PERFORMANCE OF SYSTEM OF RICE INTENSIFICATION AND CONVENTIONAL RICE CULTIVATION METHODS UNDER PUNJAB CONDITIONS

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Abstract: The productivity of the System of Rice Intensification (SRI) methodology for cultivating rice without flooding fields should be compared systematically with the results of conventional rice-growing methods because of SRI's potential for water-saving and Punjab's diminishing groundwater supplies. During Kharif season of 2007-08, some 20 experiments were carried out under irrigated conditions in different soil types with different varieties of rice. The two alternative treatments were assessed in randomized villages within 14 blocks of Gurdaspur district, namely SRI with one plant per hill and 25 x 25 cm spacing (T1) vs. conventional transplanting at 2-3 plants per hill with 15 x 15 cm spacing (T2). Similar trials have been conducted since 2005-06.

Growth parameters and dry matter distribution were measured at two-week intervals as were yield components and grain yield at maturity. Dry weight of stems, leaves and roots; the total dry weight of leaf area; total root growth per hill during the growing period; and total number of tillers per plant were all significantly higher in SRI plants compared to conventional with SRI methods of cultivation -- 26 tillers per plants with SRI compared to 16 tillers per plant conventionally grown. The numbers of tillers per m^2 were also higher -- 376 vs. 240 tillers per m^2. It was noticed that leaf blades were stronger in SRI plants than with conventional rice methods. Root systems were also stronger in the case of SRI

Yield components (a) number of panicles per hill and (b) number of spikelets per panicle were significantly higher in SRI. Grain yield with SRI was as high as 110 qt per hectare (11 t/ha) planting PAU-201 variety.

Overall results suggested that the higher yield production with the SRI farming system may be due to vigorous and healthy growth of plants which develop more productive tillers and a stronger root system, which ensures greater resource utilization in SRI compared to conventional transplanted rice. Therefore, SRI methods can be introduced to small and marginal farmers in Punjab as a sustainable and ecofriendly farming system of rice.

Media Summary: The System of Rice Intensification (SRI) for rice cultivation produces greater grain yield compared to commonly-used conventional methods of rice cultivation in Punjab with better utilization of natural resources. Less water (by 40-50%) is required for irrigation, and soil health is improved by activating microbial activity in the soil due to higher aeration and more provision of organic matter.

Introduction: Punjab is a predominantly agricultural state. The main cropping pattern in Punjab is the rice-wheat rotational farming system, with about 24.87 lakh hectares of rice being grown. Average rice productivity is now 3,858 kg per ha in 2005-06 (3.86 t/ha). Rice has not been a traditional crop in Punjab State, and even now, only a small fraction of the production is being consumed in the state, Punjab being the major supplier of rice to the rest of India. Increasing the productivity of rice is a major challenge due to the declining land area under agriculture and the ever-increasing costs of cultivation. Further, the declining supply of underground water as water tables drop year annually will be a major problem in the years ahead, due to increasing demand for water for non-agricultural purposes and the uncertainty and reduction of total water supply.

Constraints on water availability for rice production are increased by the frequent failures of monsoons as well as the unequal and uncertain distribution of rainfall during the year. The net area irrigated by shallow tube wells is 2.5 m ha, and by deep tube wells, it is 1.6 m ha. Rice crops currently need to be irrigated 24 to 28 times. Over 70% of the tube wells in the state are in the central districts, and the area they serve represents about 85% of the total land used for rice during Kharif season. As a consequence, ground water supplies are over-exploited in 118 blocks of the 138 blocks in Punjab State.

Punjab has already exhausted its upper layer of groundwater, and farmers are now using high-powered pumps to reach supplies lower in the soil horizon. As of 2006, submersible pumps have replaced about 30% of the centrifugal pumps in the state in order to draw up deep-lying water. In 2006, tube wells consumed 7,500 million kilowatt-hours of electrical power. Punjab expends Rs. 2,400 crores on electricity subsidies. Of this, Rs. 1,500 crores are utilized for rice cultivation. The high demand for electrical power has prompted the Punjab State government to buy power worth Rs 2,800 crores in 2006-2007.

This demand is increased each year by the lowering water tables that are reducing ground water access and raising farmers’ costs of irrigation. These factors make water-saving technologies as well as economically-beneficial methods for rice production all the more urgent. Besides this, there is need to develop methodologies which will maintain soil health and sustainability along with getting higher productivity per unit area.

Overall, the productivity per hectare in the State has stagnated in recent years. At the current rate of population growth, the country will need to be producing about 130 MT of rice by 2025 to feed the ever-growing population. Agriculture in Punjab faces its worst challenge since 1970. Last year, the state recorded a growth in agricultural output of only 1.86%, much lower than in preceding decades, a reflection of resource constraints. Ground water resources in the state have taken a sharp dip, while the area under agriculture is declining due to urbanization, industrialization and other factors. So there is need for techniques of rice cultivation that can produce more yield with less water -- and with fewer other inputs to enhance profitability, which has also taken a sharp decline.

Materials and Methods: All the trials have been carried out on various farmers’ fields in different blocks of the district during Kharif season of 2005-06, 2006-07 and 2007-08. The experiments consisted of 2 treatments: T1 – crop establishment according to SRI methods (10-12 day-old seedlings planted one plant per hill at 2-leaf stage at a spacing of 25x25 cm); and T2 -- with conventional transplanting and puddling of 35 day-old seedlings planted 2 seedlings per hill with randomized spacing. Size of plots was 2 *kanals*

(1000 m^2) each. Nurseries were sown on raised nursery beds followed by adding FYM at 2 kg per square meter. Various varieties like PAU-201, PUSA-1121 and Basmati-386 were used.

For T1, soil was kept moistened but without standing water up to panicle initiation, and thereafter throughout the grain-filling stage, a water level 1-2.5 cm deep was maintained. First weeding was done 10 days after transplanting with a conoweeder, and a 2^{nd} weeding was given 20 days after transplanting. One more weeding was given manually to remove any left-over weeds. 65 kg of urea per acre in two splits was given, and 25 kg DAP per acre was applied before transplanting, as compared to 100 kg urea and 25 kg DAP applied for T2 plots. Irrigation water was drained out from the fields 15 days before harvesting. 2 treatments of tilt @ 200 ml per acre were applied at dough stage of growth before panicle initiation to improve the quality of grains. Yield components and final yield were calculated at physiological maturity from 10 m^2 areas in the center of each plot.

Results and Discussion: Plant height was 3-4 cm shorter in SRI plants as compared to conventional methods. However, the dry weight of stems, leaves, roots, and total plant weight per hill was greater throughout the growing season with SRI, resulting in higher total dry weight compared to conventional method treatment at maturity. Average number of tillers per plant was 26 compared to 16 with SRI and conventional methods, respectively. Number of productive tillers was higher in T-1 systems, which take up more nutrients from deeper layers of soil

No. of irrigations applied in SRI vs. non-SRI methods of rice cultivation			
1	SRI (T-1)	Non SRI (T-2)	Saving of irrigation water
	13 (2.5 cm depth – intermittent drying and wetting)	25 (5 cm depth and standing water)	40-45%

Yield Components and Grain Yield: The number of panicles per m^2 was significantly different between the methods. The results from SRI treatment with PUSA 1121 -- 376 panicles per m^2 -- was significantly higher than with conventional method -- 240 panicles per m^2. The number of grains per panicle was higher in SRI -- 398 grains per panicle in case of PAU-201, and 225 grains per panicle in case PUSA-1121 variety of Basmati -- followed by 273 grains with PAU-201 and 130 grains with PUSA 1121 from conventional methods. Weight of grains per panicle was 11.35 gm with SRI as compared to 7.25 gm wt of grains produced with conventional method using PAU-201 variety.

Comparative results of different varieties under SRI method of rice cultivation

Sr no.	Parameter	PAU-201		PUSA-1121		Basmati 386	
		T-1	T-2	T-1	T-2	T-1	T-2
1	No. of panicles per sq mt	412	245	376	240	325	163
2	No. of grains per panicle	398	273	225	130	173	135
3	Wt. of grains per panicle (gms)	11.35	7.25	3.65	7.34	3.11	2.21
4	Yield per sq mt (gms)	1,250	795	631	466	421	320
5	Height of plant (cm)	92.21	115.01	117.03	122.35	137.12	142.03

Adoption and expansion in area under SRI method of rice cultivation

Year	No. of farmers	Area (acres)
2005-06	10	3
2006-07	25	30
2007-08	150	175

Trials of SRI method of rice cultivation were started in the year of 2005-06 on 3 acres with 10 farmers. Two years later, the area under SRI had increased up to 175 acres with 150 farmers.

Overall results indicated even though the plant density was much lower with SRI, i.e., 16 plants per m^2, they produced a larger number of productive tillers with more leaves producing higher dry matter comparable to conventional method. In the SRI treatment, minimal chemical fertilizer was used, and water use was also less (by 40-45%). However, greater ground exposure due to the lesser number of plants per m^2 and having no standing water enhanced weed growth in the SRI plos as a result. This necessitated more weeding, which added to the cost of production. However, weeds which are churned into the soil act as source of food for microorganisms and enhance soil structure. Further, the larger root systems resulting support larger canopies which lead to more photosynthetic activity.

Some of the photosynthate produced in the canopy goes into the soil through root exudation and other form of rhizodeposition. The carbohydrates, amino acids and other compounds that plant roots put into the rhizosphere support larger, more diverse, and more active populations of soil organisms, ranging all the all the way from the tiniest microbes (bacteria and fungi) up to visible and obviously beneficial earthworms (Norman Uphoff).

It was also observed that rice plants under SRI methods seldom lodge. SRI methods change the way that plant, soil, water and nutrients are managed, rather than relying on inorganic fertilizers or other agrochemicals. SRI also reduces the need for irrigation water by about 40-50 % and diminishes the requirements for capital and seed (Uphoff 2003). Irrigation water is completely drained out 15 days before harvesting to facilitate uniform ripening of grains. Studies that were carried out in Gurdaspur district during the last three years confirmed that the yield increase is mainly attributable to the greater number of tillers per m^2, number of grains per panicle, and resulting healthier plants with low pest and disease problems that enhance efficient resource capture for grain production in SRI.

Conclusion: Overall results of growth and yield parameters suggest that rice plants under SRI methods grow vigorously, producing more tillers and stronger root systems, resulting in more grain production compared to conventional methods of rice cultivation. According to Henri de Laulanié and Association Tefy Saina in Madagascar, there is an organic philosophy which supports SRI. Agronomy is the science of life, and life is autonomous. In rice cultivation, rice is the true master of the game, and the rice planter is its knight or in other words, its disciple. The environment is understandably important as this is shaped by the way that soil, fertilizer and nutrition treatments are managed. What is essential is the way that the rice itself is enabled to utilize its environment**.**

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