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NATURAL RESOURCE MANAGEMENT

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Bio-intensive complementary cropping systems for higher productivity and profitability

Salient features

Bio-intensive system of raising maize for cobs + vegetable cow pea (1:1 ratio) on tractor made broad beds (BB) and *Sesbania* in furrows (F) during *kharif* and mustard in furrows and zero till sown 3 rows of lentil on broad beds in *rabi* while zero till sown 3 rows of green gram on beds in summer (for grain and residue incorporation) is suitable for marginal- and small- farm holders.

Performance results

The system produces the yield of 18.32 t ha^{-1} as rice equivalent with productivity of 50.2 kg grain $ha^{-1}day^{-1}$ and profitability of ₹363 $ha^{-1}day^{-1}$. The complimentary effects could be reflected in the system as in broad bed and furrow (BBF) system, the furrows served as drainage channels during heavy rains in *kharif* which were utilized for *in-situ* green manuring with 35 t ha^{-1} green foliage incorporated after 35 days of sowing and timely sown mustard crop in these furrows resulted a good harvest 1.94 t ha^{-1} and a bonus yield of lentil (1.44 t ha^{-1}) can be harvested. In the summer, green gram could yield 1.05 t ha^{-1} grains while incorporation of green foliage of about 4 t ha^{-1} in the soil further helps the system favourably.

Cost of technology

The cost of cultivation of bio-intensive complementary cropping system ranged from ₹48,000 to 64,500 per ha. The output in terms of rice equivalent yield jumped from 6.7 to 18.3 tonne ha^{-1}.

Impact and benefits

In overall 40% water, 10-20% energy, 30-40% nutrients and 50% pesticide use could be saved on one hand while productivity could be doubled on the other when compared to existing rice-wheat system.

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Integrated farming system model for western plain zone of Uttar Pradesh

Salient features

Integrated Farming System (IFS) approach is an appropriate strategy to improve the livelihood of marginal- and small- holders. IFS model for 1.5 ha comprising of crops (1.04 ha) + dairy animals (2 buffaloes + 1 cow) + horticulture crops (fruits, vegetables and flowers in 0.20 ha) + fishery (composite fish culture in 0.10 ha) + apiary (10 bee boxes) + vermicompost (0.01 ha) + boundary plantations all along the farm boundaries is found to be viable for 7 member family size. All the farm- and animal- wastes and crop residues were recycled in such a way that output of one enterprise was used as input for other and *vice-versa*.

Performance results

The IFS approach enabled to fulfil most of the household needs, sustained production through recycling of farm- wastes and crop residues, provided green fodders and feed concentrates to the dairy animals and green biomass. The bees collected nectar from the flowers of field crops and helped in cross pollination. More than 36% of total annual NPK requirements of crops can be met by recycling/addition of farm and animal wastes, crop residues and intercropping of dual purpose legumes etc. within the system itself. In addition to this, the silt of fish pond can be mixed in to soil once in three years. A total amount of 18.56 kg N, 6.21 kg P and 74.24 kg K was added by excavation of 15 cm deep ground soil surface of 800 m^2 pond area saving an amount of about ₹950. The OC of the soil was as high as 1.20 % with an average value of 0.95. Total manpower requirement for the model is 684 mandays /ha/year. The relative share of different component enterprises included in the IFS model were from Crop (41 %), Dairy (48 %), Horticulture (6 %) followed by Fishery (3.0 %) and Apiary (2 %) respectively.

Cost of technology

Annual Cost ₹197,883; Annual Gross Return ₹362,775; Net returns ₹164,892

Impact and benefits

IFS approach enables to get round the year income and nutritious food (cereals, pulses, oilseeds, sugar, vegetables, fruits, meat and milk) and feed & fodder (round the year green fodders, grains etc.) for human and animals. In addition, an average amount of rupees ranging from ₹46,663 in first four year and ₹77,932 in fifth year can be expected to meet other liabilities of the family. More than 57 per cent of the total cost of production of different farm commodities (₹188,574 per annum) could be met from the inputs (out- put of other enterprise/enterprises) generated within the system itself.

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Nutrient management for organic maize-potato-onion system

Salient features

In India many crop rotations involving maize are feasible. Maize-potato- onion is one of the important cropping systems under assured irrigation. The organic nutrient management packages for the system on holistic approach includes combinations of bulky organic manures like farmyard manure, the non-edible oilcake like neemcake, enriched organic manures like vermicompost and biofertilizers in various combinations. Application of one-third of FYM, one-third of vermicompost and one- third of neem oil cake along with rock phosphate and PSB can result into 32.2 t ha^{-1} maize equivalent yield besides increasing soil organic carbon, available N and P to the tune of 37.5, 92.7 and 203.6 % respectively over initial status.

Performance results

Maize equivalent yield of 32.2 tonne ha^{-1} can be obtained with organic package consisting of 33 % N application through FYM, 33 % N application through vermicompost and 33 % N application through neem- oilcake plus rock phosphate plus phosphatic biofertilizers.

Cost of technology

Organic nutrient management packages is based on the practice of the recycling on farm produced organic resources like crop residue, animal waste, green manuring.

Impact and benefits

Organically grown maize, potato and onion fetch higher profit to the farmers besides improving the soil- health in the long run. Soil organic carbon, available N and P increased by 37.5, 92.7 and 203.6 % respectively over initial status. Organic nutrient management package also improved the soil microbial diversity and also quality of the produce.

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Package of practices for organic production of crops in cropping system

Salient features

Package of practices for organic production of cropping systems have been developed under Network Project on Organic Farming. The systems which was giving consistently (6 years) higher net returns (>20 %) over inorganic farming are identified for the following five agro climatic zones.

View of Organic Farming Experiments

Cropping systems for organic production

(i) Western Himalayan zone : Cauliflower-radish-tomato and cabbage-radish- capsicum for Himachal Pradesh, rice-wheat-*Sesbania* and rice-pea (vegetable)- *Sesbania* for Uttarakhand

(ii) Eastern Himalayan zone: Rice-carrot for Meghalaya

(iii) Transgangetic Plains zone: Maize-gram, maize –potato- summer moong, rice-wheat- summer moong and maize-berseem – maize+cowpea in Punjab

(iv) Central Plateau and Hills zone: Rice-wheat-berseem for Madhya Pradesh

(v) Southern Plateau and Hills zone: Chilli- onion and turmeric +onion for Tamil Nadu and groundnut-sorghum for Karnataka

Salient technical features

(i) Western Himalayan zone: 50 % of recommended dose of N through reinforced farmyard manure + 50 % of recommended dose of N through vermicompost + spray of aqueous leaf extract of *bhang* (*Cannabis sativa*) for pest management in Himachal Pradesh, 25 % of recommended dose of N each of through enriched compost + vermicompost + non- edible oilcakes + farmyard manure + stale seed bed + 2 hand hoeing at 20 and 40 days after sowing for weed management in Uttarakhand.

(ii) Eastern Himalayan zone: 33 % of recommended dose of N through farmyard manure + 33 % of recommended dose of N through vermicompost + 33 % of recommended dose of N through local compost + spray of *karanji* @ 3 ml / lit for pest and disease management + mulching with fresh eupatorium/ ambrosia alone or with one hand weeding for weed management in Meghalaya.

(iii) Transgangetic Plains zone: 33 % of recommended dose of N through green manure + 33 % of recommended dose of N through farmyard manure + 33 % of recommended dose of N through vermicompost during *kharif* and 33 % of recommended dose of N through farmyard manure + 33 % of recommended dose of N through vermicompost + 33 % of recommended dose of N through crop residue during *rabi* + seed treatment with neem-cake + 2 sprays of *Trichoderma harzianum* for pest management in Punjab.

(iv) Central Plateau and Hills zone: 50 % of recommended dose of N through farmyard manure + 50 % of recommended dose of N through neemcake in cereals and 33 % of recommended dose of N through farmyard manure + 33 % of recommended dose of N through neem-cake + 33 % of recommended dose of N through vermicompost to berseem + soil application of *Pseudomonas fluorescence* + two sprays of neem extract for pest management + combination of two hand weeding along with mechanical weeding for weed control in Madhya Pradesh.

(v) Southern Plateau and Hills zone: 50 % of recommended dose of N through farmyard manure + 50 % of recommended dose of N through non edible oilcakes + neem + *mahua* cake + *Trichogramma* + neem spray + bird perches for pest and disease management + using of mechanical weeder + one hand weeding for weed management in Tamil Nadu and 33 % of recommended dose of N through enriched compost + 33 % of recommended dose of N through vermicompost + 33 % of recommended dose of N through green leaf manure + *Verticillium lecani* + eco-neem + neem seed kernal extract + botanicals for pest management in Karnataka.

Principles of successful adoption, recommendation to different agro climatic regions and improvement over existing systems

The package for organic production of crops has been evolved over the period of six years of experimentation under various agro-climatic conditions. The cropping systems and packages recommended are specific to the particular agro-climatic zone. New packages of input identified for organic production of systems are found to enhance net returns by more than 20 % and organic carbon by 10-15 % over the conventional practice of chemical farming.

Eco-friendliness of the technology

Organic farming package identified for different regions does not include any chemical input for management of pest and diseases. Hence, these packages are highly suitable to environment.

Performance results

All the practices recommended for the different agro climatic regions have recorded more than 20 % increase in net returns and 10-15 % increase in organic carbon over conventional practice. Net returns ranged from ₹25,888 to as high as ₹64,310 ha^{-1} in various agro-climatic regions according to the cropping systems and their premium price received by the organic products.

Cost of technology

ACZ	Cost of Package (₹/ha)	Output (₹/ha) (Gross returns)	Net returns (₹/ha)
Himachal Pradesh	102,117	179,657	77,540
Uttarakhand	35,158	45,413	10,255
Punjab	60,144	149,667	89,523
Madhya Pradesh	48,478	151,290	102,812
Tamil Nadu	44,924	79,384	34,460
Karnataka	15,804	41,590	25,786

Impact and benefits

The new package identified for each agro-climatic zone are expected increase the net returns of the farmers by at least 20 % by way of reducing the cost of production. Moreover, the timely availability of adequate chemical fertilizer is a national issue which can be addressed through the newly developed packages of organic farming in the cropping system mode. The packages of organic production in all the zones identified are relying on the natural process of pest and disease management, thus reducing the cost on account of pesticides and herbicides. In addition, the package is having the innumerable benefits on environment in general and society in particular as production of organic products is having its own advantages.

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Conservation agriculture for improving productivity and profitability of wheat in rice-wheat cropping system

Salient features

Conservation agriculture aims to produce with minimum disturbance to soil and environment. The machineries such as bed planter, zero-till drill, strip-till drill and rotary-till drill can be used in wheat for resource conservation in terms of better benefit: cost ratio, energy output: input ratio, water use and management of *Phalaris minor*.

Performance results

Zero, strip and rotary till drills and bed planter provided higher wheat yields (2-12%), net returns (7-18%), cost effectiveness (9-14%) and energy efficiency (20-29%); required lower specific energy (16-21%) and specific cost (4-6%); and reduced *Phalaris minor* (56-79%), other weeds (66-79%), when compared with conventional sowing of wheat.

Cost of technology

The cost of sowing by these machines ranged from ₹1,200 to 1,800/- than ₹6,000 in conventional sowing.

Impact and benefits

The rotary, strip and zero till drilling and bed planting were time saving (78, 77, 83 and 75%), labour saving (76, 73, 78 and 70%), diesel saving (65, 84, 86 and 86%), cost saving (71, 78, 82 and 77%), energy saving (65, 84, 87 and 86%) and also irrigation water saving (10, 10, 11.0 and 35%) when compared with conventional sowing of wheat. Also, there was saving of about 20-25% in seed and fertilizer inputs in bed planting compared to conventional sowing. Net saving of ₹4,200-4,800 on account of wheat sowing.

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