



REPORT ON THE WORLD RECORD SRI YIELDS IN KHARIF SEASON 2011 IN NALANDA DISTRICT, BIHAR STATE, INDIA

A paddy yield of 22.4 tons/hectare reported from the SRI trial plot of a farmer in Darveshpura village, Bihar, Shri Sumant Kumar, has attracted considerable attention because it surpasses the previously accepted world record yield of 19 tons/ha reported from China. With four other farmers in the village, also first-time SRI practitioners, achieving paddy yield levels of 18 or 19 tons/ha, Sumant Kumar's achievement was not an isolated occurrence.

Local Situation

The most successful farmers involved in these reports were well-educated and have good learning ability for adopting innovative technology on their fields. As agriculture is their single source of household income, they were trying to utilize the inputs available to them in the best possible way. These farmers used green manuring, particularly dhaincha (*sesbania*), as well as vermicompost and

other organic sources of nutrients along with some amount of chemical fertilizers. No major insect pests or diseases were observed in these rice fields during the crop growth period, possibly reflecting the suite of crop management practices.

Darveshpura village and the SRI demonstration plots are situated on the banks of the Sakri River. The water table is high, and soil organic matter has been built up and maintained. The soils are generally sandy clay and well-drained, with no water logging. Soil pH is in the neutral range. The climate and rainfall distribution were better in 2011 than in the previous year, when much of Bihar experienced serious drought conditions.

Farmers in this area practiced various rotations during the cropping year. The main rotations were: rice (kharif)/wheat (rabi)/then moong (mung bean, a short-season legume) and finally dhaincha (*sesbania*) for green manuring, or alternatively,

rice/maize/moong/dhaincha. Other rotations include: rice/potato/onion; rice/lentil/gram; rice/mustard or toria, a rapeseed; groundnut/arhar (red gram); maize/red gram intercropping; or some other mixed cropping rotation. In a few pocket areas, a rotation of rice/potato/muskmelon or watermelon was also raised.

The Successful Farmers

The names of these five farmers – all relatively young, between 30 and 35 years old – are Sumant Kumar, Krishna Kumar, Nitish Kumar (coincidentally the same name as Bihar's Chief Minister), Vijay Kumar, and Sanjay Kumar. Their rice crops were cultivated on upland soils with tubewell irrigation, and all worked closely with the local staff of the Agricultural Technology Management Agency (ATMA) for Nalanda district. Because they have tubewell irrigation, they have both incentive and capability for applying water sparingly.

The successful farmers have more than high school education, with 10 years of schooling plus 2 or 3 years of additional training beyond matriculation. Their landholdings were medium-sized for the region, 5 to 7 acres (2.0 to 2.8 ha). The size of Sumant's SRI test plot was 1 acre, from which an area of 50m² (10x5m) in the middle was harvested and evaluated to calculate yield. This measurement was made with the Department of Agriculture standard methods. The same methods were used for evaluating the farmers' yields with conventional agricultural practices. The SRI plots of each of the other four farmers were also 1 acre each. Their area of conventionally-grown paddy rice in 2011 was 5 to 7 acres.

Cultural operations

Sumant Kumar planted the Bayer hybrid variety Arise-6444, while the other four farmers used Syngenta's hybrid 6302. These are medium-duration varieties with a usual crop cycle of about 150 days, but in this season, Sumant's SRI crop reached maturity in 142 days. Upland nurseries of 100 m² were established, with a seed rate of 5 kg/ha for the SRI nursery compared with a usual rate of 35-40 kg/ha. Both the SRI and regular nursery were sown on June 20, 2011, with the seeds for both nurseries treated with Carbendazim (2 g/kg) for protection against seed-borne diseases. The SRI nursery soil was kept moist but not flooded, while the regular nursery was irrigated with a pump set. Seedlings were removed from the SRI nursery on July 3, while those used for regular rice cropping were taken out on July 15. The respective seedling ages were thus 12 days and 24 days.

Deep ploughings of the SRI field were done on May 1 and June 16, followed by shallow ploughing on June 21 and June 29, with puddlings of the field on July 2 and July 3, the latter being the day of transplanting. The ploughing operation incorporated the dhaincha (green

Other High Yields in the Village

	Production in 10x5 m ² area (kg)		Production (t/ha)	
	Wet	Dry	Wet	Dry
Name				
Krishna Kumar	101	90.9	20.2	18.18
Nitish Kumar	98	88.2	19.6	17.64
Vijay Kumar	96	86.4	19.2	17.28
Sanjay Kumar	95	85.5	19.0	17.10

manure) vegetative material into the soil of both the SRI and the normal-practice fields. Farmyard manure (FYM) was applied to the SRI field at the rate of 6 tons/ha and was incorporated during land preparation. Both the SRI and the normal-practice fields received the same amounts of inorganic fertilizer, added as basal doses the day before transplanting, i.e., July 2 for the SRI field, and July 15 for the regular field. The applications of P and K were, respectively, 80 kg/ha of diammonium phosphate (DAP) and 40 kg/ha of potash. During the season, some N was applied as urea, at a rate of just 40 kg/ha, in split doses on July 18 and August 22, a relatively low rate of N supplementation.

For organic soil fertilization of the SRI plot, there was an application of poultry manure on July 2 at a rate of 400 kg/ha, plus 100 kg/ha of vermicompost and 40 kg/ha of a compound containing phosphorus-solubilizing bacteria (PSB) at the same time. Also, a micronutrient foliar spray of monohydrated zinc sulphate @ 25 kg/ha, was applied on both the SRI and conventional fields on August 22. The fertilization practices followed for SRI compared to usual production practices thus differed only in that the latter did not receive FYM, poultry manure, or vermicompost prior to transplanting. Also, for the conventional crop, the top dressings of urea were later (July 18 and August 30) as was the

Other High Yields in the Village

	SRI (Rs./ha)	Conventional (Rs/ha)	Savings (Rs./ha)	Reduction %
Nursery	1,200	1,800	600	33
Transplanting	2,390	2,895	505	17
Weeding	2,600	4,405	1,805	41
Total	6,190	9,100	2,910	32

ZnCl foliar spray (August 30).

SRI seedlings were transplanted at 25x25 cm distance in a grid pattern, one seedling per hill, giving a plant density of 16/m². Regular-practice seedlings were transplanted 12 days later in a random pattern in the field, with 3-5 seedlings per hill. The plant population under SRI management was thus much lower than with standard crop management practices; with SRI, there was a 75-80% reduction in the number of plants.

The main weed problem for these farmers were broad-leaved weeds, and in the regular field a herbicide (2,4-D) was sprayed to control these, applied at a rate of 1.5 liters/ha. In Sumant Kumar's SRI field, there was no chemical weed control --only soil-aerating cono-weedings done at 13 days and 26 days after transplanting. No chemical crop protection measures were taken as no insect pests or diseases or rodents were observed in either the SRI or regular fields.

The regular field was managed with flood irrigation, while the SRI field was served by sprinkler irrigation. SRI crop received about one-third as much water during the crop-growing season as with flood irrigation.

Sumant Kumar's SRI and regular fields were harvested, respectively, on November 10 and November 20, so his SRI crop matured 10 days sooner from the date of sowing in the nursery, giving much higher yield. The SRI crop cycle was 142 days, compared to the usual time to maturity of 150 days (in this case, 152 days for the regular-practice field). The weight of the paddy rice harvested from the cutting of 50 m² on the SRI plot was 112 kg. This

Variety	No. of farmers	Average SRI yields (t/ha)
Syngenta 6032	4	17.85
Arise 6444	8	12.82
Loknath 505	1	12.75
Pusa 44	39	7.90
Dhaniya 775	3	7.66
VNR	1	7.62
Basmati Kohinoor	1	6.75
All varieties	57	9.34

represents a wet-rice yield of 22.4 t/ha. The dried weight from the harvested area was 100.8 kg, which amounts to a dried-weight yield of 20.16 t/ha, well above the previously reported world-record yield from China of 19 t/ha.

These farmers along with Sumant Kumar have been advised to use a similar package of practices with the same hybrids on the same plots in the next kharif season to assess yield stability. All agronomic yield-contributing factors will be recorded with soil testing of nutrients.

Economic Evaluation

A common perception of SRI management has been that it is more labor-intensive. When farmers first begin to use the new methods, when they are just starting on their learning curve, the work does go more slowly. But the data available from the Department of Agriculture indicate as seen in other evaluations that there is labor-saving in most of the cultivation operations when SRI methods are practiced.

An assessment in Bihar has revealed that with the great reduction in nursery area and with a much lower seed rate, with SRI there is a saving of 40 man-hours per hectare for nursery management, and another 50 man-hours are saved for the pulling out and transporting of seedling bundles from the nursery area to the main field.

Due to more widely spaced transplanting and much lower numbers of plants, fewer labourers were required for SRI methodology. Farmers needed 50-60 women labourers

in conventional method, whereas only 25–30 labourers were needed with SRI.

Once skill is acquired in using the conoweeder, weed control operations can also require less labour compared with the usual hand weeding. Moreover, this becomes a less laborious process than for manual removal of weeds.

The results show SRI reducing labour for these major operations by 32% in the sampled farms, with a major saving in weeding of some 40%, and 33% less labor needed for nursery preparation and management as there is less nursery area and no need to carry seedlings far away from the nursery to the main field.

More labor is needed to manage the water applications according to the SRI principle of keeping the paddy soil moist but not continuously saturated. But the cost of labor for irrigation is offset considerably by a reduced cost for the water itself. There is also more cost for harvesting because the yield is much higher, but this added cost is compensated for several times over by higher production and resulting greater income. Cost per kilogram of paddy produced is much lower with SRI management, giving farmers more income.

Varietal Differences

From Agriculture Department data for 57 farmers in Nalanda district where crop-cut estimates of yield were made for farmers using SRI methods, differences in average yields for different varieties are shown below. The average SRI yield for the whole set of farmers was 9.34 tons/ha. These results are very encouraging for SRI production methods, and also for hybrid varieties. Note that with larger numbers of farmers, the average for Arise 6444 is less than for Syngenta 6032, which underscores that the growing environment, which can include the soil biota, has as much or more impact on results than simply the genotype involved. This also suggests that

farmer differences are important in accounting for yield outcomes.

Observations

The experiences of Sumant Kumar and his neighboring farmers give strong support to the recommendations followed in SRI method

- Manage a smaller nursery carefully with lower seed density and with aerobic soil conditions;
- Transplant young seedlings singly, carefully, and with wide spacing;
- Apply only as much water as the plant needs for its growth;
- Control weeds with soil-aerating weeding; and
- Enhance organic matter in the soil as much as possible.

What has not been assessed in Darveshpura is what effect, if any, these practices may have had on the soil biota: the massive and complex populations of bacteria, fungi, protozoa, and other larger organisms like mites and earthworms that inhabit the soil which has favorable conditions. These diverse organisms are known to have many beneficial effects on plant growth and to be promoted in aerobic soil with abundant organic matter.

It can be hypothesized that in this situation the soil biota played some role, perhaps an intermediary role, in producing healthy and more productive rice plants. That as many as five farmers in fairly close proximity achieved such super-yields lends some weight to this hypothesis and raises the possibility that soils in Darveshpura have some particularly beneficial species or associations of soil organisms. This seems to be supported by experience in this village with their potato crop last year.

The results from the 2011 kharif season in Bihar should remove any remaining reservations about utilizing SRI ideas and methods on a broader scale, making appropriate adaptations to local conditions, which is part of the SRI methodology.

M.C.Diwakar, Arvind Kumar, Anil Verma, and Norman Uphoff