*Indian Journal of Agronomy* **47** (2) : 151–154 (June 2002)

# Productivity and economics of rice (*Oryza sativa*)-based crop sequences under stored water supply in Kymore plateau of Madhya Pradesh

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Received : May 2001

## ABSTRACT

A field experiment was conducted during 1999–2000 and 2000–2001 on a silty clay-loam soil, to identify suitable rice (*Oryza sativa* L.) based cropping systems with high productivity under stored water supply in Kymore plateau of Madhya Pradesh. Rice, as a base crop, was sequenced with other feasible winter crops, viz. wheat (*Triticum aestivum* L. emend. Fiori & Paol.), pea (*Pisum sativum* L.) for green pods, potato (*Solanum tuberosum* L.) and tomato (*Lycopersicon esculentum* Mill. nom. cons.). Green pods of pea taken after rice with 4 irrigations gave the highest rice equivalent yield (84.99 q/ha) and net return (Rs 42,900/ha). The second best sequence was tomato after rice (89.63 q/ha and Rs 38,200/ha) followed by potato after rice (67.52 q/ha and Rs 28,470/ha). Wheat after rice gave the lowest rice-equivalent yield (46.92 q/ha) and net return (Rs 18,940/ha) with 4 irrigations. Irrigation efficiency and water-use efficiency were higher in potato and tomato grown after rice. Rice yield up to 28 q/ha and net return up to Rs 9,000/ha were common in all the sequences. Rice pea sequence recorded lower land-use efficiency and higher production efficiency, while the reverse was true in case of rice–wheat sequence.

***Key words :*** Rice-based crop sequences, Productivity, Economics, Rice-equivalent yield

Rice is the main fall-season crop of Kymore plateau which represents the hot sub-humid climatic zone. The rice–wheat is the dominant cropping system in this zone under the situation of assured water supply. However, the cropping intensity is only 133%. Due to high market price, vegetable crops grown after rice may be more profitable instead of wheat with the same amount of available water. Profitability of vegetables grown after rice has not yet been investigated. Therefore taking wheat as the principal winter-season crop, an experiment was conducted to identify ideal rice-based rotations as well as irrigation requirement which can suit the farmers of the region.

## MATERIALS AND METHODS

A field experiment was conducted during winter season of 1999–2000 and 2000–2001 on the farmers field of village Kapsa (Rewa). The soil was silty clay-loam having pH 6.98, organic carbon 0.54%, electrical conductivity 0.32 dS/m, available N, $P_2O_5$ and $K_2O$ 194.6, 13.68 and 293.67 kg/ha respectively. The treatments comprised 3 irrigation frequencies, *i.e.* 2, 3 and 4, in the main plots and 4 winter crops in the crop sequences with rice as the base crop in the sub-plots (as per Table 2). These were laid out in split-plot design with 3 replications. The recommended dose of N and $P_2O_5$ applied were 100 and 60 kg/ha to wheat ('DL 803-3') and tomato ('Pusa Rubi'), 20 and 40 kg/ha to pea ('Azad 1'), 150 and 75 kg/ha to potato ('SLP 16-45') through diammonium phosphate and urea.

The sprouted seeds of rice ('Jawahar 3-45') were broadcast @ 100 kg/ha on the puddled soil by the first week of July, and the crop was harvested on the second week of October. Rice was fertilized with 80 kg N and 50 kg $P_2O_5$/ha. All the winter season crops were sown after rice by the second fortnight of November. The irrigation of these crops was given as per schedule (Table 1). During both the years, wheat was harvested between 10 and 15 April, green pods of pea between 15 January and 10 March, tomato between 15 February and 15 April, and potato between 15 and 20 February. The mean of weather parameters showed a maximum temperature of 20.2–44.5°C, minimum temperature of 4.4–31°C, relative humidity 63–97%, and mean annual precipitation of 1,050 mm spread over 49 days. The comparison among the cropping sequences was done by converting the respective yields of winter crops into rice-equivalent yield on the price basis.

## RESULTS AND DISCUSSION

### *Rice-equivalent yield*

Among the rice-based cropping sequences, green pods of pea taken after rice proved significantly more productive which recorded rice-equivalent yield up to 80.30 q/ha, followed by tomato 77.46 q/ha and potato 57.09 q/ha (Table 2).

The lowest productivity in terms of rice-equivalent yield was recorded in case of wheat grown after rice. This may be due to low market value of wheat compared to green pods of pea or tomato. Moreover, the gradual reduction in yield of wheat after rice might be attributed to impaired soil structure developed out of continuous puddling of soil for rice and lack of legume crops in the sequences. Singh *et al.* (1984) and Padhi (1993) reported similar results. However, these results differ from those of

**Table 1.** Irrigation schedule (days after sowing) for winter crops

| No. of irrigations | Winter crop | | | |
|---|---|---|---|---|
| | Wheat | Green peas | Tomato | Potato |
| 2 | 21 | 20 | 30 | 20 |
| | 80 | 60 | 70 | 60 |
| 3 | 21 | 20 | 30 | 20 |
| | 60 | 40 | 60 | 60 |
| | 85 | 60 | 90 | 80 |
| 4 | 21 | 30 | 20 | 20 |
| | 42 | 50 | 60 | 40 |
| | 70 | 70 | 90 | 50 |
| | 90 | 85 | 115 | 70 |

Hasan (1999), who reported that wheat after rice proved to be the best over winter-season crops other than vegetables. Four irrigations proved significantly superior to 2 or 3 irrigations. This may be due to sufficient soil moisture available to the crop plants for the absorption of required plant nutrients applied to the soil, thus fertilizer-use efficiency might have enhanced.

The interaction of winter crops × irrigation was found to be significant. As such, green pods of pea taken after rice with 4 irrigations resulted in highest rice-equivalent yield. This was followed by tomato after rice and potato after rice. Vegetables, viz. pea (green pods) and tomato, responded well to more number of irrigations owing to their high moisture requirement compared with wheat crop.

### *Economics and productivity*

Maximum net returns were obtained from green pods of pea taken after rice (Table 2). This was followed by tomato grown after rice. The lowest net return was obtained from wheat grown after rice.

Four irrigations recorded the maximum net returns, followed by 3 irrigations. Green peas taken after rice with 4 irrigations further enhanced the net reutrn up to Rs 42,900/ha. The second best interactions was tomato grown with 4 irrigations.

Total productivity and net profit from different crop sequences varied only in case

**Table 2.** Rice-equivalent yield and net returns from winter crops as influenced by irrigation and crop sequences (pooled for 2 seasons)

| Crop sequence | Irrigations | | | Mean |
|---|---|---|---|---|
| | 2 | 3 | 4 | |
| *Rice-equivalent yield (q/ha)* | | | | |
| Rice–wheat | 37.21 | 40.63 | 46.92 | 41.58 |
| Rice–pea (green pods) | 75.32 | 80.62 | 84.99 | 80.31 |
| Rice–potato | 47.43 | 56.32 | 67.52 | 57.09 |
| Rice–tomato | 64.34 | 78.42 | 89.63 | 77.46 |
| Mean | 56.07 | 63.99 | 72.26 | |
| *Net return (Rs/ha)* | | | | |
| Rice–wheat | 14650 | 16650 | 18940 | 16740 |
| Rice–pea (green pods) | 38390 | 41150 | 42900 | 40810 |
| Rice–potato | 15600 | 22930 | 28470 | 22330 |
| Rice–tomato | 23610 | 33030 | 38200 | 31610 |
| Mean | 23060 | 28440 | 32120 | |
| CD (P = 0.05) | *Irrigation* | *Crop sequence (winter crops)* | *Interaction* | |
| Rice-equivalent yield | 3.56 | 6.87 | 10.44 | |
| Net–returns | 660 | 760 | 13200 | |

**Table 3.** Yield, net return, land-use efficiency, production efficiency, irrigation efficiency and water-use efficiency under different crop sequences

| Crop sequence | Yield (q/ha) | | | Net returns (Rs/ha) | | | Land use efficiency (%) | Production efficiency (kg/ha/day) | Irrigation efficiency (%) | Water use (q/cm/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rice | Rice equivalent | Total | Rice | Winter crop | Total | | | | |
| Rice–wheat | 28 | 41.58 | 69.58 | 9,000 | 16,740 | 25,740 | 60.02 | 32.36 | 68.56 | 1.64 |
| Rice–pea (pods) | 28 | 80.31 | 108.31 | 9,000 | 40,810 | 49,810 | 47.94 | 61.89 | 72.11 | 1.80 |
| Rice–potato | 28 | 57.09 | 85.09 | 9,000 | 22,330 | 31,330 | 52.05 | 44.78 | 76.02 | 5.56 |
| Rice–tomato | 28 | 77.46 | 105.46 | 9,000 | 31,610 | 40,610 | 64.38 | 44.88 | 72.95 | 6.20 |

*Production efficiency is based on the rice-equivalent yield plus rice yield

of winter crops under each sequence (Table 3). Rice pea sequence recorded the lower land-use efficiency (LUE) and the highest production efficiency (PE), whereas the situation was reverse in case of rice–wheat sequence. Irrigation efficiency and water-use efficiency were higher in potato and tomato grown after rice. This may be due to increased productivity of these crops per unit of water used over wheat and pea. The findings allude that pea (green pods) taken after rice with 4 irrigations was the most profitable in comparison to wheat grown after rice. The second best vegetable crop was tomato grown after rice with 4 irrigations.

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