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Short Communication

Estimation of Wheat Production, Forecasting and Risk Analysis

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ABSTRACT

Wheat is a staple food of people of Pakistan and the largest grain crop of the country. The average yield of wheat in Pakistan is far less than the potential yield and yield realized by the progressive farmers and research stations. The purpose of present study is to estimate the average wheat yield and forecast the future wheat production in Jhang (Pakistan). The best fitted production function was used to estimate the future wheat yield. The primary data were collected by questionnaire/ interviews method. Wheat yield was simulated by using a computer programme @Risk and its companion product Best-Fit. @Risk simulated the wheat yield over the planning horizon hundred of times, each time calculating and saving the wheat yield that was computed with particular sets of values of wheat yield production function. Best-Fit determined the Tnormal distributions as the most appropriate distribution for these variables. @Risk constructed the forecasted wheat yield probability distributions for future. The risk is measured as dispersion from the mean value.

Key Words: Wheat production estimation; Forecasting; Risk analysis; Stochastic simulation

INTRODUCTION

Wheat is the main staple food of the people and the largest grain crop of the country. It contributes 13.8% to the value added in agriculture and 3.4% of GDP. Wheat was cultivated on an area of 8176 thousand hectares, showing a 1.8% increased over last year. The size of wheat crop is provisionally estimated at 19767 thousand tones, which is 3.0% higher than last year. Wheat production was less than target (20 million) by 1.2% because crop was affected by adverse weather in the month of March. Consequently, wheat production was below targeted production, which also created shortage (Government of Pakistan, 2003 - 04).

In agriculture, the producers are largely exposed to risks and uncertainties. Risk means a situation in which the probability of obtaining some outcome of an event is known; that is, known probabilities cannot be precisely assigned to these outcomes. In daily life a risky situation is one in which one of the outcomes may involve some loss to the decision maker (e.g. un-favorable weather). Uncertainty means a situation in which the probability of obtaining a given outcome of an event is not known (Todaro, 1997).

Production risk is random variability inherited in a farm's production process. Weather, diseases, and pest infestation lead to production risk in crop and livestock production, fire, wind, theft and causalities are other source of production risk. Yield fluctuation is greatly influenced by weather and other un-controllable factors. Risk and Uncertainty influences the efficiency of resource use in agriculture and decision-making processes of farmers. Anderson and Griffiths (1982) extended their multistage estimation approach for quantifying the impact of selected factor of production and empirical relationships in the analysis of efficient allocation of resources. Thus risk bearing is concentrated among the individual farmers and farms families, rather than spread over numerous corporate shareholders. Low elasticities of prices and incomes for many commodities are subject to weather and other un-controllable events, causing a wide swing in commodity prices. The effects of these factors combine to severely test farmer's risk bearing capacities and thus hamper their efficiency and welfare position (Barry, 1984).

The main objectives of this study were to (i) estimate the wheat production function, (ii) forecast the wheat production for next fifteen years, and (iii) evaluate the risk involved in wheat production.

METHODS AND PROCEDURES

District Jhang (Pakistan) was selected as the universe of this study because the wheat is the major crop of this area. The study is based on primary and secondary data. A random sample of 50 farmers was selected from each of the three Tehsils of district Jhang. Hence, 150 farmers were selected as respondents for this study. This random sample of 150 farmers was selected after consultation with the staff of agriculture department in district Jhang.

A production function was estimated by using the OLS regression technique. The estimated model was of the following form:

Y = f (X1, X2, X3, X4,)

Where,

Y = Yield of wheat crop (maunds per acre).

X1 = Total number of irrigations.

X2 = Seed Rate (Kilograms per acre).

X3 = Fertilizer (number of DAP bags per acre).

X4 = Soil fertility (Nitrogen in percentage available in the soil).

Forecasting and risk analysis. Wheat production was forecasted for the future of 15 years. Best-Fit was used to find the probability distributions for the independent variables of the estimated wheat yield production function. By using 15 years data of number of irrigations, seed rate and bags of DAP; Best-Fit determine the Tnormal distributions as the most appropriate distribution for these variables. These distributions contain four arguments mean, standard deviation, minimum and maximum values. @ Risk performed the simulation. @ Risk uses the simulation or Mont Carlo simulation to perform the risk analysis. Simulation means distribution of possible outcomes is generated by allowing the computer to recalculate the work sheet over and over again, each time using different randomly selected sets of values for probability distributions in cell values and formulas. The computer is solving the work sheets repeatedly using a large number of possible combinations of input variable values.

@Risk simulated the wheat yield over the planning horizon hundred of times, each time calculating and saving the wheat yield that was computed with a particular set of values of wheat yield production function. @Risk constructed the forecasted wheat yield probability distributions for 15 years. Standard deviation measures the volatility of the yield around the average yield. Most farmers would prefer less volatile yield to more volatile yield, other things being equal. The coefficient of variation (C.V.) was also estimated to explain the variability. The coefficient of variation measures the variability relative to expected value or mean of the probability distribution. The coefficient of variation was estimated by using the following formula:

C.V. = (Standard deviation/ Mean wheat yield)*100.

Time often has a very important impact on estimates; they become less and less certain as projections extend in future. To make the yield a random process, an uncertainty around the fixed trend of each production function was added. This purpose was accomplished by adding an error term (root mean square error) to the fixed trend in the worksheet. For adding an error term to the fixed estimate, the mean of the error term probability distribution should be zero. In all iterations of simulation, a new value for error term was sampled for each cell and was used to add to the fixed trend estimate in that cell, allowing variation around the fixed estimate.

RESULTS AND DISCUSSION

The research was conducted in District Jhang of Punjab. Three Tehsils were selected as sample area, consisting of ShorKot, Jhang and Chiniot to estimate wheat production, forecasting and risk analysis. Data was collected through questionnaire including general information of the respondents, total area under wheat crop, soil types, soil fertility levels and production technology. After collection and analysis of data the following results were obtained. The total land of all the respondents under study was 4536 acres. A production function was estimated by using the OLS regression technique. The estimated OLS regression model is given below:

The value of R square was 0.424 and the F-ratio of the estimated for wheat yield was 26.694, which was significant at the 5% level of significance. The estimated coefficients and other related information is given in Table I. The result showed that wheat yield was positively related to quantity of seed rate, DAP and Nitrogen but negatively related to the number of irrigations. The negative sign indicates that on average, the farmers were providing, at least one extra irrigation.

Table II shows the results of the simulated mean wheat yield over 15 years planning horizon (2003 - 04 to 2018 - 19). On average the mean wheat yield is 35 maunds per acre. The results show that as the planning horizon is

Table I. Estimated Coefficients of the OLS Regression Model for Wheat Production

	Coefficients	Standard Error	t-values	Significance
(Constant)	14.849	3.928	3.781	.000
No. of irrigations	-2.062	.667	-3.089	.002
Seed rate Kg /acre	.348	.086	4.058	.000
DAP Bags	9.229	1.461	6.319	.000
Nitrogen in percentage (%)	7.595	3.025	2.511	.013

Table II. Simulation Mean Wheat Yield, Standard Deviation and Coefficient of Variation

Years	Simulated Mean Wheat Yield	Standard Deviation	Coefficient of variation
2003-04	34.928	2.285	6.54
2004-05	34.963	2.348	6.71
2005-06	34.923	2.649	7.58
2006-07	34.981	3.040	8.69
2007-08	34.972	3.277	9.37
2008-09	34.971	3.628	10.37
2009-10	34.848	4.144	11.89
2010-11	34.910	4.608	13.17
2012-13	34.810	4.940	14.18
2013-14	37.937	5.433	15.55
2014-15	35.010	6.212	17.74
2015-16	35.028	6.333	18.07
2016-17	35.996	6.815	19.47
2017-18	34.950	7.361	21.06
2018-19	34.806	8.021	23.04

increasing, the simulated wheat yield probability is also increasing, other things being equal. The standard deviation of mean wheat yield measures the variation around the mean. Higher the variation in mean wheat yield higher the risk involved. This is also evidenced from the coefficient of variation. The coefficient of variation (C.V.) is also estimated and is given in Table II. As the planning horizon is increasing, (C.V.) is also increasing, other things being equal.

The results were presented in the form of distributions that are described by their mean and standard deviation. The stochastic simulation approach provides greater decision making information, such as probability distribution of wheat yield, which is not available from a deterministic model.

CONCLUSIONS

The result showed that wheat yield was positively related to the quantity of seed rate, DAP and Nitrogen but negatively related to the number of irrigations. On average the mean simulated wheat yield was 35 maunds per acre.

The coefficients of variation show that the forecasted wheat yield in the near future has smaller coefficient of variation than the far future. In other words as the planning horizon is increasing the coefficient of variation is also increasing. The standard deviation of the simulated wheat yield was increasing as we move in the future, which indicates greater risk.

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