

Organic Farming and SRI: Need for sustainable Agriculture in India

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Introduction:

Traditionally in India, rice has been grown as subsistence crop till the green revolution techniques were initiated to increase the production and productivity. To achieve this, huge investments was made on major irrigation projects, new high yielding varieties, input delivery systems and factory made subsidized external inputs as chemical fertilizers, pesticides, weedicides etc. were introduced. But excessive use of chemical fertilizers resulted in less remunerative, environmentally unsustainable rice cultivation. It is in this context that SRI technique (System of Rice Intensification) and organic farming are favored not only in India but across the world. Organic rice growers who adopt SRI technique-an innovative technique of rice cultivation, rely more on homegrown items like crop residues, compost and green manure which brings down cash component of expenditure for inputs and promotes sustainable agriculture in India.

System of Rice Intensification (SRI) emerged in the 1980's as a synthesis of locally advantageous rice production practices encountered in Madagascar by Fr Henri de Laulanie, a Jesuit Priest who had been working there since 1961. But, it is Dr. Norman Uphoff from Cornell International Institute for Food and Agriculture, Ithaca, USA, who had brought this method to the notice of outside world in the late 1990s. Today SRI is being adopted in many states in India and the response from farmers has been overwhelming seeing the benefits of the method, notwithstanding the constraints. As SRI technique led to three to four times more production of rice, India-a country striving for hunger and unemployment problem, accepted and implemented it in later years.

The Objectives of the study:

1. To assess the problems associated with excessive use of chemical fertilizers on human health and environment.
2. To study the positive aspects of organic manuring used in System of Rice Intensification -the more appropriate agricultural practice for sustainable development.

Hypotheses:

- Excessive use of chemical fertilizers in traditional rice farming has become fatal for soil, environment and mankind.
- "Fertilize with compost - add chemical fertilizer only if needed", is the main principle of SRI that keeps soil free from chemical pollutants and safer for human beings.

Methodology Used:

In the present study an effort has been made to analyze the harmful effects of chemical fertilizers used in the states of Punjab, Haryana, western U.P., for which secondary data have been collected from different sources and analysed. To assess the impact of SRI in the state of Bihar which has been bereft of the benefits of Green Revolution, where SRI technique has been adopted by the farmers in all 38 districts for the last few years, a sample size of 100 farmers was selected by applying stratified random sample method and survey was conducted by questionnaire method in the districts of Nalanda, Patna, Gaya and Muzaffarpur. 10 scientists of ICAR, Patna, Krishi Vigyan Kendra, Muzaffarpur and Farm Research Centre, Patna were also interviewed.

Fertilizers Use in Traditional Rice Farming:**(a) Chemical Fertilizers**

Both the organic manure and chemical fertilizers are essential for rice cultivation. 13 essential nutrients namely 6 macro nutrients (N, P, K, S, Ca and Mg) and 7 micro nutrients (Fe, Mo, Zn, B, Mn, Cl and Cu) are considered generally. Urea or neem-coated Urea (to increase the nitrogen use efficiency), Phosphorus (DAP, Triple Super Phosphate) to overcome the Phosphorus deficiency and Potassium Sulphate, Potassium Chloride to increase the Potassium contents in soil, Gypsum is applied basally with NPK in the main field in non calcareous heavy soil. Zinc Sulphate with sand mixture is applied to the leveled field.

Table 1: Recommended Fertilizer Dose in Rice (Kg/ha)

Kharif(Bihar)		
Fertilizer	Irrigated	Rainfed
N	80	60
P	40	30
K	20	20

Source: Status Paper –03, Directorate of Rice Development, GOI

(b) Bio-fertilizers

Bio-fertilizers have definite advantage over chemical fertilizers. Chemical fertilizers supply over nitrogen whereas biofertilizers provide in addition to nitrogen, certain growth promoting substances like Hormones, vitamins, amino acids etc.

Continuous use of chemical fertilizers adversely affects the soil structure whereas biofertilizers improve the soil texture.

Biofertilizers are no substitute for chemical fertilizers. Blue-green algae, Azotobactor, Azolla, Azospirillum, and Rhizobium are main bio-fertilizers.

(c) Chemical use for weed management

Use of herbicides to control weeds in upland rice is increasing continuously. Herbicides are expensive for small farmers but not for large farmers who face problem of labour shortage. (Behra et al., 1997)

Anilofos, Bentazone, Copper Sulphate, Propanil, Bifenox, Thiobencarb are some frequently used chemicals for controlling weeds.

(d) Pest and Disease Management

Pest and disease management is done by spraying different chemicals as-

Table 2:

Insecticides	Fungicides
1.Chlropyriphos	1.Carbendazim 40g
2.Phosphomidan	2.Mancozeb80g
3.Endosulphan 35EC	3.Copper oxychloride 100g
4.Monocrotophos36WS C	4.Edifenphos 40ml
5.Carbofuran 3G	4.Carbofuran
6.Melathion 50 EC	

Fungal diseases are controlled by crop rotation, seed treatment with Thiram/Caption@4g/Kg,edifenphos 500 ml, Mancozeb 1Kg Captafol 625g/ha.

Bacterial diseases are controlled by spraying Streptomycin Sulphate and Tetracycline combination 300g+Copper Oxychloride 1.25Kg/ha.

Impact of Chemical Farming:

- Increased use of nitrogen, Phosphorus and Potassium fertilizers caused the deficiency of micronutrients in the soils.
- Likewise, biological life in soil has been affected negatively due to pesticides, weedicides and fungicides.
- In addition, soil salinity and toxicity emerged as problems in association with extension of canal irrigation and application of poor quality underground water.
- The widespread use of nitrogen fertilizers has resulted in the release of nitrous oxide into the air.
- Use of pesticides multiple manifold during Green Revolution. About 125 deaths were reported in 1986 as caused by poisoning due to pesticides.
- Chemical fertilizers when sprayed, mixes with the water and seeps into the ground. As a result the ground water is contaminated and so as the drinking water.
- Traditionally rice is grown in water- flooded conditions which allow arsenic to be more easily taken up by its roots and stored in the grains. And arsenic is a known carcinogen linked to several cancers, and believed to interfere with fetal development.

Organic Farming and Rice Production:

Materials that come from plant or animal wastes or by-products such as cattle or poultry manure, composted rice straw or other crop residues, sewage sludge, oil cakes, green manures, and legume clippings are generally termed as components of organic farming.

Organic material or manure is normally applied uniformly across the rice field, two or more weeks before being incorporated into the soil during land preparation. Sometimes rice straw is directly composted in the field after harvesting season. Manures and other organic sources are used to improve soil fertility and soil organic

matter content and to provide micronutrients and other growth factors not normally supplied by inorganic fertilizers.

Organic manures improve the physical, chemical and microbiological properties of soils and ultimately the crop yields. On an average, organic manures such as FYM and compost contain 0.5-1.0% N, 0.6% P₂O₅ and 0.5% K₂O. Ten tones of compost will thus supply 50-10 kg N, 20 kg P₂O₅ and 50 kg K₂O.

Rice straw and rice hull (husk) can be used as main organic source of Silicon (Si) for rice. A Silica supply which is required by rice plants to enhance the photosynthetic capacity as a whole and oxidation power of the plant's roots, can be incorporated into the soils by disking or puddling.

Table 3: Nutrient Content of various Organic Materials

Organic material	% N	% P ₂ O ₅	% K ₂ O
Crop residue (rice straw)	0.5-0.8	0.15-0.26	1.2-1.7
FYM (cattle manure)	0.8-1.2	0.44-0.88	0.4-0.8
Compost	0.5-2.0	0.44-0.88	0.4-1.5
Sewage sludge	1.6	1.76	0.2
Pig manure	0.7-1.0	0.44-0.66	0.6-0.9
Sheep & goat manure	2.0-3.0	0.88	2.1
Poultry manure	1.5-3.0	1.15-2.25	1.0-1.4
Oil cakes	2.5-8.0	0.66-2.86	1.2-2.3
Green manures			
Sesbania	1.7-2.8	0.1-0.2	1.4-1.9
Azolla	2.0-5.3	0.16-1.59	0.4-6.0

Source: Rice Science, 2013,378-412

SRI (System of Rice Intensification): An innovative method of Rice Production and Organic Farming:

The term 'Chemical Farming', can be used for excessive use of chemical fertilizers such as Urea, weedicides and pesticides in conventional rice production. Rice is the main crop in our country; hence organic farming is needed for rice cultivation. As traditional rice farming in India is totally dependent on excessive use of water, chemical fertilizers, pesticides, fungicides etc., an innovative and alternative method of rice farming is desirable in our country. SRI practices which led to three to four times more production of rice, was popularized by the states of Tamilnadu and Andhrapradesh. As an initiative of the Bihar Government, SRI or 'SRIVIDHI' was adopted in all 38 districts to alleviate the food crisis in the state. As SRI revolution was brought by mainly using organic manure, farm yard manure and Green manure, it may be called as 'Organic Farming.'

Organic farming in SRI uses following manures in lieu of chemical fertilizers-

1. Bovestin Powder-a fungicide used for seed treatment.

2. Green Manures-Some plants are grown, cut and left, or ploughed into the soil to provide even more fertility to soil. Such plants are fast to decompose, don't attract pests and diseases, leguminous and provide nutrients needed to the soil. Plants used as green manures are-

- a) **Sun hemp** (*Crotalaria juncea*) - It is a vigorous growing green manure crop, which can be incorporated at 10 weeks after sowing. Quantity of nitrogen fixed by the crop is 70-80 kg/ha.

- b) **Dhaincha** (Sesbania) It is a quick succulent green manure crop, which can be incorporated at about 8 to 10 weeks after sowing. Sesbania can produce up to 80-100 kgs/ha in around 45 days.

Table 4: Nutrient content of Sesbania (Dhaincha) after 45 days

Nutrient	Content (%)
Nitrogen(N)	2.70
Phosphorus(P)	0.14
Potassium(K)	1.56

3. Vermicompost- Also called worm compost is the end-product of the breakdown of organic matter by some species of earthworm. Vermicompost is a nutrient-rich, natural fertilizer and soil conditioner. It also contains million of microbes which help break down nutrients already present in soil into plant-available forms. Vermicomposting has been recognized as an eco- friendly technology for converting organic wastes into high value organic manure, rich in nitrates, available phosphorus, calcium, vitamins, natural phyto-regulators and micro flora in balanced form which help in restoring the natural fertility of soil (Purakayastha and Bhatnagar, 1997).

4. Farm Yard

Manure(FYM)-It is prepared mainly using cow dung, cow urine, waste straw and other dairy wastes. It is rich in nutrients and availability of Potassium and Phosphorus from FYM is similar to that from chemical fertilizers.

Table: 5

Nutritional Status of FYM (%)

Nitrogen	0.5000
Phosphorus	0.2500
Potassium	0.4000
Calcium	0.0800
Sulfur	0.0200
Zinc	0.0040
Copper	0.0003
Manganese	0.0070
Iron	0.4500

Basic features of SRI:

1. Improving soil fertility and preparation of main field

Unlike in traditional method, saline or alkaline soils are not suitable for SRI cultivation. The provision of proper drainage facility and leveling of land is required before transplantation to enable water to spread uniformly and to remove excess water from the field.

To improve soil fertility, application of tank silt, Farm Yard Manure (15 tons/hectare) or Vermi-compost', Green manure crops (Sun hemp or Sesbania) and penning livestock are commonly used.

Tank silt should be applied at the rate of 15-20 cartloads per acre (40-50 tons/ha). This improves the moisture holding capacity of the soil, which in turn results in better yields.

Application of well decomposed FYM/ compost is a must for SRI method of cultivation. At least 15 cartloads or 3 tractor loads (6tons) of FYM/ compost should be applied per every acre.

Sun hemp and Sesbania are the common green manure crops. Green manure crop is cultivated for about 45 days and it takes another 10 days to get decomposed into organic matter. Sow the paddy nursery on the day of incorporating the green manure crop into the soil. By the time the green manure crop gets decomposed the nursery would be ready for transplantation.

Livestock Penning is a traditional practice in which cattle, goats and sheep are flocked in the field during the night. The soil gets enriched with the dung and urine of the animals.

2. Seed Treatment

Pre soaking of HYV seeds for 12 hours and broadcasting of sprouted seed treated with Bavistin (a fungicide) is the regular practice recommended for SRI.

3. Nursery Bed Preparation

The nursery bed is prepared in 4 layers:

***1st Layer:** 1 inch (2.54 cms) thick well decomposed FYM/ Vermicompost

***2nd Layer:** 1.5 inch soil

***3rd Layer:** 1 inch well decomposed soil

***4th Layer:** 2.5inch of soil

4. Weed Management

- Weeds are regularly incorporated into soils by moving the conoweeders between the rows. No weedicides or herbicides are used. Mulching is also useful for weed management. Weeds are useful for the soil as organic manure. So the weeds should be allowed to grow and then turned into the soil intermittently. Use the weeder on the 10th and 20th day after transplantation.

5. Pest & Disease Management

- The uniqueness of SRI method lies in not using the chemical pesticides and herbicides. Wider spacing and use of organic manures results in healthy growth of the plants and incidence of the pests and diseases is naturally low. The pests can be easily managed by using some organic concoctions either as preventive measurer as and when needed. Amrit Jalam is one such concoction.
- Amrit Jalam is prepared with Cow urine, Cow dung, Jaggery (organic) - 250 grams and Water (chlorine free). Mix all the above materials in a plastic container or an earthen pot. Let them ferment for 24 hours. Dilute this with water in the ratio of 1:10. Filter the solution using a fine cloth. This can be used for spraying. When Amrit Jalam is sprayed, it not only gives nitrogen to the plants but also repels harmful insects and micro organisms.

Results and Analysis:

- SRI deviates from the green revolution standard that intends to increase grain yields either by improving genetic potentials of crops, making them more responsive to chemical inputs, and/or by increasing the use of external inputs (i.e.; water, agro-chemicals).SRI requires neither of these considerations.(Uphoff,2007).
- In fact, SRI uses hybrid seeds which are treated before transplanting into the main field. Transplantation of young seedlings (8-10 days) at proper spacing (10x10 inches) allows enough sunlight to reach the leaves of each plant thus reducing competition for water, space and nutrients resulting in the spread of roots and healthy growth of plants. It minimizes the need of plant nutrients.
- No need of weedicides as weeding is done by conoweeders .It incorporates the weeds into the soil and aerates the soil. A greening effect of the plants can be observed 1-2 days after weeding.
- SRI reduces Methane emissions by 22-64% as waterlogged fields are not needed as we find in conventional cultivation or green revolution.
- No any side effects of SRI have been observed in the states those implemented it.

Conclusions

Both the organic manure and chemical fertilizers are essential for rice cultivation. An integrated approach of plant nutrient system will play an important role in sustainable rice production, especially as the land used for crop production dwindles down due to urbanization and there is a constant stress on the cultivable farm area as more and more areas taken away for non agricultural purposes and become unavailable for farming. The constant increasing pressure on cultivable land to raise yields to feed the teeming population has forced the agriculturists to favour chemical fertilizers. But realizing the ill-effects of inorganic fertilizers during Green Revolution, we must shift to organic farming and implementing the SRI Technique which follows the principle-“Fertilize with compost - add chemical fertilizer only if needed” to achieve sustainable agriculture.SRI, on one hand uses organic substances which maintain the soil fertility, lesser contamination of ground water, makes best uses of biological wastes, urban and rural wastes without harming the human health.

Another positive aspect of SRI is the increased 3-4 times yields which is very helpful in solving the food security of the people of India. Using municipal and sewage wastes for making organic manure recycles nutrients for crop production, besides reducing the pollution. Green manuring practice of growing plants like sesbania, Sunnhemp, leguminous/non-leguminous plants grown on bunds of waste lands utilizes the unused lands.

Traditional rice farming using huge water logging result not only in excessive weed growth but also salinization of the rice fields.SRI reduces weed growth and salinity of soil by using less water and organic manures. Besides, emission of Methane gas which is characteristics of rice fields, is also reduced by application of SRI.Based on above study it can be concluded that the application of organic manures like green manures, press mud vermicompost along with recommended dose of fertilizer could be recommended to maintain and sustain soil health in rice under SRI over the conventional method..

Suggestions

- ❖ Manufacturing and allied agricultural activities such as livestock and pigs farm, poultry farm, fishing farm, sheeping, dairying etc. must be ensured in rural areas for providing materials for preparation of organic manures.
- ❖ Proper recycling of rice straw and rice husk is not common among moist rice farmers. Recycling of rice straw and husk after harvesting; must be trained to farmers by agricultural scientists and concerning government departments.
- ❖ Proper training about SRI and applications of organic manures should be provided to farmers.
- ❖ State government should be aware about the setting up of Vermi- compost units at village level. Even every farmer who is adopting SRI must have his own Vermi compost plant.
- ❖ Some organic materials may contain toxic substances or heavy metals as in municipal wastes and sewage sludge.
- ❖ Organic manures are bulky and difficult to handle and transport; some organic manures are messy and with unpleasant odor for farmers to handle. (Palaniappan and Annadurai, 2001). If society wishes to reduce environmental problems by recycling organic materials, the government must either subsidize their use or offer some incentive to the farmer.

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