Influence of Organic Nutrient Management in Aromatic Rice on Productivity, Nutrient Concentration and Economics

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Indian scenario in Organic Cultivation

- India had only 1.03 mha under organic farming with 677,257 organic farmers in 2007 and it is estimated to increase to 2.0 mha in 2012 (NCOF, 2007).
- There are a number of “Organic by default” farms which have either never been chemically-managed/cultivated or have converted back to organic farming because of the farmers' beliefs or purely for reason of economics.
- Organic production in India growing @ 15-20% annually.
- Domestic market of organic produce in India is Rs 1500 crore.
- Organic food exports increased from to 78 m $ (2007-08) to 100m $ (2008-09).
- India exported organic produce of Rs 2500 Crores in 2007-08 (0.2% of the world).
- Albert Howard “Father of Organic agriculture” worked in India (Foreign service) during early 20th century.
Certified Organic Products Produced & Exported from India

- Cereals like wheat, rice particularly Basmati rice
- Beverage products like tea and coffee
- Spices like black pepper, white pepper, coriander, mustard, clove, cardamom, ginger, nutmeg, cinnamon, vanilla, chilli, turmeric, etc.
- Fruits like banana, pineapple, passion fruit and mango
- Vegetables - okra, brinjal, garlic, onion, tomato, potato
- Sugar and similar products
- Cashewnut, Groundnut
- Cotton
Indian Experience

- Traditionally Indian farmers are organic
- Gradually changed to chemical based cultivation since 1950’s
- Chemicals increasingly applied with Green Revolution
- Liberal use of chemicals led to health hazards
- Air, water and soil pollution noticed everywhere
- Soil fertility declined in many places, yield stagnated, factor productivity declined
- Concern developed for safe food production and environment protection
- A new trend began for returning to organic farming
National Programme for Organic Production (NPOP)- Launched by Ministry of Commerce, Govt. of India in 2000
Accreditation agencies under NPOP:
- APEDA (Agricultural and Processed food Products Export development Authority)
- Spices Board
- Coffee Board
- Tea Board
- Coconut Development Board
- Directorate of Cashew and Cocoa Development
- No. of states declared ‘organic states’
Basmati rice, characterized by long slender and silky grains, typical aroma, grain elongation upon cooking and good cooking qualities, is distinct from other aromatic rices.

Grown exclusively in Indo-Gangetic plains. India’s delicious and luxurious Basmati rice is well known all over the world.

India accounts for 60% of Basmati export globally.

Large portion of Indian Basmati rice production (2.5 million tonnes) is exported.
Possible inputs for organic Farming of rice

Manures
- Compost
- Vermicompost

Biofertilizers
- Blue Green Algae
- Sesbania
- Azolla
- Glyricidia
- Crotalaria
- Pongamia
- Cowpea

Green manuring
Blue Green Algae (BGA)

- BGA are attractive biofertilizers for rice which fix nitrogen and supply it to plants. It is recommended for organic farming of rice.
- Contributes 20-30 kg Nitrogen/ha and increases soil organic matter content.
- Suppresses weeds growth.
- Increases P-availability.
- Excretes plant growth regulators.
- Increases soil microbial population.

Azolla

- Azolla is an aquatic fern that harbours a N-fixing cyanobacterium *Anabaena azollae*.
- It is used as a bio-fertilizer for rice crop.
- High biomass production with high nitrogen fixing ability.
- Increases availability of macro and micronutrients.
- Improves soil physico-chemical properties and reduces water loss.
- Contributes 30-40 kg N/ha.
- Applied @ 1 tonne /ha.

Vermicompost: 1.0-1.6% N; 0.2-0.4% P2O5; 0.2-0.3% K2O and micronutrients.

FYM: 0.5-0.7% N; 0.4-0.8% P2O5; 0.5-0.9 K2O and micronutrients.
Organic farming in rice based cropping system through microbial inputs

Crop nutrition (main plot)

- T1: Organic (BGA@ 2.0 Kg/ha + Azolla @ 1.0 t/ha/ Azotobacter @ 0.5 kg/ha + FYM @ 5.0 t/ha + Vermicompost @ 5.0 t/ha)
- T2: INM (FYM 5 t/ha + Chemical Fertilizer N₉₀ P₆₀ K₆₀)
- T3: Chemical fertilizer alone N₁₂₀ P₆₀ K₆₀ (Recommended dose)

Cropping systems (Sub plot)

- Rice - Wheat (Control)
- Rice - Broccoli
- Rice - Cabbage
- Rice - Cauliflower
- Rice - Carrot

- For other crops also above fertility treatment were taken.
- Resource Conservation techniques followed
- Experimental design: Factorial R.B.D
- Main Plot size : 500 m²
- Rice variety ‘Pusa Basmati 1401’
- Transplanted rice
- Weed management through manual weeding
Effect of organic and inorganic nutrition of rice on grain yield (2009-11)

**Organic:** (BGA@ 2.0 Kg/ha + Azolla @ 1.0 t/ha + FYM@ 5.0t/ha + Vermicompost@ 5.0 t/ha)
**INM** (FYM @ 5.0 t/ha + Chemical fertilizer @ N$_{90}$ P$_{60}$ K$_{60}$)
**Chemical fertilizer alone** (N$_{120}$ P$_{60}$ K$_{60}$) - Rec. dose
Effect of rice nutrition on grain yield during 2003-08
Effect of crop nutrition on grain yield of Basmati rice in 2011
Testing on farmer’s fields
Management of pests

1. Cultural control: Land preparation, irrigation, transplanting, manual weed control, time of planting, destruction of crop residues etc. eg. BPH, YSB, sucking pests etc.

2. Mechanical control: Collection and destruction of various stages of pests eg. Rice bug, case worm etc.

3. Biological control: Parasites like Trichogramma and Predators like spiders, beetles, grass hoppers etc.

4. Use of pheromone traps - YSB, Leaf folder etc.

5. Use of Biopesticides/ botanicals like Neem products etc.

Pheromone traps
There was no serious incidence of any insect pest or disease in organic farming though there were severe incidences of BPH in some rice fields in IARI over the years.

- Population of beneficial insects like spiders was found to be increased under OF over inorganic and INM treatments.
Comparison of Organic and Conventional Basmati rice Cultivation on Damage by Insect Pests Infestation

The diagram above illustrates the comparison of Insect Damage (%) between Organic and Conventional systems of cultivation. It shows that Stem Borer damage is lower in Organic cultivation compared to Conventional, while Leaf Folder damage is significantly higher in Conventional compared to Organic. The error bars indicate the variability or precision of the measurements.
Comparison of Organic and Conventional Basmati Rice Cultivation on Disease Incidence

Disease Incidence (%) vs. Disease Types:
- BLB
- Sheath Blight
- Brown Spot
- Stem rot
- Blast

Comparisons:
- Organic
- Conventional

Graph displays disease incidence percentages for each type across both cultivation systems.
There was no serious attack of any insect pest or disease in organically grown rice crop.
Effect of crop nutrition on concentration of iron, zinc, copper and manganese in rice grains

- Iron
- Zinc
- Copper
- Manganese

Treatments

Organic
INM
Chemical
Micronutrient concentration in wheat grain

- Organic
- INM
- Chemical

Micronutrients:
- Iron
- Zinc
- Manganese
- Copper

Concentration (ppm)
Iron concentration in vegetable crops

Iron content in broccoli

Iron concentration in cabbage

Iron concentration in cauliflower

Iron concentration in carrot
Economics of different methods of rice crop nutrition

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Grain yield (t/ha)</th>
<th>Straw yield (t/ha)</th>
<th>Harvest Index</th>
<th>Cultivation Cost (Rs/ha)</th>
<th>Gross return (Rs/ha)</th>
<th>Net Return* (Rs/ha)</th>
<th>Net Return** (Rs/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td>4.72</td>
<td>9.20</td>
<td>33.9</td>
<td>48,392</td>
<td>113,040</td>
<td>64,647</td>
<td>90,607</td>
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<td></td>
<td>1.34</td>
<td>1.87</td>
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<tr>
<td>INM</td>
<td>4.58</td>
<td>8.90</td>
<td>34.0</td>
<td>41,424</td>
<td>109,660</td>
<td>68,236</td>
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<td>1.65</td>
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<tr>
<td>Chemical (control)</td>
<td>4.36</td>
<td>8.40</td>
<td>34.2</td>
<td>37,783</td>
<td>104,320</td>
<td>66,537</td>
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<td></td>
<td></td>
<td>1.76</td>
<td></td>
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<tr>
<td>CD at 5%</td>
<td>0.24</td>
<td>0.57</td>
<td>NS</td>
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</tbody>
</table>

Net return* at normal price
Net return** at 25% premium price
Value in parentheses indicate Benefit : Cost ratio

1 EURO = 69 Indian Rupees
# Yield and Economics of Different Crops in Rabi Season

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield of Economic product (t/ha)</th>
<th>Cost of cultivation (Rs/ha)</th>
<th>Gross return (Rs/ha)</th>
<th>Net return (Rs/ha)</th>
<th>Net return (Rs/ha)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WHEAT (HD 2851)</strong></td>
<td></td>
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<tr>
<td>ORGANIC</td>
<td>4.71 a</td>
<td>31545</td>
<td>81810</td>
<td>50265 (1.59)</td>
<td>63217 (2.00)</td>
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<tr>
<td>INM</td>
<td>4.77 a</td>
<td>27450</td>
<td>82417</td>
<td>54967 (2.00)</td>
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</tr>
<tr>
<td>CHEMICAL</td>
<td>4.33 b</td>
<td>24840</td>
<td>77630</td>
<td>52790 (2.13)</td>
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</tr>
<tr>
<td>C.D at 5%</td>
<td>0.36</td>
<td></td>
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<tr>
<td><strong>CABBAGE (Golden Acre)</strong></td>
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<tr>
<td>ORGANIC</td>
<td>33.54 a</td>
<td>65,675</td>
<td>2,68,320</td>
<td>2,02,654 (3.09)</td>
<td>2,69,725 (4.11)</td>
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<tr>
<td>INM</td>
<td>34.15 a</td>
<td>63,323</td>
<td>2,73,200</td>
<td>2,09,877 (3.31)</td>
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<tr>
<td>CHEMICAL</td>
<td>32.90 b</td>
<td>59,780</td>
<td>2,63,200</td>
<td>2,02,420 (3.39)</td>
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<tr>
<td>C.D at 5%</td>
<td>0.67</td>
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<tr>
<td><strong>CAULIFLOWER (Pusa Snow ball K-1)</strong></td>
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<tr>
<td>ORGANIC</td>
<td>31.64 a</td>
<td>65540</td>
<td>3,16,400</td>
<td>2,50,860 (3.83)</td>
<td>3,95,500 (6.03)</td>
</tr>
<tr>
<td>INM</td>
<td>32.29 a</td>
<td>63890</td>
<td>3,22,900</td>
<td>2,59,010 (4.05)</td>
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</tr>
<tr>
<td>CHEMICAL</td>
<td>30.54 b</td>
<td>61765</td>
<td>3,05,400</td>
<td>2,43,635 (3.94)</td>
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<tr>
<td>C.D at 5%</td>
<td>0.76</td>
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<tr>
<td><strong>BROCCOLI (Pusa KT 1)</strong></td>
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<tr>
<td>ORGANIC</td>
<td>20.36 a</td>
<td>68,786</td>
<td>4,07,200</td>
<td>3,38,414 (4.91)</td>
<td>4,40,214 (6.40)</td>
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<tr>
<td>INM</td>
<td>19.78 a</td>
<td>66340</td>
<td>3,95,600</td>
<td>3,29,260 (4.96)</td>
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<tr>
<td>CHEMICAL</td>
<td>18.64 b</td>
<td>63780</td>
<td>3,33,600</td>
<td>3,72,800 (5.85)</td>
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<tr>
<td>C.D at 5%</td>
<td>0.69</td>
<td></td>
<td></td>
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<tr>
<td><strong>CARROT (Nantes)</strong></td>
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<tr>
<td>ORGANIC</td>
<td>30.74 a</td>
<td>63670</td>
<td>3,07,400</td>
<td>2,43,730 (3.83)</td>
<td>3,84,250 (6.03)</td>
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<tr>
<td>INM</td>
<td>30.26 a</td>
<td>61500</td>
<td>3,02,600</td>
<td>2,41,100 (3.92)</td>
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<tr>
<td>CHEMICAL</td>
<td>29.41 b</td>
<td>59722</td>
<td>2,94,100</td>
<td>2,34,378 (3.92)</td>
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<tr>
<td>C.D at 5%</td>
<td>0.63</td>
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</tbody>
</table>

*Benefit : Cost ratio in parentheses

*at 25% premium price
On-farm Testing

On-Farm Trials (OFTs) were conducted for 3 years in farmer’s fields in 2 states of India to verify the research results. In OFTs, best organic treatment was compared with traditional practice of crop management. Two rice varieties viz. ‘Pusa Basmati-1’ and ‘Pusa Basmati 1121’ were taken.

A plot size of 1000 m² was taken for each treatment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rice Grain yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>‘Pusa Basmati-1’</td>
</tr>
<tr>
<td>Traditional Practice</td>
<td>4.41</td>
</tr>
<tr>
<td>Organic practice</td>
<td>4.25</td>
</tr>
<tr>
<td>C.D (0.05)</td>
<td>0.21</td>
</tr>
</tbody>
</table>
CONCLUSIONS

- Yields of *Basmati* (aromatic) rice with organic nutrient management was significantly higher than chemical fertilization.
- There was no/less incidence of insect-pest or disease in organic management.
- Organic farming is profitable only when produce are sold at premium price.
- Concentrations of Fe, Zn and Mn in rice grain increased significantly due to organic management over chemical fertilization.
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