the entire period, but a positive growth in the other periods. Thus, the change in the growth rate from negative to positive for potato and the inconsistent pattern in the growth rate of jute explain the high variability in their productivity. Moreover, the spectacular increase in the positive growth rate for sugarcane is essentially the result of a spurt in its productivity in the latter years, especially from 1979/80 (see Tables 2 and 4).

Table 14
Semilog Trend Rate of Growth of Moving Averages of Productivity of Cash Crops for Different Periods

Cash Crops	Trend Rate of Growth during			
	1966/67 to 1985/86	1968/69 to 1985/86	1970/71 to 1985/86	1972/73 to 1985/86
Sugarcane	2.48 (9.45) *	2.73 (9.02) *	3.04 (8.60) *	3.52 (8.75) *
Oilseeds	1.11 (7.89) *	1.26 (7.94) *	1.31 (6.65) *	1.12 (4.73) *
Tobacco	-0.54 (-2.70) **	-0.44 (-2.08)	-0.43 (-1.61)	-0.36 (-1.02)
Jute	1.18 (4.43) *	1.43 (4.77) *	1.08 (3.18) *	0.37 (1.36)
Potato	-0.02 (-0.08)	0.33 (1.57)	0.46 (1.76)	0.62 (1.86)

Figures in parentheses are t-value.
* Significant at or below 1 percent level.
**Significant at 5 percent level.

On the whole, the estimated trend rates of growth of different periods are consistent for all food and cash crops whose trend coefficients have been observed statistically significant during the entire period.

SUMMARY AND CONCLUSION

The present study focused on the estimation of productivity trends of ten principal food and cash crops of Nepal during the period 1965/66-1986/87. Graph, moving average and trend equation were used to discern the trend. Among the ten crops, paddy of the food crops and potato of the cash crops did not exhibit a statistically significant trend. They are the leading crops of their respective groups. Among the other crops maize, millet and barley from food crops, and tobacco from the cash crops showed a statistically significant negative trend. But the wheat of food crops, and sugarcane, oilseeds and jute among the cash crops were found with statistically significant positive trend. Thus, compared to food crops, the results for cash crops are found satisfactory. However, considering their share (mentioned in INTRODUCTION section) in the overall index of agricultural production, it can be inferred that the overall land productivity of food crops and cash crops has decreased during the period 1965/66 - 1986/87. This may imply dismal performance of Land Act 1964 and other productivity augmenting measures implemented since the start of the third five year plan in the country. On the other hand, the decrease in productivity may be due to ecological imbalance. Since the decrease in agricultural productivity has a far-reaching effects in the every nook and corner of the economy, an attempt must be made by the government to search the reasons for such a decrease.

The large variation in the productivity of some crops and the use of linear and semilog models may not permit much to extrapolate the estimated trend coefficients. However, among the crops whose trend coefficients are found statistically significant, a study of their computed t-ratio for different periods and a deep observation of their graphs reveal a large variation only in jute, a break in the sugarcane productivity, and a cyclical pattern in the productivity of wheat, oilseeds and tobacco. The cyclical pattern present in the last group of crops requires a fifth degree polynomial. Therefore, a straight line and semi-log trend equations are appropriate to approximate their trend. Moreover, there is a rising tendency of sugarcane productivity in the both parts of the kink. In this light it seems safe to extrapolate the estimated trend for the recent future. Thus, these results call for a vigorous and sustained effort on the part of government as well as individual farmers to enhance the agricultural productivity in Nepal.

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Appendix A.1
Productivity (yield per hectare) of principal food crops

S.No.	Year	Paddy	Maize	Wheat	Millets	Barley
					(Metric Tons)	
1.	1965/66	1.99	1.90	1.25	1.20	1.05
2.	1966/67	1.83	1.83	1.27	1.20	1.05
3.	1967/68	1.84	1.81	1.07	1.11	0.91
4.	1968/69	1.87	1.81	1.12	1.12	0.91
5.	1969/70	1.91	1.84	1.17	1.11	0.93
6.	1970/71	1.95	1.87	0.85	1.13	0.92
7.	1971/72	1.95	1.73	0.93	1.13	0.93
8.	1972/73	1.76	1.85	1.20	1.11	0.92
9.	1973/74	1.97	1.80	1.13	1.13	0.93
10.	1974/75	1.98	1.81	1.14	1.12	0.93
11.	1975/76	2.07	1.65	1.18	1.14	0.93
12.	1976/77	1.89	1.79	1.04	1.13	0.83
13.	1977/78	1.81	1.66	1.12	1.07	0.88
14.	1978/79	1.85	1.64	1.17	1.08	0.87
15.	1979/80	1.64	1.28	1.20	0.97	0.90
16.	1980/81	1.93	1.63	1.22	1.00	0.86
17.	1981/82	1.98	1.58	1.32	1.00	0.86
18.	1982/83	1.45	1.41	1.36	0.94	0.88
19.	1983/84	2.07	1.51	1.34	0.93	0.88
20.	1984/85	1.97	1.42	1.18	0.93	0.86
21.	1985/86	2.02	1.42	1.24	0.91	0.79
22.	1986/87	1.78	1.38	1.31	0.91	0.86

Source: (1) HMG/N, DFAMS: Agricultural Statistics of Nepal, 1983, pp. 12-16.

(2) HMG/N, MOF: Economic Survey: 1987/88, 1988, p. 4.

Appendix A.2

Productivity (yield per hectare) of principal cash crops

(Metric Tons)

S.No.	Year	Sugarcane	Oilseeds	Tobacco	Jute	Potato
1.	1965/66	15.36	0.54	1.13	1.21	6.68
2.	1966/67	15.47	0.57	0.69	1.20	6.98
3.	1967/68	15.39	0.53	0.75	0.98	5.74
4.	1968/69	15.39	0.53	0.76	0.94	5.77
5.	1969/70	15.99	0.55	0.76	0.96	5.77
6.	1970/71	16.38	0.52	0.76	0.96	5.60
7.	1971/72	16.20	0.52	0.76	1.00	5.76
8.	1972/73	16.50	0.53	0.76	1.02	5.71
9.	1973/74	16.72	0.56	0.69	1.21	5.73
10.	1974/75	16.54	0.58	0.71	1.21	5.72
11.	1975/76	16.77	0.61	0.72	1.24	5.88
12.	1976/77	17.30	0.57	0.74	1.12	5.15
13.	1977/78	16.91	0.59	0.76	1.19	5.39
14.	1978/79	16.82	0.64	0.72	1.46	5.50
15.	1979/80	17.18	0.52	0.73	1.19	5.42
16.	1980/81	20.02	0.63	0.76	1.14	5.66
17.	1981/82	23.44	0.70	0.70	1.21	6.15
18.	1982/83	24.25	0.63	0.78	1.28	6.30
19.	1983/84	22.39	0.66	0.78	1.06	6.51
20.	1984/85	23.36	0.66	0.75	1.22	6.41
21.	1985/86	24.27	0.57	0.54	1.29	5.10
22.	1986/87	24.68	0.58	0.56	1.18	5.34

Source: (1) HMG/N, DFAMS: Agricultural Statistics of Nepal, 1983, pp. 17-21.

(2) HMG/N, MOF: Economic Survey: FY 87-88, 1988, p. 5.