ECONOMIC FEASABILITY OF ORGANIC MATERIALS IN ORGANIC FARMING OF RICE-BASED CROPPING SYSTEMS

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ABSTRACT

The field experiments were carried out on research farm of Indian Agricultural Research Institute, New Delhi during crop cycles of 2006-2007 and 2007-2008. The experiment was laid out in a strip plot design with three replications. Treatments consisted of two cropping systems (Rice-wheat and rice-wheat-mungbean) in columns, six combinations of different organic materials and biofertilizers [farmyard manure equivalent to 60 kg N ha\textsuperscript{-1} (FYM), vermicompost equivalent to 60 kg N ha\textsuperscript{-1} (VC), FYM + crop residue of preceding crop @ 6 t ha\textsuperscript{-1} for rice and wheat and 3 t ha\textsuperscript{-1} for mungbean (CR), VC + CR, FYM + CR + biofertilizers and VC + CR + biofertilizers] and control (no fertilizer applied) in rows. Application of vermicompost + crop residue + biofertilizers was most productive and FYM + crop residue + biofertilizers was economical for nutrient need of rice-based cropping systems. Rice-wheat-mungbean cropping system was more sustainable economically to the traditional rice-wheat cropping system.

Keywords: Rice, wheat, mungbean, organic farming, FYM, vermicompost, biofertilizers, crop residue and agroeconomic.

INTRODUCTION

The rice (\textit{Oryza sativa}) – wheat (\textit{Triticum aestivum}) cropping system (RWCS) occupy about 28.8 million hectares (m ha) in five Asian countries, namely, India, Pakistan, Nepal, Bangladesh and China (Prasad, 2005). Organic farming of Basmati rice-based cropping system is another alternative system for sustainability of crop production and natural resources. Moreover, there is a great demand of organically grown food in European and Middle East countries and offer two to two and half times higher prices for organic produce. Thus research on organic farming will open new vistas in Indian Agriculture. Organic farming often has to deal with a scarcity of readily available nutrients in contrast to inorganic farming which rely on soluble fertilizers. The aim of nutrient management in organic systems is to optimize the use of on-farm resources and minimize losses (Kopke, 1995). Maximum use of crop residues should be made that can contribute toward building soil fertility (Jasdan and Huchtaon, 1996). Rice and wheat straw has large potential for plant nutrients in organic farming of rice-wheat system. The straw in the system accounts about 35-40% N, 10-15% of P and 80-90% of K removal by these crops (Sharma and Sharma, 2004). Incorporation of straw, thus, results in recycling of a sizable amount of plant nutrients. However, there is a great difficulty in using the plant residue of cereals due to higher C: N ratio. Hence there is an urgent need to develop a suitable technology to use crop residue in organic farming. We have to mix the plant residues of cereals with well decomposed...
farmyard manures/compost/vermicompost or plant residue of legumes for narrowing down of C:N ratio so as to overcome the adverse effect of immobilization of native plant nutrients. Sharma et al. (1995) and Sharma and Prasad (1999) reported that incorporation of mungbean residue was found to be at par with Sesbania green manure in rice-wheat system.

**MATERIAL AND METHODS**

The field experiment was conducted in the research farm of the Indian Agricultural Research Institute, New Delhi for two years from 2006-2007 to 2007-2008. The soil type of the experimental field was a sandy clay loam (*typical Ustochrept*) with 52% sand, 23% silt and 25% clay. The experiments were laid out in a strip plot design consisting of two cropping systems (rice-wheat and rice-wheat-mungbean) with six fertilizer treatments and a control (no fertilizer applied), and replicated three times. The six fertiliser treatments consisted of combinations of organic manures (vermicompost, farmyard manure & crop residues) and biofertilizers including the following: (1) farmyard manure equivalent to 60 kg N ha\(^{-1}\) (FYM), (2) vermicompost equivalent to 60 kg N ha\(^{-1}\) (VC), (3) FYM + crop residue of preceding crop (crop residue applied @ 6 t ha\(^{-1}\) in wheat and mungbean and @3 t ha\(^{-1}\) in rice) (CR), (4) VC + CR, (5) FYM + CR + biofertilizers (B) and (6) VC + CR + B] Biofertilizers consisted of blue green algae + cellulolytic culture (CC) + Phosphorus solubilizing bacteria (PSB) in rice and *Azotobacter* + CC + PSB for wheat and *Rhizobium* + PSB for mungbean. Residue of previous crop was incorporated before the sowing/planting of succeeding crop. It means, rice residue was incorporated for wheat, wheat residue for rice in rice-wheat cropping system and in mungbean in rice-wheat-mungbean cropping system, followed by residue incorporation in wheat in this cropping system. *Vigna radiata* was sown with hand plough in the rows at a uniform spacing of 25 cm. It was grown to picking of pods for grain and then incorporated with the help of tractor drawn mould board plough as green manure. The nutrient composition of rice, wheat and mungbean residues given in Table 1.

**Table 1. Chemical composition of crop residues**

<table>
<thead>
<tr>
<th>Composition</th>
<th>2006-07</th>
<th>2007-08</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Rice</td>
<td>Wheat</td>
</tr>
<tr>
<td>Total N (mg kg(^{-1}))</td>
<td>4700</td>
<td>3900</td>
</tr>
<tr>
<td>Total P (mg kg(^{-1}))</td>
<td>680</td>
<td>490</td>
</tr>
<tr>
<td>Total K (mg kg(^{-1}))</td>
<td>14600</td>
<td>15600</td>
</tr>
<tr>
<td>Organic C (mg kg(^{-1}))</td>
<td>408000</td>
<td>400000</td>
</tr>
<tr>
<td>Fe (mg kg(^{-1}))</td>
<td>434.23</td>
<td>349.80</td>
</tr>
<tr>
<td>Zn (mg kg(^{-1}))</td>
<td>100.52</td>
<td>29.89</td>
</tr>
<tr>
<td>Mn (mg kg(^{-1}))</td>
<td>58.23</td>
<td>73.69</td>
</tr>
<tr>
<td>Cu (mg kg(^{-1}))</td>
<td>40.02</td>
<td>16.85</td>
</tr>
</tbody>
</table>
Productivity of rice based cropping systems was calculated in terms of rice equivalent (RE) by using the following expression:

\[
\text{Wheat yield} \times \text{Wheat price} \\
\frac{\text{Wheat}}{\text{Rice price}} = \text{RE of wheat}
\]

\[
\text{Mungbean yield} \times \text{Mungbean price} \\
\frac{\text{Mungbean}}{\text{Rice price}} = \text{RE of mungbean}
\]

Total productivity = Rice yield + RE of wheat and RE of mungbean

Cost of cultivation of rice, wheat, and mungbean was calculated on the basis of prevailing rates of inputs and gross income was calculated on the basis of procurement price of rice and wheat grain and prevailing market price of rice and wheat straw. The income was obtained by subtracting cost of cultivation from gross income i.e.

\[
\text{Net income} = \text{gross income} - \text{cost of cultivation}
\]

The net profit of the rotation was calculated by adding the net profits of the rice, and wheat together.

**RESULTS**

The combination of FYM + crop residue (CR) resulted in higher increase in growth and yield attributing characters of rice than FYM alone which led to 28-38% increase in grain yield and 27-33% increase in straw yield. However, higher increase in grain yield with FYM + CR as compared to FYM alone was not significant. Application of FYM + CR gave significantly higher gross profit of rice than FYM alone in both the years of study. Net profit of rice increased with the application of FYM + CR over control by Rs 11050-14710 ha\(^{-1}\) against Rs 6060-9050 ha\(^{-1}\) with FYM alone. The combination of FYM + CR was better than FYM alone for improvement in growth and yield attributes of wheat which resulted in 13-15% increase in grain yield over FYM alone. The combination of FYM + CR also increased gross and net income by 12-15 and 12-15%, respectively over FYM alone. The combination of FYM + CR resulted in higher increase in all the growth parameters, yield attributes except in number of grains pod\(^{-1}\) which led to 35-39% increase in grain yield of mungbean over FYM alone. The combination of FYM + CR increased gross income of mungbean by Rs 5580-6920 over FYM alone and by 7480-9400 ha\(^{-1}\) over control but net return decreased by Rs 420 in first year and increased by Rs 930 in second year over FYM alone. Combination of FYM + CR significantly increased productivity of rice-based cropping systems over FYM alone by 14-16%. The increase in productivity led to 16-19% higher increase in higher increase in gross income and 10-12% higher increase in net income over FYM alone. Kachroo *et al.* (2006) reported that incorporation of wheat residues in rice increased the productivity and yield components of rice.
Application of VC + CR resulted in higher increase in number of tillers in first year, test weight in second year and panicle length, grain fertility percentage in both the years of study and significantly decreased in unfilled grains per panicle in both the years as compared to VC alone, which led to 33-40% increase in grain yield and 29-39% increase in straw yield with VC + CR against 19-34% increase in grain yield and 23-27% increase in straw yield with VC alone over control. VC + CR was superior to VC alone in respect of gross return and net profit of rice in both the years. The combination of VC + CR was significantly better than VC alone for improvement in growth and yield attributes of wheat which resulted in 18-12% increase in grain yield and 10-18% increase in straw yield over VC alone. The combination of VC + CR increased gross profit by Rs 5890-6930 over VC alone, but net return decreased by Rs 110 in first year and increased by 930 in second year. Combination of VC + CR significantly increased productivity of rice-based cropping system over VC alone gross income by 12-15% and net income by 11-14% over VC alone. Bisht et al. (2006) reported that inclusion of mungbean as catch crop after wheat harvest in rice-wheat system and its incorporation (after picking of mature pods) to serve as green manure crop in situ in rice-wheat-mungbean cropping system was found most productive, remunerative and sustainable system.

Inoculation of BGA + PSB with FYM + CR led to 7.7-9.6% increase in grain yield and 3.6-6.2% increase in straw yield over FYM + CR. Inoculation of BGA + PSB with FYM + CR also significantly increased gross profit of rice by Rs 6000-9340 ha⁻¹ and net return of rice by Rs 5840-9180 ha⁻¹ over FYM + CR. Inoculation of Azotobacter + PSB with FYM + CR in wheat significantly increased number of grains spike⁻¹ and test weight over FYM + CR which resulted in 10-13% higher increase in grain yield and 8-10% higher increase in straw yield over FYM + CR, which in turn resulted in net income with FYM + CR + B over FYM + CR. Inoculation of Rhizobium + PSB with FYM + CR increased gross and net profit of mungbean by Rs 1590-2100 ha⁻¹ and Rs 1410-1920 ha⁻¹ over FYM + CR or VC + CR, respectively. Inoculation of biofertilizers with FYM + CR significantly increased productivity of rice-based cropping systems by 9-13%, gross profit by 9-11% and net profit by 13-15% over FYM + CR.

Inoculation of BGA + PSB with VC + CR increased gross return by Rs 4550-6520 over VC + CR and net return of rice by Rs 4390-6360 ha⁻¹. Inoculation of Azotobacter + PSB with VC + CR resulted in significant and non-significant increase in all the growth parameters and yield attributes of wheat over VC + CR alone which resulted in 7-11% increase in grain yield, 4-7% increase in straw yield, 7-10% increase in gross income and 10-17% increase in net income over VC + CR. Inoculation of biofertilizers with VC + CR also made higher contribution to rice based cropping system as compared with VC + CR as VC + CR + B increased productivity by 6-7%, gross profit by 6-7% and net profit by 9-13% over VC + CR.

On the basis two years investigation, it may concluded that Application of vermicompost + crop residue + biofertilizers (BGA + cellulolytic culture + PSB in rice, Azotobactor + cellulolytic culture + PSB in wheat, Rhizobium + PSB in mungbean) was most productive and FYM + crop residue + biofertilizers was economical for nutrient need of rice-based cropping systems. Both these combinations resulted in higher improvement in grain quality and physical, chemical and biological properties of soil. Rice-wheat-mungbean cropping system was more sustainable economically to the traditional rice-wheat cropping system.
Fig. 1. Effect of cropping systems, organic materials and biofertilizers on productivity of rice base cropping systems

![Graph showing productivity of rice base cropping systems](image)

Fig. 2. Effect of cropping systems, organic materials and biofertilizers on net return of rice-based cropping systems

![Graph showing net return of rice-based cropping systems](image)
REFERENCES


