The Supply Function of Wheat in Nepal

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This paper will attempt to derive the basic result of Supply Function of wheat in Nepal by using simple econometric techniques. Here we are working with time-series data from 1964/65 to 1977/78.

The paper is divided as follows :

Section I discusses the production of wheat and its importance. Objectives, hypothesis, limitations, techniques of deriving the results, hypothesis testing are specified in section II, and estimated supply model, presentation and analysis of data are designed in section III. Interpretation of the results and conclusion are contained in section IV.

Section I

Much attention has been devoted in recent years to the sources of agricultural development. The development of the food and agricultural sector contributes to the growth and stability of national economy as a whole. Many developing countries, in their vigorous efforts

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towards improving food production have accorded a higher degree of priority to food and the agricultural sector.

In an economy like our own, where more than 90 percent of labour force is engaged in agricultural sector, accounting for two–thirds of the gross domestic product, neither economic development can be stepped up, nor can there be any notable improvement in the living standard of the people without first increasing the agricultural production significantly. At the present level of our development, foodgrains alone constitute a large part of the mass consumption. A large part of our exports, too, originate in the agricultural sector. At the initial stage of development, most of the industries, which have already been established or will be establish in future, must be dependent on agricultural raw-materials. It is, therefore, emphasised in every plan period to funnel down to the village level the agricultural education, research, extension, credit, fertilizer, seeds, irrigation as well as other developmental programme.

It is also necessary to recognise that the farmers play a predominant role in order to achieve the goals of agricultural development. Although the over-all tragets of the agricultural programme are determined by the government, their fulfilment largely depends on the contribution of all the farmers and families who are engaged in agriculture.

The most important crop of our country is paddy, which occupies 60.7% of the total cultivated area followed by maize 22.8% and wheat 13.9%. From the production point of view, though wheat is the third important crop, it is the second crop grown in Terai and the first important crop grown in winter.

Now-a-days wheat has become the secondary crop to many farmers in Terai belt, though it was the important crop only to the Far–Western region some years ago. From the cultivation point of view, since long the farmers are engaged in wheat cultivation. But the developmental programme in relation to wheat production such as seed multiplication, cultural investigation, fertilizer investigations, disease investigations etc, are the present day extensive activities towards this sector.

During recent years wheat is gaining increasing popularity in our country. The attitude of the farmers is changing and many farmers have realized the importance of wheat as a secondary

crop after rice. The area under wheat cultivation has increased primarily due to expansion in area. But the productivity has not increased. It is only 1.12 m. ton/ha in average. At present wheat is being grown in 360,000 hectares, which is near about 15.5% of total cultivated area of 23,26,000 hectares.

The area under production, grain, yield and percentage change in area and production during various years and price index of wheat are presented in Table-1.

Table-1

Fiscal Year	Area in hectares '000'	Production in M. Ton. '000'	Grain Yield M. Ton/ha	Price index
1964/65	100	126	1.26	100
1965/66	118	147	1.25	117
1966/67	126	159	1.26	106
1967/68	192	205	1.07	173
1968/69	208	233	1.12	111
1969/70	226	265	1.17	112
1970/71	228	193	0.85	103
1971/72	239	223	0.93	119
1972/73	259	312	1.20	164
1973/74	274	308	1.12	176
1974/75	291	331	1.14	222
1975/76	329	387	1.18	179
1976/77	348	362	1.04	155
1977/78	360	401	1.11	179

Source: Agricultural Statistics of Nepal. 1976 & 1977

The area under wheat production and the yield have increased significantly. It is near about four times during the 14 years period. But the average yield has not increased. It might be due to the cumulative effect of the extension of wheat into marginal and rainfed area as well

as big expansion of acreage in the Tarai and irratic trend of price. The area is in increasing trend but the production and price involved upward with an erratic trend. Area has increased by 260,000 hectares until 1977/78 in comparision to that of 1964/65. From 1964/65 to 1969/70 production also has increased tremendiously, but in 1970/71 production has declined. Again it has started to increase, but the increment is in erratic trend. The higher prices of chemical fertilizer as well as other agricultural inputs, lack of irrigation and the decreasing trend in the product price, wheat cultivation has become less profitable. In F. Y. 1970/71; 1972/73; and 1973/74 the decline in wheat production in comparision to previous years might be due to the dry winter condition and heavy rainfall during harvesting season. Between the F. Y. 1974/75 and 1977/78 the production of wheat increased by 21. 26%, area under the cultivation increased by 23.79% during the same period. However during the same period the productivity of wheat per hectares declined by 2.63%.

The institutional involvement as well as financial aid to the farmers specially to wheat production, have become the main gesture to produce more surplus wheat in coming years.

As the question may arise why our study focus on the "Supply function of wheat in Nepal." The answer will be that, area, production, investment from government side and the consumption of chemical fertilizer in wheat production have increased significantly within a short period of time. But the development of this sector has not made any significant impact on the total food grain production of the country. Such is the case in our on this sector. So, in this existing condition our interest should be to study the effect of lagged prices of wheat and rice, area under wheat cultivation and the use of fertilizer in wheat production.

Furthermore, we are facing market problem to sell surplus wheat and farmers have to accept low price. Therefore our effort should b concentrated towards a case study of wheat. This is based on supply function until now, and study by showing functional relationship is lacked in this sector. So, we think this study will be a valuable one to some extent and will establish a base for future. On these background a study on supply function of wheat in Nepal has been increasingly felt.

Section II
Objectives:

The supply function of wheat in Nepal has the following major objectives.

i)   To ensure a sufficient supply of wheat product as required by the people.

ii) To show the importance of wheat production in Nepal in near future.

iii) To show how farmers have responsed in wheat production.

iv) Lastly, to indicate that the government should take price incentive policy on wheat.

Hypothesis:

The model of this analysis has been constructed taking into account the following considerations:

(a) Farmers would response lagged price–positively.

(b) Area under wheat cultivation is nearly elastic.

(c) The use of chemical fertilizer under wheat cultivation is significant.

(d) Farmers would response lagged price of rice negatively i.e., if the price of rice increases there is every possibility to shift their programme in more rice production.

Limitations:

This study is not based on the deep and sophisticated analysis of econometric tools. It will try to show elasticities by using simple regression analysis and cobb–douglas production type of model.

The model has been estimated using the secondary and time-series data under the rooting of simultaneous equtions and has been assumed that:

$$st\ (Total—supply)=Total\ production\ +(M-X)*$$

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*Export & import are shown here for the sake of model only. Though, export exists in border areas, but it is insignificant, while import takes place in every year and we have to import more wheat in famine's year. Here both variables have dropt out intentionally.

Where M & X are import & export respectively. M & X intentionally have not taken under this supply model.

The model presents several important variables like price, area, use of fertilizer, lagged price of wheat and rice as independent variables, though weather and irrigation were much more important. But due to the unavailability of data our model is not able to include them also.

In this supply model rice has been taken as substitute for wheat. So their lagged prices have taken into consideration. The purpose is that farmers have limited resources with them. Our assumption is that farmers are engaging in paddy & wheat cultivation. If they feel, wheat cultivation is more profitable than paddy, then they will use their limited resources to wheat cultivation.

The result has drawn by using log & non-log and constant elasticity. If the work is on log, coefficients of idependent variables indicate elasticity. If it is not in log, elasticity is calculated by applying theoritical procedure. In our case F.Y. 1964/65 to 1977/78, will be reported in constant form.

Though, price may varied from place to place and from month to month, but average annual price has taken into consideratton and later it has indexed. The essence of the supply function is that farmers always expect next year's price to be higher than this year's price- i.e., if the price of wheat is high or low in previous year than their expectation would to be the same price in this year also.

Techniques of deriving the results

There are various techniques that have been derived to estimate the supply function since W. Candler in his study "An aggregate Supply Function for New Zealand Wheat", consi- dered the wheat acreage as the dependent variable and ten independent variables. The sign for wheat price was negative. It was interpreted that over the period studied, the gross relationship- had been a high acreage associated with low prices. This may be due to government interference dempening the free price operation. After tenting the significance only four variable were found to be significant : (a) wheat price lagged on year (X_b), (b) fat lamp price (X_c), (c) red clover

acreage (X_j); and (d) last year's acreage (X_k). The final equation was:

$$X = 155.00 + 0.269\ X_b - 0.108\ X_c + 0.145\ X_j + 0.505\ X_k .$$

Method of W.A. Cromarty

He estimated elasticity of supply for wheat from the model:

$$Y_{11} = 105.181 + 5.407\ Z_{13} - 0.370\ Z_{12} + 3.77\ Z_{14} + 0.2636\ (Y_{12} - i)$$

Where

Y_{11} = Wheat production.

Z_{13} = Seeded acreage of wheat for the previous year or announced allotments when in effect.

Z_{12} = Fertilizer in North Dakota and Kansus.

Z_{14} = Index of Weather influence in wheat areas (1943 = 100).

$(Y_{12} - i)$ = higher price of wheat for the previous year or current year support price.

The coefficient for Z_{12} was negative, but it was found to be insiginficant, the standard error being larger than the coefficient.

Hypothesis testing

We have applied two types of test for testing of our hypothesis. They are F–test and t.– test respectively, with which we would be able to justify whether the coefficients are signi-ficant or insignificant. And we can also predict the significance and insignicance of model

F – test

It is also called the Variance Ratio Test and F is defined as a static form by taking a ratio whose numerator is the mean of the square of number N_1 of independent random varia-

bles; and whose denominator is the mean of the squares of a number N_2 of random varia-bles, independent of each other and of those in the numerator.

Thus in our case, we have,

$$F(N_1, N_2) = \frac{RSS/df_1}{ESS/df_2}$$

The number N_1 and N_2 are called the degrees of freedom of the numerator and of the denominator, respectively.

Where, RSS = regression (or explained) sum of squares.

ESS = error (unexplained) sum of squares.

TSS = total sum of square.

($\therefore$ RSS = TSS – ESS).

df_1 = k; where, k= no. of independent variables.

df_2 = n–1–k;   n=no. of observations.

t – test

The whole analysis of data and interpretation of the coefficients of independent variables on our supply function is based on t–test. With which we are able to iustify whether the coefficients are statistically significant or insignificant.

The t statistics with N_2 degrees of freedom of the ith element is defined as;

$$tai = \frac{ai}{\sqrt{ESS/df_2} \cdot \sqrt{Vi}}$$

Where ai = co-efficient of the ith element.

vi = vector element of the ith unit in matrix notion.

Section III

Estimated Supply model:

(a) Linear:

$$st = a_0 + a_1 \, Pwt_{-1} + a_2 \, P_{rt-1} + a_3 \, A_1 + a_4 \, F_t + f_t.$$

(b) Constant elasticity or cobb–Douglas:

$$\log st = \log b_0 + b_1 \log P_{wt-1} + b_2 \log P_{rt-1} + b_3 \log A_t + b_4 \log F_t + e_t$$

Where:

st = Aggregate production of wheat within the country in metric tons.

P_{wt} = Average annual price of wheat Rs/Kg. (indexed).

P_{rt} = Average annual price of rice course Rs/Kg. (indexed).

P_{wt-1} = Previous year's wheat price (indexed).

P_{rt-1} = Previous year's rice cource price (indexed).

A_t = Arer under wheat cultivation in year t in 'ooo' heactres.

F_t = Consumption of fertilizer in wheat production in year t in M.tons.

f_t and e_t are error terms.

Presentation of the data

To estimate the supply function of wheat in Nepal, 14 years period (1964/65 to 1977/78) has been selected. Data related to production, area and prices are taken from the I_B & 2nd publication of "Agricultural statistics of Nepal" H.M.G. Ministry of Food, Agriculture and irrigation Marketing Services, Agricultural Statistics Division of July 1972, Nov. 1977 respectively. For 1977/78 unpublished data are taken from the same office.

F_t (consumption of fertilizer on wheat production) is taken from the hand book of "Agriculture inputs corporation". It has increased until 1974/75 and in 1976 it has decreased and again started to increase. As no authentic data is available to indicate the cropwise use of fertilizer in the country it is very difficult to know the fertilizer details about use in wheat production from 1964/65 to 1971/72. Since the fiscal year 1974/75, Agricultural inputs corporation has started to publish estimated cropwise consumption of fertilizer. The consumption of fertilizer in wheat production in the years 1974/75, 1975/76 ,1976/77 & 1977/78 is 52%, 50% and 38% respectively of the total fertilizer consumption through out the country. And a study undertaken by World Bank in 1972 revealed that wheat consumption was 43.01% of the total amount sold during the same year. ✳

So by looking the trend an attempt is made to reveal wheat consumption 48.1% out of the totol amount sold during the corresponding year. This is calculated by taking the geometric mean of the above mentioned five figures.

Analysis of data

Applying the method of multiple–regression system under simulataneous equation model, this study will attempt to arrive results for the estimation of supply for wheat. Using the mentioned technique the supply of wheat in Nepal is as follows:

Supply function

(a) In linear form:

$$st = 36.36331 + 0.49166\ P_{wt-1} + 0.00353\ F_t + 0.92458\ A_t\ -(1)$$

t–value   (1.3371575)   (1.2562123)   (1.0570114)   (2.7162596)✳✳

$$R^2 = .94 \qquad \overline{R}^2 = .92 \qquad F_{3,10} = 37.604732^{**}$$

✳ The role of the fertilizer and the related inputs in the agricultural development of Nepal (an introduction paper) National Seminar on the development of the ' Use of fertilizer and related inputs". Jointly sponsored by FAO/NORAD and AIC.

Elasticities:

Supply elasticities with reepect to lagged price of wheat, lagged price of rice, use of fertilizer in wheat production and wheat cultivated area are:

$$e_{pwt-1} = 0.2473108: \qquad e_{prt-1} = 0.3627408;$$

$$e_{Ft} = 0.141255; \qquad e_{at} = 0.8349575 \text{ respectively.}$$

In constant elasticity model, the supply function of wheat is as follows:

$$\log st = \log (1.695429) + 0.44628 \log P_{wt-1} - 0.46953 \log P_{rt-1}$$

t-values $\qquad$ (2.3135219) * * $\qquad$ (2.278367) * *

$$+0.04217 \log F_t + 0.88329 \log A_t \qquad\qquad (2)$$

$\qquad$ (0.3821214) $\qquad$ (3.334355) * * *

$$R^2 = .95 \qquad\qquad \overline{R}^{-2} = .93 \qquad\qquad F_{3,10} = 42.15601 \ * \ *$$

Note :

The figures in the parenthesis are their t-values. The stars refer to the significance of the relevient statistic.

For t-test:

One star indicates significant at 10% probability level.

Two stars indicates significant at 5% probability level.

Three stars indicates significant at 1% probability level.

For F-test:

Two stars indicate significant at 1%. probability level.

one star indicates significant at 5% probability level.

R^2 above .50 indicates the significance of the model.

The two equations of supply function arc in linear form and in constant elasticity model respectively.

In equation (1) coefficient on lagged price of wheat and lagged price of rice are significant at 20% and 30% probability level respectively. The coefficient on area under wheat cultivation is significant at 5% level of confidance and finally the coefficient on fertilizer is not significant. $\bar{R}^2$ and R^2 yield .94 and .92 respectively and F-test is also highly significant.

In equation (2) all the coefficients except fertilizer are significant. Coefficient on lagged price of wheat and rice are significant at 5% and the coefficient on area is significant at 1% level of significance. Value of R^2 and $\bar{R}^2$ are high and F-value is highly significant.

By comparing equations (1) and (2), we can say that equntion (2) has better axplanatory power than equation (1); so the interpretation of this supply model is basically depended on equation (2).

Section IV

Interpretation of Results:

When all the variables are logged than the coefficients indicate elasticities. For the supply of wheat it indicates that farmers have positively reponsed lagged wheat price. A 100% increase in lagged price i.e. $(t-1)^{th}$ period of wheat caused 44.63% in t^{th} year's production. The only way to stimulate farmers to produce more wheat in coming years is possible by increasing its price. Its t-value is significant and supply model is also significant from all viewpoints.

Again, the coefficient on lagged price of rice is significant at 5% level of significance. The sign on this coefficien is negative. We think it is reasonable and implies some economic sense. It indicates that Nepalese farmers have limited resources if they feel the price of rice to be high, then this will lead all their resources to paddy production. Because the growth rate of wheat's price is only 4.66%* within 14 year's period, while growth rate of

* Self calculated

rice price, fertilizer price is high than that of wheat. The price of rice might play a significant role in the supply of wheat. So to increase the supply of wheat there must have been a considerable improvement on its exsiting price.

Further, the coefficient on fertilizer use is positive but insignificant. It is just opposite of our assumed hypothesis. So it creates a problem in analysing the result. The consumption of fertilizer in wheat production has increased significantly. But a 100% increase in fertilizer consumption cause only 4.22% increase in wheat production. i. e. t-value is also too insignificant. It shows that fertilizer has not responsed in wheat production by increasing the consumption of fertilizer wheat supply can not be increased. So far the cropwise use of fertilizer is concerned maximum amount of fertilizer has been used in wheat production through out the country. So it can be said that farmers do not know scientific method of fertilizer use. Dr. K.K. Jha in his article * "Decreasing in Fertilizer use in Rupendehi District" has given some argument that 12% of the total fertilizer sold by AIC was smuggled into India in 1975/76.†

The major portion of the fertilizer is being used on Tarai belt. Instead of being used in our farmer's field it is going to be smuggled into India. It can be said that the production of wheat can not be increased only by increasing the figures in AIC's statistics. Again Dr. K.K. Jha gives an example in the same article and claimed that there was shortage in weight of fertilizer bags supplied by AIC. Each big supplied contained only 44 kgs. of fertilizer instead of 50 kgs. i.e., 12% shortage in every bag. 12% smuggling into India and 12% shortage in every bag gives the total of 24% and it is not a neglect figure. Besides this there may so many other conditions which are responsible in giving the insigificance result. The use of fertilizer in unirrigated land will not lead to continuous growth in production. So the use of fertilizer may be useless instead of being useful. The vast dry land, decomposed fertilizer supplied by AIC, miss utilization of fertilizer by farmers may be the causes in showing insignificance results.

Further, the coefficient on area is highly significant. It is significant at 1% level of significance A 100% increase in area cause a 88.33% increase in production.

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* "The Economic Monthly (Nov., Dec. 1977). Economic Instruction Committee. Kirtipur, Kathmandu.

†The same article, pp. 16 (4).

It indicates that production of wheat can increase only by increasing the area under its cultiva-tion. Though it is not unitary elasticity, but approaches to its nearness. Being of the coefficients highly significant we can conclude that it is elastic.

To sum up the supply function of wheat yielded on R^2 of .95. The coefficients for P_{wt-1} (0.44628), P_{rt-1} (–0.46953) and A_t (0.88329) are significant at 5% & 1% probability level respectively. Though the coefficient for f_t (0.04216) is not significant. The supply function illustrated that farmers are responsive. There is every possibility to increase wheat by increasing its price and area under its cultivation.

The datum used on this supply function are as follows:

Data used for analysis of the supply function of wheat in Nepal.

F.Y.	Wheat production in M. T. '000'	Area in Ha. '000'	Price index of wheat 1964/65=100	Price of rice 1964/65=100	Consumption of fertilizer in wheat production in M. T.
1964/65	126	100	100	100	315
1965/66	147	118	117	117	900
1966/67	159	126	106	126	2541
1967/68	205	192	173	139	5491
1968/69	233	208	111	134	5353
1969/70	265	226	112	152	7329
1970/71	193	228	103	152	8173
1971/72	223	239	119	145	10939
1972/73	312	259	164	177	15017
1973/74	308	274	276	196	16955
1974/75	331	291	222	219	18954
1975/76	387	329	179	221	15565
1976/77	361	348	155	195	18539
1977/78	401	360	179	228	20000

Source: For-production, area and price;–Agriculture Statistics of Nepal 1977.

For fertilizer;–AIC (Agriculture Inputs Corporation).

Conclusion

In every plan period a large amount of resources is diverted towards the agricultural sector. But the situation is that we have to import wheat from outside during food deficit years. Taking the growth rates of population and food production to be constant of this existing situation, we have to import food from outside within few years. So on the one hand we have to feed our people and we have to increase our goods domestic product by increasing wheat product on the other. In this regard the following incentives should be taken from government side. These policies should be as:

(1)   Price support policy,

(2)   market regulating,

(3)   doing study in export prospect,

(4)   entering into the market as an additional buyer,

(5)   increasing irrigation facilities and,

(6)   reducing in fertilizers as well as agricultural input's prices.

This paper is simply an attampt to fulfill the long felt need for the study of the supply of wheat in Nepal. The results are drawn by applying econometric tools, and hence the conclusions need careful consideration.

From the supply model it can be forecasted that still we have more land in wheat cultivation, because its elasticity (coefficient in A_t) is 0.88 i.e. nearly 1. If irrigation facility is provided with scientific method of cultivation, no doubt, wheat production can be increased in near fnture too. In this regard. government should take price incentive policy. This is the main finding of this paper.

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