NITI Aayog

Assessing the Impact of

System of Root Intensification Method of Natural Farming

in Gaya district of Bihar

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PREFACE

This document is a brief report that summarizes the field research conducted by NITI Aayog to assess the impact of System of Root Intensification (SRI) method of Natural Farming on crop yield, cost of cultivation, natural resource conservation and perceived benefits of natural farming on livelihood of farmers in comparison with intensive or regular way of farming in Gaya district of Bihar state. NITI Aayog researchers studied the impact of SRI method of natural farming by interviewing farmers about natural farming impact on various dimensions such as socioeconomic, resource conservation and livelihood aspects of farmers and farming in Gaya district of Bihar state. The research findings show that SRI method of natural farming outperforming in terms of yield and reduction in cost of cultivation. Besides, several perceived ecosystem benefits. Finally, the researchers suggest for further promotion and scaling up of the SRI method of natural farming in the suitable regions of India.

TABLE OF CONTENTS

INTRODUCTION

Natural Farming is a chemical-free alias traditional farming method. It is considered as agroecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity. Natural farming is one of the several approaches towards sustainable food production and it is practiced in various regions by inventing their own way of local practices using on-farm/ locally available inputs and it is free from chemical fertilizers and pesticides. Natural Farming has many indigenous forms in India. Government of India is promoting Natural Farming through Bharatiya Prakritik Krishi Paddhati' (BPKP) introduced during 2020-21 as a sub scheme of Paramparagat Krishi Vikas Yojana (PKVY) for the promotion of traditional indigenous practices including Natural Farming. System of Root Intensification (SRI) is one of the innovative approaches towards natural farming practiced and promoted by Bihar government and Preservation and Proliferation of Rural Resources and Nature (PRAN) NGO in Bihar state.

PRAN implemented various SRI projects supported by Bihar Rural Livelihood Promotion Society (BRLPS), TATA Trust, Azim Premji Philanthropic Initiative (APPI), Govt. of Bihar, Govt. of Jharkhand, Govt. of India, Deshpande Foundation, United way, Ashoka Trust, UN Women, UNICEF and other donors. So far we demonstrated SRI method of crop cultivation with 2,01,915 households in Gaya, Nawadah, Nalanda, Madhubani districts of Bihar, Jaunpur and Varanasi districts of U.P. PRAN was the first to demonstrate SRI which was scaled up by Govt. of Bihar.

The System of Root Intensification is a resource and climate-smart, agro ecological methodology for increasing the productivity of paddy, wheat, Mustard and more recently other crops by changing the management of plants, soil, water and nutrients. SRI method of natural farming is based on four major principles that interact each other.

1. Healthy seed material establishment
2. Reduced plant density/seed material per unit area
3. Improved soil conditions through enrichment with organic matter,
4. Reduced and controlled water application.

Based on these principles, farmers are practicing SRI method of natural farming to respond to their agro-ecological and socio-economic conditions. Adoptions are often undertaken to accommodate changing weather patterns, soil conditions, labor availability, water control, access to organic inputs, and the decision to keep away from chemical fertilizers which is not only increasing cost of cultivation but also poisoning the soil and the food is being grown.

THE PRINCIPLES OF SRI WHICH ARE IN LINE WITH NATURAL WAY OF FARMING PRACTICES

1. Very young seedlings should be used, to preserve the plant's inherent growth potential for rooting and tillering
2. Transplanting single seedling per hill should be done quickly, carefully, shallow and skillfully, in order to avoid any trauma to the roots, which are the key to plants' success;
3. Reduce the plant population by spacing hills widely, so that both the roots and canopy have room to grow and can have greater access to nutrients, sunlight, etc.;
4. Provide growing plants with sufficient water to meet the needs of roots, shoots and soil biota, but never in excess, so that the roots do not suffocate and degenerate;
5. Active soil aeration improves crop growth in order that both roots and beneficial aerobic soil organisms are in benefit;
6. Augmenting organic matter in soils, as much as possible, improves performance of the crop, by improving soil structure and functioning and supporting beneficial soil organisms.

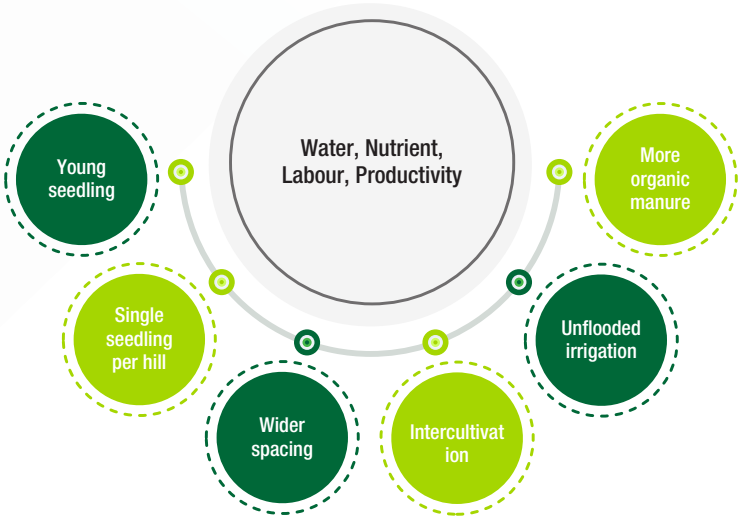

Figure 1: SRI Hexagon

SIGNIFICANCE OF SRI PRINCIPLES

Principle	Significance
Young seedlings	Much greater potential for tillering and root growth as earlier arrival within a better growing environment in the main field extends the time for tillering. Besides, no transplanting shock if transplanting is done carefully.
Single seedling per hill	Seeds requirement is very low and no competition for nutrients, water and space within seedlings. Less seedlings per unit area, combined with wider spacing enables all leaves to be photosynthetically active; whereas with crowding, lower leaves do not get enough exposure to sunlight for photosynthesis. This deprives the plant and especially the roots of possible supply of photosynthesis.
Wider spacing	Promote more profuse growth of roots and tillers in case of paddy and wheat. More space (below and above ground) per hill for access to nutrients, water and light. Inter-cultivation with mechanical weeder is made possible.
Moist and unflooded water management system	Non-hypoxic condition of soil favors root health and functioning, and supports more abundant and diverse communities of beneficial aerobic soil organisms. Besides, no degeneration of roots, which otherwise will be as much as 75% degraded by panicle initiation under flooding. Exposing the soil to sunlight is favorable for warmth. Also water savings of up to 40% with energy saving where water is pumped.
Inter-cultivation	Churning up of the soil activates the microbial, physical and chemical dynamics. Due to reduced seedling per unit area triggers greater root growth and tillering. Weed biomass is incorporated into the soil as green manure and therefore, weeding costs can be reduced.
Liberal use of organic manures	Gives better plant growth response than inorganic fertilizers, more sustained supply of nutrients and favorable growth of soil flora and fauna enriches soil health.

Source: *(Aviral, 2017)*

PURPOSE OF THE SURVEY

The purpose of the survey was to assess the impact of System of Root Intensification (SRI) method of Natural Farming on crop yield, cost of cultivation, natural resource conservation and perceived benefits of natural farming on livelihood of farmers in comparison with intensive or regular way of farming in Gaya district of Bihar state.

STUDY AREA AND SAMPLING FRAMEWORK

The paper based face-to-face survey was conducted with 63 farmers in the Gaya district of Bihar state during last week of March 2022. The survey covered the blocks of Tankupa, Bodhgaya, Mohanpur, Sherghati, Gurua and Manpur (See figure 2). Nine villages are randomly selected from the list of villages practicing SRI method of natural farming. Purposive random sampling method was applied for sample section. In addition discussed with NGO staff promoting natural farming in Bihar.

Figure 2: Survey villages in different blocks of Gaya district in Bihar state

KEY FINDINGS

Socioeconomic status of the survey respondents: Out of 63 farmers surveyed practicing SRI method of natural farming, 47 were female and 16 were male farmers with average age of the farmers is 38 years and average household size is seven members. Majority of them are small and marginal farmers, and reported their primary source of income is agriculture and livestock as secondary source of income.

Figure 3: Women farmers in SRI method of Rice field cultivated

Generally women involvement in agriculture is higher, particularly when the landholding is small. In the study area majority of them are marginal farmers with an average seven members in the family. Generally, men involve in non-farm activities away from the village and women continue farming in their own land. It may be due to fertile alluvial soils, all the farmers happy with SRI method of natural farming and the farmers reported that their livelihood is improved after switching natural farming from intensive method of farming.

One of the women farmers mentioned that, "*We used to spend all our bare minimum earnings from other sources in purchasing costly inputs like fertilizers, pesticides and seeds, after converting our land into SRI method of natural farming, we don't have those expenses and yield is also better now. Besides, we are happy that, we are eating safe and healthy food in the family".*

Cost of practicing SRI method of natural farming: In comparison to intensive farming method where costly inputs (seeds, fertilizers, and pesticides) are being used, SRI method of natural farming requires less cost for cultivation. Farmers use locally available material such as *Jivamrita/jeevamrutha, Bijamrita/beejamrutha (seed treatment), Acchadana (mulching) and Whapasa (moisture).* Besides, farmers use their cattle dung and decomposed farm waste as an input to enhance soil fertility.

Figure 4: Farmers using mechanical weeder in SRI method

All the respondents reported that cost on fertilizer and pesticides are almost nil, and cost on seeds significantly reduced due to less quantity of seeds used in SRI method of natural farming. For example, around 40 kgs of paddy seeds per acre is used in intensive farming system, while in SRI method of natural farming only around 2kgs are used. The critical and very important practice with SRI method of natural farming is healthy seed selection by using local screening method. Also, very young seedlings are used, to preserve the plant's inherent growth potential for rooting and tillering. Transplanting single seedling per hill is done quickly, carefully and skillfully, in order to avoid any trauma to the roots, which are the key to plants' success.

Figure 5: Farmers transplanting Rice seedlings from seed bed

Therefore it significantly reduced their expenditure on seeds. Besides, labor use is also significantly less as plant density at the time of seedling is very less. Further, respondents reported that cost of land preparation is lesser than intensive farming system as they do not throw away farm waste, instead they use as natural mulch, and also stubbles they don't remove and burn, but they transplants seedling in presence of stubbles that preserve the soil moisture in case of paddy cultivation. SRI method uses all the natural waste generated on-farm as inputs for next season. All the farmers reported their cost of cultivation is significantly reduced after adopting SRI method of natural faming.

Figure 6: Root growth in normal rice field and in SRI method

Enhanced root volume and length of SRI compared to normal method. This is due to low plant density that allows plat to express its fullest possible resulting maximum tillering and yield in SRI method of rice cultivation.

YIELD COMPARISON BETWEEN NATURAL FARMING AND INTENSIVE FARMING

Majority of the survey respondents reported that they observed noticeable increase in the yield in the natural farming. More than 89% of the respondents reported that there is more than 50% increase in the yield, particularly in rice and wheat. Further, they mentioned there is increase in the income by more than 50%.

Figure 7: Farmer in his rice field cultivated by adopting SRI method

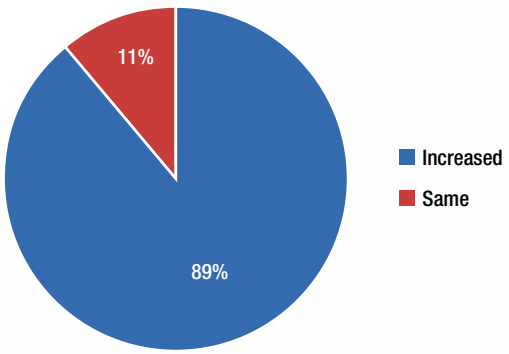

Figure 8: Yield comparison between SRI method and intensive farming

Figure 9: Technical staff from NITI Aayog visit to SRI method of wheat cultivation in Gaya, Bihar

PRAN NGO has made experimental trials to assess the yield comparison between conventional farming and SRI method of paddy cultivation, and the results as shown below

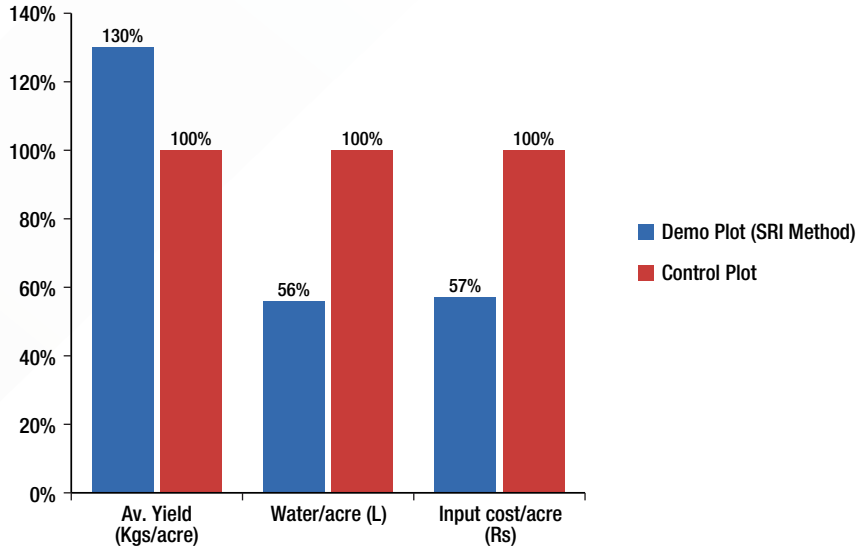

Figure 10: Comparison between Demo Vs Control Plot of Paddy

Source: *PRAN NGO*

The experiment results showed that, 44% reduction in supplementary irrigation in demo plot (SRI method) as compared to control plot (conventional method) of paddy cultivation. Similarly, 2,98,242 Litre of supplementary irrigated water per acre is saved. Further, 30% more yield in demo plot as compared to control plot

690 Kg of grain per acre is additionally produced. Input cost was reduced by 43% and saving of rupees 18730/- per acre in demo plot with comparison to control plot. Chemical less quality grain and straw is produced.

Source: *PRAN NGO*

Similar field experiment was conducted by PRAN NGO in Gaya district of Bihar state to assess the impact of SRI method of wheat cultivation and the results as shown below

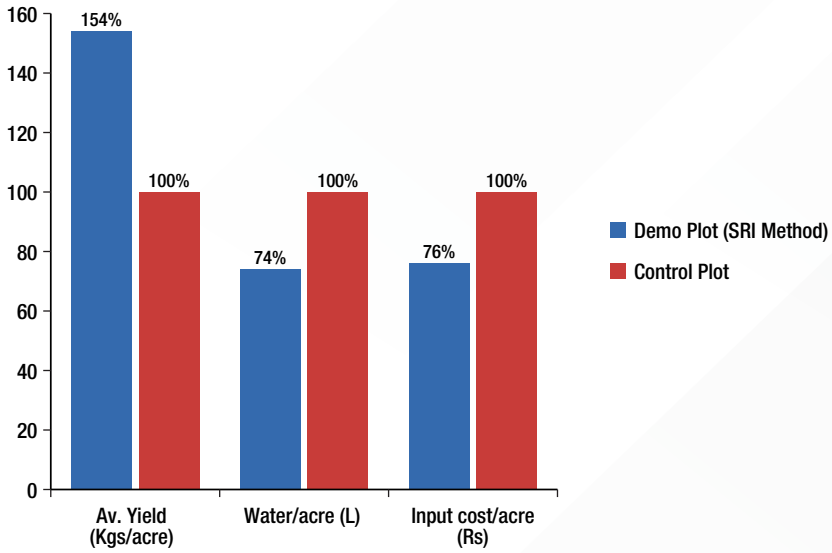

Figure 11: Comparison between Demo Vs Control Plot of Wheat

Source: *PRAN NGO*

The 26% reduction in supplementary irrigation in demo plot as compared to control plot. 97,479 Litre of supplementary irrigated water per acre is saved. 54% more yield in demo plot as compared to control plot

673 Kg of grain per acre is additionally produced Input cost is reduced by 32% per acre in demo plot with comparison to control plot. Chemical less quality grain and straw is produced.

SOIL HEALTH, BIODIVERSITY AND NATURAL ENEMIES IN NATURAL FARMING

Survey respondents highlighted that, they observed there is significant improvement in the soil health this is attributed to not using chemical fertilizers, pesticides and use of livestock based manures. Earthworms, honeybees, bird nests and beneficiary insects are a common sight at natural farming fields. Around 69% of the survey respondents strongly agreed that there is improvement of the soil health in their farm where natural farming is practiced. In addition, 31% of the survey respondents agreed there is improvement of the soil health.

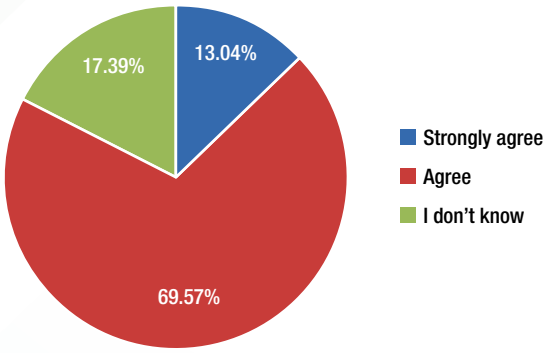

Figure 12: Improvement in diversity of beneficial insects in natural farming

One of the farmer mentioned that, "*after switching to SRI method of natural farming, the earthworm population is increased in the soil, and also honey bees, butterflies and other insect population increased*", he said.

About 82% of survey respondents observed that there is improvement in the beneficial microorganisms in the soil, besides 69% of the respondents agreed that there is improvement in the beneficial insects (predators, parasites, pollinators) in the SRI method of natural farming. However, 17% of the farmers reported they don't observe improvement in the natural enemies and beneficial insects in the natural farming. Further, 58% of the respondents reported there is decrease in the pest and disease incidence on the crops in the natural farming, and 42% of the respondents reported pest and disease incidence was same as intensive farming.

PERCEIVED CHALLENGES IN CONTINUING NATURAL FARMING

Natural farming is niche in scale of production, and farmers are keen in adopting natural farming practices due to increased cost of production (fertilizers, agrow chemicals, seeds etc.), soil health deterioration, decline in ground water resources etc. However, there is lack of information / knowledge about the natural farming practices. Besides, one of the major challenges all the survey respondents reported that there is lack of separate market for naturally produced products and also there is no price premium for naturally produce products. Further, survey respondent's highlighted separate market and recognition for naturally produced products my act as pull factor towards bringing more and more area under natural farming. Another important information farmer revealed that, SRI method of natural farming more suitable for small and marginal farmers. It was noticed during interactions that concern regarding SRI was misinterpreted by some farmers, and SRI is a more rigorous and exact regime that needs precision-timed operations and constant supervision. Further, unavailability of trained labor is major concern.

CONCLUSION

Based on the filed survey involving 63 farmers who are practicing natural farming, it is observed that SRI method of natural farming is performing better in terms of increased yield particularly in wheat and rice. Besides, decrease in cost of production by avoiding fertilizers, pesticides and seeds. Further, farmer's perceived benefits such as improvement in soil health, biodiversity and natural resource conservation in natural farming as against intensive farming is recorded. It is observed that a majority of the farmers who are practicing natural farming are small and marginal farmers with average household size of 7 members per family. It is also noticed that natural farming is best suit for small and marginal farmers.

Considering the multifunction nature of natural farming there is need for promoting such a farming system with initially incentives to farmers and also establishing separate market for naturally produce, commodities. It is ethically correct to incentivize farmers who are contributing towards sustainable food production as against farmers who are practicing intensive farming method by using high dose of other chemicals. That potentially effects environment and food system.

The benefits of SRI method of natural farming in terms of productivity are higher and the cost of production is lower than the conventional method, the government of Bihar is promoting farmers to use SRI practice in the crop production. Despite policy support has been extended by state Government, still the adoption of SRI method has been restricted to some farmers. Besides, findings presented above showed significant role of SRI in increasing yield particularly in rice and wheat, the central question remains why SRI method adaptation is lower in Bihar, when most of the farmers are confronted with low income and low agriculture productivity in intensive farming.

The demonstration of SRI method of natural farming may have noticeable bearing on the use of SRI method of natural farming in the state of Bihar. There is need for training and capacity building of farmers particularly women farmers about SRI method of natural farming and production techniques such use of green fertilizers, preparation of *Jivamrita/ jeevamrutha, Bijamrita/beejamrutha (seed treatment), Acchadana (mulching) and Whapasa (moisture)* etc. can help in scaling up of natural farming. Involvement of civil society may promote SRI practices in Bihar. Recognitions of successful farmers at block level, district level and state level can also promote farmers to use SRI practice. Besides, use of services of celebrities to join their hands towards '*Vocal for local*' may help in popularizing natural farming in the Bihar and in the country.

In spite of no large-scale scientific studies has yet provided proof of natural farming impact in increasing the yield and other environmental benefits, the increasing number of farmers adopting the natural farming, particularly in Bihar, Andhra Pradesh, Gujarat, Maharastra and Karnataka states that clearly indicate that they had experienced its benefits. Mere absence of large scientific studies doesn't mean it's bad. There are studies ongoing and to be completed, it is being proven in the field and accepted by lakhs of farmers and it is farmers' own practices that are demonstrating this.

STUDY LIMITATION

The survey involve only 63 farmers belongs 9 villages in 4 blocks of Gaya district in Bihar. Besides, all the survey respondents are small and marginal farmers. Therefore, the results may not be generalized to larger area and also to medium and large farmers. So there is need for further research in multi locations or regions involving different landholdings (small, marginal, medium, larger holding) involving larger sample size to arrive to science backed conclusions.

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Aviral, P. (2017). Determinants of system of root intensification (sri) method, in Bihar state, India. *Jurnalul Practicilor Comunitare Pozitive*, *17*(2), 3–16.