

On-farm evaluation of agronomic management on productivity and economics of rice (*Oryza sativa*)–wheat (*Triticum aestivum*) system*

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The field experiment was conducted during 2006–08 at 18 locations of farmers' field in Dehradun and Pauri districts of Uttarakhand to study the effect of agronomic management practices in rice (*Oryza sativa* L.)–wheat (*Triticum aestivum* L. emend. Fiori & Paol.) cropping system. Recommended packages and practices resulted in higher incremental net returns (Rs 6 496/ha and Rs 18 717/ha in rice and wheat, respectively) over farmers' practices. Highest total system incremental net returns of Rs 25 213/ha was also recorded with recommended packages and practices.

Agronomic management is a most important non-monetary input for getting potential yield and high net returns in any crop or crop sequence. Rice–wheat is the predominant cropping system in the districts of Dehradun and Pauri of Uttarakhand. Most of the farmers here use to grow old varieties of rice and wheat without row arrangement. Fertilization is mainly limited to nitrogenous fertilizers only. All these together contribute to low productivity of the crops. During 2006–07, productivity of rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L. emend. Fiori & Paol.) in Uttarakhand was 1.94 tonnes/ha and 2.04 tonnes/ha, respectively. Ratio of NPK use in the state has been 12:2.8:1 during 2006–07 instead of 4:2:1 as advisable.

Therefore, the present study was undertaken to find out the effect of different agronomic management practices on grain and straw yield and gross, net and incremental returns over farmers' practice in rice–wheat cropping system.

An on-farm investigation was carried out in 18 villages of 6 blocks in districts of Pauri and Dehradun of Uttarakhand, namely Pauri, Khirsu, Dugadda in district Pauri and Kalsi, Vikasnagar, Doiwala in district Dehradun continuously for 2 years from 2006–07 to 2007–08. Four treatments were evaluated in randomized block design considering every location (18) as a replication.

*Short note

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T₁, farmers' practice (in general no line sowing, old varieties, imbalanced use fertilizer use, i.e. high nitrogen, less or no phosphorus and potassium); T₂, farmers' practice + improved variety; T₃, farmers' practice + improved variety + line sowing/transplanting and T₄, farmers' practice + improved variety + line sowing/transplanting + balanced fertilization

During the rainy (*kharif*) season rice was taken and during winter (*rabi*) season wheat was taken continuously during 2006–07 and 2007–08. During 2006–07, 'Pant Dhan 12' and 'PBW 343' were taken as improved varieties in rice and wheat, respectively. While during the next year 'PR 113' rice variety and 'UP 2572' wheat were taken as improved ones. Soils was low in available N (150–300 kg), medium in available P (10–20 kg), high in available K (225–310 kg) and medium to high in organic carbon (0.5–0.90%). The data was recorded on grain and straw yield and cost of cultivation and calculated as per the prevailing market prices of inputs and the produce.

Highest grain yield (4 733 kg/ha) and straw yield (6 298 kg/ha) of rice was recorded with the treatment having all recommended packages and practices (T₄), followed by T₃ (farmers' practice + improved variety +line sowing/transplanting) (4 549 kg/ha and 6 019 kg/ha, grain and straw yield, respectively) (Table 1). Treatment T₄ found significantly superior to rest of the treatments for grain yield, however, it was at par with T₃ for straw yield. Treatments T₃ and T₄ gave significantly higher grain and straw yield of rice over the treatments T₁ (farmers' practice) and T₂ (farmers' practice + improved variety). Treatment having the improved variety along with the farmers' practice (T₂) gave significantly higher grain yield over the farmers' practice (T₁).

Highest cost of cultivation (Rs 18 661/ha) was recorded with the T₄ treatment and it was significantly higher compared to all other treatments. Treatment T₃ had higher cost of cultivation over the treatments T₁ (farmers' practice) and T₂ (farmers' practice + improved variety). Highest gross,

Table 1 Grain and straw yield (kg/ha) and economics (Rs/ha) in rice of different agronomic techniques during *kharif* season

Agronomic management	Grain yield	Straw yield	Cost of cultivation	Gross returns	Net returns	Incremental net returns
T ₁	3 673	4 954	16 980	28 929	11 949	
T ₂	4 005	5 323	17 263	31 445	14 182	2 333
T ₃	4 549	6 019	18 316	35 616	17 300	5 351
T ₄	4 733	6 298	18 661	37 107	18 445	6 496
CD (P=0.5)	160	257	195	1301	1 314	

Table 2 Grain yield and straw yield (kg/ha) and economics (Rs/ha) in wheat of different agronomic techniques during *rabi* season

Agronomic management	Grain yield	Straw yield	Cost of cultivation	Gross returns	Net returns	Incremental net returns
T ₁	3 058	3 925	16 039	46 166	30 126	
T ₂	3 345	4 221	16 397	50 707	3 4 310	4 184
T ₃	3 824	4 757	17 669	64 695	47 026	16 900
T ₄	3 965	4 941	18 004	66 847	48 843	18 717
CD (P=0.5)	113	163	440	10 710	10 742	

net and incremental returns were recorded with T₄ treatment (Rs 37 107, Rs 18 445 and Rs 6 496, respectively), followed by T₃ (farmers' practice + improved variety + line sowing). T₃ resulted in higher net returns over the T₁ (farmers' practice) and T₂ (farmers' practice + improved variety). Inclusion of line sowing in farmers' practice gave higher net returns (Rs 14 182/ha) over the farmers' practice.

Selection of improved variety (T₂, farmers' practice + improved variety) over the old variety (T₁, farmers' practice) resulted in significant increase in cost of cultivation by Rs 283/ha only and it ultimately significantly increased the gross returns by Rs 2 516/ha and net returns by Rs 2 233/ha. When improved variety was sown in lines (T₃) it resulted in significant increase in cost of cultivation by Rs 1 053/ha over the treatment having improved variety but no line arrangement (T₂), and finally it increased net and gross returns by Rs 3 118 and Rs 4 171, respectively and this increase was also significant. When the treatment having all recommended packages and practices (T₄) was compared with T₃, it was found that cost of cultivation increased by Rs 345/ha only while, net and gross returns increased by Rs 1 145/ha and Rs 1 491/ha, respectively.

Rs 1 681/ha higher cost of cultivation was recorded with T₄ than T₁ and net and gross returns were increased by Rs 6 496/ha and Rs 8 178/ha, respectively. It is obvious that inclusion of improved variety, line sowing and recommended fertilization in rice crop increased the cost of cultivation but inclusion of these factors also resulted in higher grain and straw yield in rice which in turn increased the net and gross returns. Sharma *et al.* (2007) and Bhagat R K (2002) also reported similar findings.

Significantly highest grain (3 965 kg/ha) and straw yield (4 941 kg/ha) of wheat was recorded with the treatment T₄

(farmers' practice + improved variety + line sowing/transplanting + balanced fertilization) and these yields were significantly higher over the rest of the treatments (Table 2). T₃ (farmers' practice + improved variety +line sowing/transplanting) gave significantly higher grain and straw yield over T₁ and T₂. Treatment T₂ was significantly superior to T₁ for grain and straw yield. Inclusion of improved variety (T₂: farmers' practice + improved variety) did not increase the cost of cultivation significantly over the farmers' practice. However when the crop was sown in lines along with the improved variety (T₃: farmers' practice + improved variety +line sowing/transplanting) it resulted into increase in cost of cultivation over T₁ and T₂. T₄ resulted in significantly highest cost of cultivation (Rs 18 004/ha) than rest of the treatments, except T₃. Highest gross, net and incremental returns (Rs 66 847/ha, Rs 48 843/ha and Rs 18 717/ha, respectively) were recorded with T₄ (farmers' practice + improved variety + line sowing/transplanting + balanced fertilization), however, these were at par with T₃. Treatment T₃ and T₄ gave higher net and gross returns over the treatments T₁ and T₂.

Inclusion of improved variety did not cause significant increase in cost of cultivation, net returns and gross returns over the farmers' practice. However, when wheat was sown in lines along with the improved variety, it resulted in significant increase in cost of cultivation (Rs 1 272/ha) along with net returns (Rs 12 716/ha) and gross returns (Rs 13 988/ha) over the treatment T₂. Farmers' practice + improved variety + line sowing/transplanting + balanced fertilization had increased cost of cultivation (non-significant) by Rs 335/ha over the treatment T₃; farmers' practice + improved variety +line sowing/transplanting but it resulted in significant increased net returns by Rs 1 817/ha and gross returns by Rs

Table 3 Total system yield and economics of different agronomic techniques in rice-wheat system

Agronomic management	Total system yield (kg/ha)	Total cost of cultivation (Rs/ha)	Total gross returns (Rs/ha)	Total net returns (Rs/ha)	Total incidental net returns over farmer's practice (Rs/ha)
T ₁	6 317	33 019	75 095	42 076	
T ₂	7 350	33 660	82 152	48 492	6 416
T ₃	8 373	35 985	1 00 311	64 326	22 250
T ₄	8 698	36 666	1 03 954	67 289	25 213
CD (P=0.5)	264	487	10 903	10 060	

2 152/ha. Pandey *et al.* (2001) also reported that complete package of practices resulted in significantly higher mean grain yield (3, 021 kg/ha) and net returns (Rs 7 797/ha) compared with the grain yield (1 497 kg/ha) and net returns (Rs 1 670/ha) obtained under farmer's practice. Several other workers have also reported increased net and gross returns by use of improved variety, line sowing and recommended fertilization (Sharma *et al.* 2007 and Rinwa *et al.* 2003).

Rice-wheat system as a whole

When treatments were compared for the economics and grain and straw yields of the rice-wheat system as a whole, it was found that treatment T₄ (farmers' practice + improved variety + line sowing/transplanting + balanced fertilization) had higher system yield (8 698 kg/ha) and it was significantly higher than the rest of the treatments, followed by T₃ (farmers' practice + improved variety + line sowing/transplanting) (Table 3). Farmers' practice (T₁) produced minimum system yield (6 317 kg/ha).

Highest cost of cultivation (Rs 36 666/ha) was recorded with the treatment T₄ and it was significantly higher over rest of the treatments. Treatment T₃ (farmers' practice + improved variety + line sowing/transplanting) had significantly higher cost of cultivation over the treatments T₁ and T₂. Farmers' practice (T₁) had least cost of cultivation (Rs 33 019/ha). Highest gross returns (Rs 10 3954/ha), net returns (Rs 67 289/ha) and incremental returns (Rs 25 213/ha) were recorded with T₄ (farmers' practice + improved variety + line sowing/transplanting + balanced fertilization),

followed by T₃ (farmers' practice + improved variety + line sowing/transplanting). Treatment T₃ and T₄ had significantly higher net and gross returns over the treatments T₁ (farmers' practice) and T₂ (farmers' practice + improved variety).

SUMMARY

The findings of the present study envisage that for feeding of the ever-growing population, farmers should go for recommended package of practices in rice and wheat cropping system without any compromise. However, resource-poor and marginal farmers who cannot afford to apply the full package should go at least one most critical factor.

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