*Indian Journal of Agronomy* 44 (2) : 237–241 (June 1999)

# Productivity and economics of different wheat (*Triticum aestivum*) based cropping sequences

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Received: July, 1997

## ABSTRACT

A field study was carried out for three years at the experimental farm of the Directorate of Wheat Research, Karnal to compare the productivity and economics of six important wheat based cropping sequences. Among the crop sequences tried, the most remunerative crop sequence was the one where Pusa Basmati were grown during *kharif* and wheat during *rabi* season with and without green manuring in one year crop rotation followed by the sequences where a crop of berseem was included during *rabi* or soybean and Pusa Basmati were grown during *kharif* in two-year rotation. Maize-wheat rotation gave the lowest average returns and the least profit. In basmati rice-wheat sequence, on an average about 85% net return was contributed by basmati rice and only 15% by wheat. Among the crops, the most remunerative was basmati rice followed by berseem, soybean and last profitable was maize.

***Key words:*** Productivity, Economics, Wheat based cropping sequence

Over the last two and a half decades, the intensive agricultural production technology has altered the production system in north-western India. Rice-wheat which is the most important cropping sequence occupies nearly 4.0 million hectares area in the north-western plains. Other crop rotations like soybean-wheat and maize-wheat are also practised in this zone. Inclusion of former sequence changes the productivity and economics of cropping sequences (Tomar and Tiwari, 1990 and Tomar et al., 1996). Since farmers are interested in maximum net returns per unit of area, a need was felt to compare production potential and economics of various wheat based cropping sequences in this region.

## MATERIALS AND METHODS

An experiment was conducted at the experimental farm of Directorate of Wheat Research, Karnal for three consecutive years 1993-94 to 1995-96. The experimental soil was clay loam in texture. The organic carbon and nitrogen contents were low whereas the soil was medium in phosphorus and potassium. Six crop sequences were tried in a randomised block design with four replications and a plot size of 60 $m^2$. All the crops were grown as per recommended package and practices. Irrigation was applied on the basis of important physiological stages to different

crops. The various three years crop sequences are as follows.

$T_1$ : Basmati rice-wheat-Basmati rice-wheat-Basmati rice-wheat

$T_2$ : Basmati rice-wheat-GM-Basmati rice-wheat GM-Basmati rice - wheat

$T_3$ : Soybean-wheat-Basmati rice-wheat-soybean-wheat

$T_4$ : Maize-wheat-maize-wheat-maize-wheat

$T_5$ : Rice-berseem-rice-wheat-rice-berseem

$T_6$ : Rice-berseem-maize wheat-rice-wheat

The varieties, seed rates, spacing and fertiliser dose etc. are given in Table 1. Nurseries of both basmati and non basmati rice varieties were grown in the last week of May by wet method and 25 days old seedlings were transplanted. *Sesbania aculeata* as green manure crop was grown after harvest of wheat was incorporated at 8 weeks after sowing. Weeds in crops were controlled with the use of recommended herbicides like Isoguard, butachlor, atrazine, and alachlor in wheat, rice, maize and soybean, respectively. The cost of cultivation was calculated by taking into account the prevailing prices of inputs like fertiliser, seed, herbicides, irrigation, tillage operations, transportation charges, interest on working capital, risk factor and management charges, etc. except the rental value of land. The returns were calculated using the prevailing procurement price of produce.

## RESULTS AND DISCUSSION

### *Grain yield and wheat grain equivalent*

The yield data and wheat grain equivalents of various crops in different years are presented in Table 2. The data reveal that green manuring of *Sesbania aculeata* after harvest of wheat increased the grain yield of succeeding rice crop. This increase in rice yield was pronounced in first year of green manuring than the subsequent years. Maximum wheat grain equivalent was recorded in green manured plot and comparable with non green manured plot of Basmati rice-wheat sequence and minimum in case of maize-wheat sequence. In all the three years of study, during *kharif* season, Basmati rice with and without green manuring produced at par grain equivalent yield and significantly higher than grain equivalent yield recorded with other crops and lowest was recorded with maize crop. Sharma and Mitra (1988) reported beneficial effect of green manuring which corroborate our finding because green manured plot was applied half of the recommended dose of nitrogen during *kharif* sea-

**Table 1.** Varieities, seed rates, spacing and fertilizer dose applied to different crops

| Crop | Variety | Seed rate (kg/ha) | Row spacing (cm) | N | $P_2O_5$ (kg/ha) | $K_2O$ |
|---|---|---|---|---|---|---|
| Basmati rice | Pusa Basmati | 30 | 20 | 90* | 60 | 40 |
| Rice | Pusa 33 | 40 | 20 | 120 | 60 | 60 |
| Wheat | CPAN 3004 | 100 | 22.5 | 120 | 60 | 40 |
| Soybean | PK 362 | 80 | 45 | 20 | 80 | 60 |
| Maize | Jawahar | 20 | 60 | 120 | 60 | 40 |
| Berseem | Pusa Giant | 25 | | 20 | 60 | |
| *Sesbania aculeata* | | 50 | | | | |

* Half nitrogen was applied to the crop following green manuing by *Sesbania aculeata*

**Table 2.** Grain yield and wheat grain equivalent (q/ha) in various wheat based cropping sequences

| Crop rotation | 1993–94 | | 1994–95 | | 1995–96 | |
|---|---|---|---|---|---|---|
| | *Kharif* | *Rabi* | *Kharif* | *Rabi* | *Kharif* | *Rabi* |
| | | | *Grain yield* | | | |
| $T_1$ | 46.3 | 41.5 | 45.8 | 40.9 | 44.8 | 42.2 |
| $T_2$ | 43.6 | 40.1 | 47.1 | 45.8 | 45.8 | 44.1 |
| $T_3$ | 29.4 | 51.0 | 45.0 | 41.9 | 26.5 | 39.6 |
| $T_4$ | 38.1 | 45.3 | 37.2 | 43.6 | 35.8 | 38.9 |
| $T_5$ | 52.6 | 950.8* | 56.3 | 45.1 | 53.2 | 1,059.3* |
| $T_6$ | 53.7 | 980.0* | 39.3 | 46.7 | 57.8 | 38.4 |
| | | | *Wheat grain equivalent* | | | |
| $T_1$ | 91.2 | 41.5 | 85.1 | 40.8 | 75.8 | 42.2 |
| $T_2$ | 85.7 | 40.0 | 87.4 | 45.7 | 77.6 | 44.0 |
| $T_3$ | 46.6 | 50.9 | 42.0 | 45.4 | 41.4 | 39.6 |
| $T_4$ | 30.6 | 45.2 | 30.9 | 43.7 | 28.9 | 38.8 |
| $T_5$ | 49.4 | 72.1 | 45.1 | 45.1 | 50.0 | 69.0 |
| $T_6$ | 50.3 | 74.2 | 32.6 | 46.6 | 54.2 | 38.3 |
| CD (P = 0.05) | 5.9 | 3.9 | 4.8 | 3.6 | 5.7 | 4.1 |

*Berseem fodder yield (q/ha)

**Table 3.** Wheat grain equivalent, cost of cultivation, returns, and benefit/cost ratio of various cropping sequences (Rs)

| Crops rotation | Wheat grain equivalent per year (q/ha) | Returns per year ($x10^3$) | Cost of cultivation* ($x10^3$) | Net return ($x10^3$) | Benefit/ cost ratio |
|---|---|---|---|---|---|
| $T_1$ | 125.5 | 44.40 | 26.57 | 17.83 | 0.67 |
| $T_2$ | 126.8 | 44.43 | 27.37 | 17.57 | 0.64 |
| $T_3$ | 88.5 | 35.77 | 22.57 | 13.20 | 0.58 |
| $T_4$ | 72.7 | 25.70 | 20.63 | 5.07 | 0.25 |
| $T_5$ | 113.4 | 40.23 | 26.57 | 13.67 | 0.51 |
| $T_6$ | 98.7 | 34.77 | 24.40 | 10.37 | 0.43 |

*Cost of cultivation does not include rental value of land

Procurement price of various crops in different years (Rs/q)

| Year | Rice | Basmati rice | Wheat | Maize | Soybean | Berseem |
|---|---|---|---|---|---|---|
| 1993–94 | 310 | 650 | 330 | 265 | 525 | 25 |
| 1994–95 | 340 | 650 | 350 | 290 | 570 | 25 |
| 1995–96 | 360 | 650 | 384 | 310 | 600 | 25 |

son. In *rabi* season, berseem exhibited significantly higher grain equivalent yield than other treatment.

Mean of three years data showed that Basmati rice-wheat, with and without green manuring, exhibited maximum grain equivalent followed by inclusion of berseem once in two years of rice-wheat rotation compared to other treatments. Maize-wheat sequence recorded lowest wheat grain equivalent (Table 3). The difference in wheat equivalents between with and without green manuring plots could not be observed due to the fact that only 50% N was applied to the crop grown after green manuring. Similar findings were also observed by Singh *et al.* (1996).

### *Cost of cultivation*

The cost of cultivation of Basmati rice-wheat-green manuring treatment was maximum followed by Basmati rice-wheat

**Table 4.** Economics of various wheat based cropping sequences (Rs x$10^3$)

| Crop rotation | 1993–94 | | 1994–95 | | 1995–96 | | Total |
|---|---|---|---|---|---|---|---|
| | *Kharif* | *Rabi* | *Kharif* | *Rabi* | *Kharif* | *Rabi* | |
| $T_1$ | | | | | | | |
| Returns | 30.1 | 137 | 29.8 | 14.3 | 29.1 | 16.2 | 133.2 |
| Cost of production | 13.9 | 11.8 | 14.4 | 12.1 | 15.0 | 12.5 | 79.7 |
| Profit | 16.2 | 1.9 | 15.4 | 2.2 | 14.1 | 3.7 | 53.5 |
| $T_2$ | | | | | | | |
| Returns | 28.3 | 13.2 | 30.6 | 16.0 | 29.8 | 16.9 | 134.8 |
| Cost of production | 13.9 | 11.8 | 15.5* | 12.1 | 16.3* | 12.5 | 83.3 |
| Profit | 14.4 | 1.4 | 15.0 | 3.9 | 13.5 | 4.4 | 51.5 |
| $T_3$ | | | | | | | |
| Returns | 10.1 | 14.9 | 10.8 | 15.3 | 11.1 | 14.9 | 77.1 |
| Cost of production | 8.2 | 11.8 | 8.5 | 12.1 | 8.8 | 12.5 | 61.9 |
| Profit | 1.9 | 3.1 | 2.3 | 3.2 | 2.3 | 2.4 | 15.2 |
| $T_4$ | | | | | | | |
| Return | 15.4 | 16.8 | 29.3 | 14.7 | 15.9 | 15.2 | 107.3 |
| Cost of production | 8.2 | 11.8 | 14.4 | 12.1 | 8.7 | 12.5 | 67.7 |
| Profit | 7.2 | 5.0 | 14.9 | 2.6 | 7.2 | 2.7 | 39.6 |
| $T_5$ | | | | | | | |
| Returns | 16.3 | 23.8 | 19.1 | 15.8 | 19.2 | 26.5 | 120.7 |
| Cost of production | 13.0 | 13.1 | 13.5 | 12.1 | 14.0 | 14.0 | 79.7 |
| Profit | 3.3 | 10.7 | 5.6 | 3.7 | 5.2 | 12.5 | 41.0 |
| $T_6$ | | | | | | | |
| Return | 16.6 | 24.5 | 11.4 | 16.3 | 20.8 | 14.7 | 104.3 |
| Cost of production | 13.0 | 13.1 | 8.5 | 12.1 | 14.0 | 12.5 | 73.2 |
| Profit | 3.6 | 11.4 | 2.9 | 4.2 | 6.8 | 2.2 | 31.1 |

* Includes cost of raising green manure crop

and the lowest was recorded in maize-wheat sequence. Interestingly annual costs of cultivation of rice-wheat and rice-berseem-rice-wheat sequence were similar due to its cutting and transportation cost (Table 3). Among all the crops studied, the cultivation expenditure involved was maximum in Basmati rice and minimum in maize crop (Table 4).

***Net returns***

The most remunerative crop sequence was the one where Pusa Basmati was grown during *kharif* and wheat during *rabi* season with and without green manuring (Table 3) in one year crop rotation followed by the sequences where a crop of berseem was included during *rabi* or soybean and Pusa Basmati were grown during *kharif* in two year rotation. Maize-wheat rotation gave the lowest average returns and the least profit among the crop sequences tried. Benefit-cost ratio was maximum in rice-wheat sequence and minimum in case of maize-wheat sequence. The profit obtained in different years showed that in basmati rice-wheat sequence, on an average 85% net return was contributed by basmati rice and only 15% by wheat (Table 4).

It can be concluded from the present study that among the crop sequences tried, Basmati rice-wheat was the most profitable and maize-wheat gave the minimum returns. Among the various crops, basmati rice was most profitable followed by berseem, soybean and least profitable was maize. Since, berseem and soybean give reasonably good returns among the crops tried, these could be the crops which can be considered for diversification of rice-wheat system. It is more so, because the net returns from soybean were better than from coarse rice.

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