Vol XXV
No. 1

ISSN 0019-5014

JANUARY-
MARCH
1970

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

NOTES

PRODUCTION FUNCTIONS FOR THE NEW DWARF WHEATS*

After the "New Agricultural Strategy," considerable amount of research data have been generated on agro-economic aspects of producing the high-yielding wheat varieties. While generating research information on the high-yielding wheat varieties, research workers have primarily confined themselves in comparing the response of Mexican dwarf and Indian tall varieties to nitrogen[1] in analysing, revisiting and reviewing the new agricultural strategy.[2] Very little information, however, is available on the comparison of the response of various "new dwarf" wheats to fertilizer application. This has been mainly due to the fact that plant breeders are still engaged in selecting the most promising "new dwarf" wheats by some genetic manipulation of the Mexican red and the Indian amber wheats. Since some of such new dwarf wheats have been released, it is now necessary to work out and compare their response to fertilizer application for getting maximum economic returns and thus for convincing the farmers to go for the cultivation of such wheat varieties which are high-yielding and have colour similar to that of the indigenous tall varieties.

This paper attempts to study the economics of fertilizer use on the newly selected dwarf wheats, *viz.*, Kalyan Sona, Sonalika, Sharbati Sonora and Chhoti Lerma (S. 331) cultivated in the Tarai area of the State of Uttar Pradesh with following specific objectives:

(1) to study the physical and economic response of the above wheat varieties to various levels of nitrogen application,

(2) to work out the economic optima in nitrogen use for all the four varieties of wheat and

(3) to compare the economic return from various levels of fertilizer application on the four varieties of wheat.

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* Publication under Journal Series No. 194 from the Director, Experiment Station, Uttar Pradesh Agricultural University, Pantnagar (Nainital).

The authors wish to express their sincere gratitude to Dr. N. K. Anant Rao, Dean, College of Agriculture and Dr. R.L. Paliwal, Director, Research for providing all the facilities for completing the experiments and Shri Mahendra Singh, Senior Research Assistant (Wheat) in conducting the field experiments.

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2. B. S. Minhas and T. N. Srinivasan, "New Agricultural Strategy Analysed," *Yojana*, Vol. 10, No. 1, January 26, 1966; Ralph W. Cummings, Jr., R. W. Herdt and S. K. Ray, "New Agricultural Strategy Revisited," *Economic and Political Weekly*, Vol. 3, No. 43, October 26, 1968; I. J. Singh and K. C. Sharma, "All-India Co-ordinated Fertilizer Experiments on Wheat," *Economic and Political Weekly*, Vol. 18, No. 25, June 21, 1969; and I. J. Singh and K. C. Sharma : Production Functions and Economic Optima in Fertilizer Use for Some Dwarf and Tall Varieties of Wheat, Research Bulletin No. 5, U. P. Agricultural University, Pantnagar (Nainital), February, 1969.

METHOD AND MATERIAL

The fertilizer experiments were conducted at the Uttar Pradesh Agricultural University Research Station on Kalyan Sona, Sonalika, Sharbati Sonora and Chhoti Lerma (S. 331). The experiments on Kalyan Sona and Sonalika were conducted for two years, *viz.*, 1967-68 and 1968-69 and each treatment was replicated four times each year. The experiment on Sharbati Sonora was conducted in 1967-68 and on Chhoti Lerma (S. 331) in 1968-69 with four replications. Phosphorus (superphosphate) and potash (muriate of potash) were held constant at 60 kgs. per hectare for every level of nitrogen application. Different levels of nitrogen in the form of ammonium sulphate were tried. It was varied from 0 to 200 kgs. per hectare at an interval of 40 kgs. Bartlet test of homogeneity was applied to test the significance status of yield variances to the fertilizer trial data for Kalyan Sona and Sonalika for the years 1967-68 and 1968-69. Since the individual year's yield variances for these varieties were not significantly different from each other at 5 per cent probability level, the two-year yield data for these varieties were pooled together. Quadratic equation of the following form was fitted to the fertilizer trial data for all the four varieties.

$$Y = A + BN - CN^2$$

Where Y is wheat yield in kilograms per hectare. A is wheat yield in kilograms at zero level of nitrogen application. B and C are coefficients attached to N, indicating transformation ratios at different magnitudes of N, and N is kilograms of nitrogen applied per hectare.

Response of wheat yield (Y_r) to various levels of nitrogen was estimated by the following equation:

$$Y_r = BN - CN^2$$

Optimum level of nitrogen application was calculated for each variety by equating marginal revenue to marginal cost. That is,

$$\frac{dY}{dN} = \frac{P_N}{P_Y}$$

Where P_N = price of N in Rs./kg. = Rs. 2.75.

P_Y = price of wheat in Re./kg. = Re. 0.76.

To calculate net profit due to fertilizer application, costs of the optimum nitrogen dosages and the costs of the basal dosages of phosphorus and potash were subtracted from the gross return ($P_Y . Y_r$). Phosphorus in the form of super-phosphate and potash in the form of muriate of potash were priced at the rate of Rs. 2.44 and Re. 0.79 per kilogram respectively.

RESULTS AND DISCUSSION

1. *Production Functions for the New Dwarf Wheats*

Table I shows that for the maximum physical production, the new dwarf wheats require much higher dosages of nitrogen fertilization. These nitrogen

levels are even higher than the earlier varieties, *viz.*, Sonora 64 and Lerma Rojo. Singh and Sharma (1969) reported that maximum per hectare yields of 5,410 and 5,141 kgs. were obtained from Sonora 64 and Lerma Rojo at 140 and 100 kgs. of nitrogen application respectively. Table I shows that for maximum per hectare

TABLE I—ESTIMATED TOTAL YIELD AT VARIOUS LEVELS OF NITROGEN APPLICATION

(in kgs. per hectare)

Nitrogen (N)	Yield (Y)			
	Kalyan Sona	Sonalika	Sharbati Sonora	Chhoti Lerma (S. 331)
0	2365	2434	2509	1991
20	3181	3260	3221	2776
40	3904	3963	3812	3464
60	4534	4543	4282	4055
80	5071	5001	4632	4548
100	5514	5336	4862	4945
120	5865	5548	4971	5244
140	6123	5637	4960	5447
160	6289	5604	4828	5552
180	6358	5447	4576	5560
200	6337	5168	4204	5471
220	6223	4766	3711	5286
240	6015	4241	3098	5001

Note: Per hectare total wheat yields for respective levels of nitrogen application were estimated by fitting the following equations:

Kalyan Sona : $Y = 2365.26 + 43.1182N^{**} - 0.1163N^{2,**}$ $R^2 = 0.99$
(.02885) (.00014)

Sonalika : $Y = 2433.52 + 44.3708N^{**} - 0.1535N^{2,*}$ $R^2 = 0.94$
(.08509) (.00041)

Sharbati Sonora : $Y = 2509.43 + 38.5711N^{**} - 0.1527N^{2,**}$ $R^2 = 0.95$
(.06095) (.00029)

Chhoti Lerma (S. 331) : $Y = 1990.95 + 41.0785N^{**} - 0.1322N^{2,*}$ $R^2 = 0.99$
(.01362) (.00007)

* Significant at 5 per cent probability level.
** Significant at 1 per cent probability level.

yields of 6,358, 5,637, 5,560 and 4,971 kgs. from Kalyan Sona, Sonalika, Chhoti Lerma (S. 331) and Sharbati Sonora, 180, 140, 180, and 120 kgs. nitrogen per hectare will be required respectively. These findings show that if the farmers go for the cultivation of Kalyan Sona, Sonalika and Chhoti Lerma (S. 331) varieties which are superior to the Mexican red and Indian amber wheats in colour and yield, the demand for nitrogenous and other fertilizers will still be increased in the coming years. In other words, to fulfil the basic objectives of the new agricultural strategy,[3] consumption of the biological inputs like fertilizers and irrigation water will increase in the country. The policy implication of the findings in Table I is that the present level of fertilizer recommendation for dwarf wheats and the present level of fertilizer allotment to the States[4] will require further increase by the Central Government.

3. Ambika Singh and I.J. Singh, "Multiple Cropping Programme under the New Agricultural Strategy," forthcoming article in *Economic and Political Weekly* (1970).
4. I. J. Singh and K.C. Sharma, "All-India Co-ordinated Fertilizer Experiments on Wheat," *op. cit.*, p.1011.

2. Wheat Yield Response to Nitrogen

Figure 1 shows that the Kalyan Sona variety gave higher yield response than the other varieties to each level of nitrogen application. Sonalika was next to Kalyan Sona in yield response up to 100 kgs. nitrogen application. Further Figure 1 shows that beyond 100 kgs. and 20 kgs. nitrogen application, respective yield responses from Sonalika and Sharbati Sonora was much less as compared to Kalyan Sona and Chhoti Lerma (S. 331). The maximum response yield of 3,993, 3,568, 3,203 and 2,461 kgs. per hectare was obtained from Kalyan Sona, Chhoti Lerma (S. 331), Sonalika and Sharbati Sonora at 180, 180, 140 and 120 kgs. nitrogen application respectively. This indicates that at 180, 180, 140 and 120 kgs. nitrogen application per hectare wheat yield response to per kilogram of nitrogen application was 22.2, 19.8, 22.8 and 20.5 kgs. per hectare from Kalyan Sona, Chhoti Lerma (S. 331), Sonalika and Sharbati Sonora respectively.

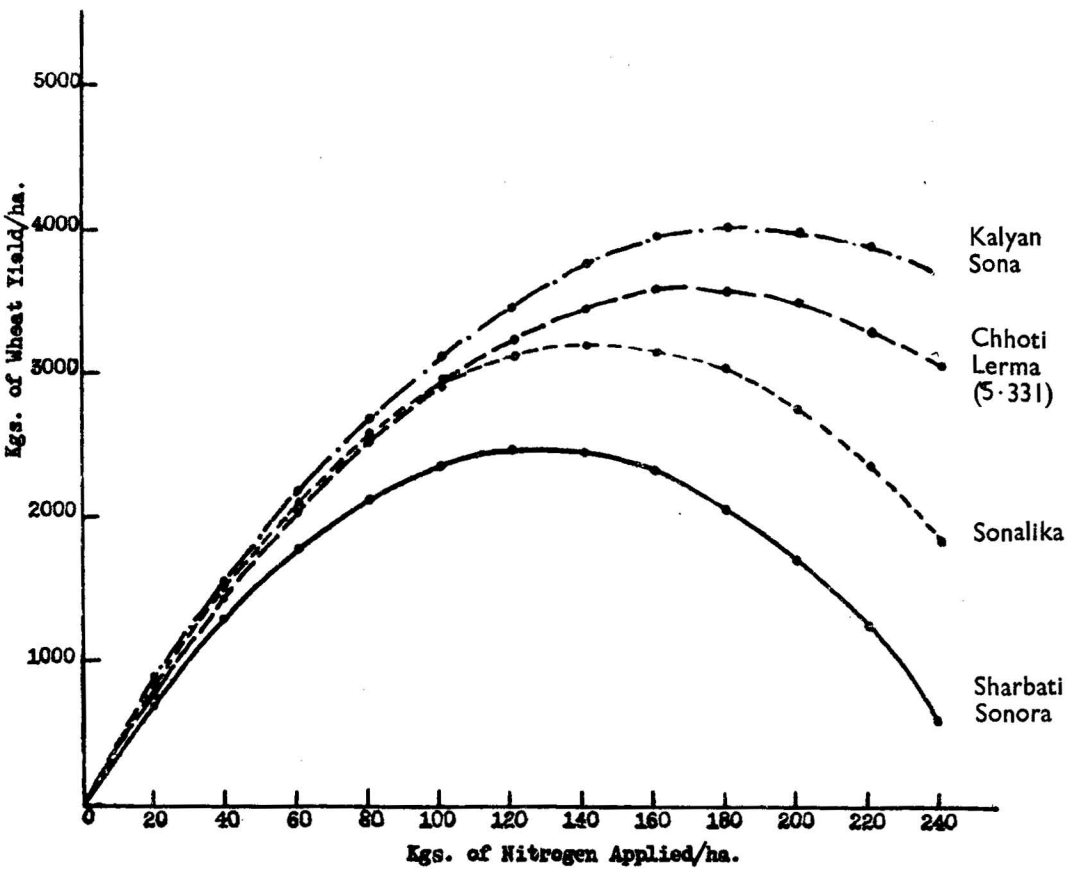

Figure 1—Response of Kalyan Sona, Chhoti Lerma (S.331), Sonalika and Sharbati Sonora to Nitrogen Application

3. Economic Optima in Nitrogen Use

Table II shows the optimum levels of nitrogen application, related response yields and net profits for all the four varieties of wheat. The respective optimum dosages of nitrogen for Kalyan Sona, Sonalika, Sharbati Sonora and Chhoti Lerma were 170, 133, 116 and 157 kgs. per hectare. The corresponding response yields at these optimum nitrogen levels were 3,968, 3,185, 2,450 and 3,551 kgs. per hectare. Net profits per hectare due to fertilizer application were Rs. 2,355, Rs. 1,862, Rs. 1,349 and Rs. 2,073 from Kalyan Sona, Sonalika, Sharbati Sonora and Chhoti Lerma (S. 331), respectively. Returns on per rupee investment on fertilization were Rs. 4.56, Rs. 4.33, Rs. 3.63 and Rs. 4.32 from these varieties. That is, for every rupee investment on fertilizers, Rs. 4.56, Rs. 4.33, Rs. 3.63 and Rs. 4.32 may be expected as return at the optimum levels of fertilizer application from Kalyan Sona, Sonalika, Sharbati Sonora and Chhoti Lerma (S. 331), respectively. These findings reveal the possibilities of increasing farm income through fertilizer application on varieties like Kalyan Sona, Sonalika and Chhoti Lerma (S. 331).

TABLE II—ECONOMIC OPTIMA IN NITROGEN USE, YIELD AND NET PROFIT

Variety	Optimum level of nitrogen application in kg./ha.(N)	Response yield at the optimum level of nitrogen application in kg./ha. (Y_r)	Gross return (Rs./ha.) ($P_y.Y_r$)	Cost of fertilizers (Rs./ha.)	Net profit (Rs./ha.) (col. 4—col. 5)	Return on investment on fertilizers (Rs.) (col. 4÷col. 5)
1	2	3	4	5	6	7
1. Kalyan Sona	170	3,968	3,015.93	660.78	2,355.15	4.56
2. Sonalika	133	3,185	2,420.69	558.84	1,861.85	4.33
3. Sharbati Sonora	116	2,450	1,861.66	513.13	1,348.53	3.63
4. Chhoti Lerma (S.331) ..	157	3,551	2,698.18	624.86	2,073.32	4.32

CONCLUSIONS

Three main conclusions may be drawn from this paper : (1) The new dwarf wheats require heavy dosages of nitrogen fertilization. For maximum physical production from Kalyan Sona, Sonalika and Chhoti Lerma (S. 331), the level of nitrogen application under the Tarai conditions varies between 140 to 180 kgs./ha. These nitrogen dosages are much higher than the dosages required for the Mexican dwarf wheats (Sonora 64 and Lerma Rojo).

(2) The wheat yield per kilogram of nitrogen application was 22.8, 22.2, 20.5 and 19.8 kgs. from Sonalika, Kalyan Sona, Sharbati Sonora and Chhoti Lerma (S. 331) respectively at 140, 180, 120 and 180 kgs. nitrogen application.

(3) At the current nitrogen-wheat prices, the most profitable levels of nitrogen for Kalyan Sona, Chhoti Lerma (S. 331), Sonalika and Sharbati Sonora were 170, 157, 133 and 116 kgs. per hectare. At these optimum levels of fertilization wheat yields of 3,968, 3,551, 3,185 and 2,450 kgs. per hectare due to fertilizer application with corresponding per hectare net profits of Rs. 2,355, Rs. 2,073, Rs. 1,862 and Rs. 1,349 may be expected from Kalyan Sona, Chhoti Lerma (S.331), Sonalika and Sharbati Sonora respectively. Therefore, given the limited quantity of fertilizers, it would be more profitable for the farmers to grow the new high-yielding wheat variety like Kalyan Sona.

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ACREAGE RESPONSE OF SUGARCANE IN FACTORY AREAS OF NORTH BIHAR*

The Tirhut Division of North Bihar has been one of the traditional sugarcane growing tracts of the country. Grown in over three lakh acres, sugarcane is the most important cash crop of the region, providing for the much needed cash requirements of a large number of subsistence farmers and catering to the raw material requirements of 25 out of the 30 sugar factories in the State. Wide fluctuations in its acreage have always been a matter of concern, and have recently assumed grave dimensions. This study was designed to probe into the causes of this instability and arrive at a meaningful, quantifiable explanation.

It has been observed that these fluctuations stem primarily from the variability in relative price position. Dutt commented on this and indicated that variations in cane acreage were governed mainly by the relative price of sugarcane and seasonal conditions at the time of sowing.[1] The Sugar Enquiry Commission also emphasized the importance of relative prices.[2] Some recent work in this area also supports this contention.[3] It has been hypothesized in this study that varia-

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* This paper forms a part of the author's Ph. D. dissertation, submitted to the Indian Agricultural Research Institute (1969). The work was done under the supervision of Dr. K. Kanungo and his valuable contributions at all stages of the work are gratefully acknowledged.

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2. Report of the Sugar Enquiry Commission, Ministry of Food and Agriculture, Government of India, New Delhi, 1965.

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