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Evaluation of Economic and Yield Sustainability in 'SRI' cultivation of Rice in Andhra Pradesh

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ABSTRACT

A Study has been undertaken in Andhra Pradesh to assess the yield and economic sustainability of 'SRI' method Vis-a-vis the conventional method of cultivation of paddy based on the secondary data extracted from the edited publication viz. Farmers experiences in SRI cultivation, of Acharya N.G. Ranga Agricultural University and WWF – ICRISAT project, Hyderabad. The methodology developed by Kiresur *et al.,* (1995) was adopted to calculate the Sustainability indices for yield and net returns of 'SRI' technology in Rice. Sustainability indices of the 'SRI' technology against conventional method varied from 63% to 154% in case of yield and 47% to 227 % in case of net returns. Inverse relationship was observed between the variation in the SI's of different crop growing situations and the overall sustainability of the technology. 'SRI' technology for Rice cultivation was fairly sustainable both in terms of net returns and yield across the agro-ecological and crop growing situations of Andhra Pradesh. However, location specific improvement of package of practices and educating the farmers about the package of practices will ensure sustainable yields and net returns needed at macro and micro levels respectively.

Key words : Economic Susatainability, SRI cultivation, Yield Sustainability.

Rice is cultivated in 44 lakh ha., in our country and it can be cultivated across the length and breadth in varied agro – climatic conditions. Rice farmers in India have contributed a lot for food security and in turn stability, self – respect and economic growth of the country. They still have a major role to play in feeding the county's growing population. Unpredictable rainfall, competition for more water from other sectors and unremunerative price are reflecting on fluctuating rice production in the country. The conventional method of paddy cultivation requires large amount of inputs particularly water, fertilizers and pesticides, contributing to high cost of cultivation and depletion of water levels. Indiscriminate use of chemical fertilizers and pesticides damaging the ecosystem equilibrium and reducing the quality of produce leaving the residues behind. Frequent droughts during 1998 to 2004 left the rice farmers in doldrums.

Andhra Pradesh experienced a severe drought in 1999 – 2000 characterized by water shortages, falling ground water levels and increased risk of contamination of surface water. The drought followed by low rainfall in Southwest and North east monsoons, resulted in serious reduction in agricultural production. Thereafter, thrust for conjunctive water use became the major concern for farmers and scientists. Under these circumstances, with a view to reduce the demand for water to grow irrigated rice while increasing rice production, the System of Rice Intensification (SRI) was introduced in Andhra Pradesh during Kharif, 2003 as an alternative methodology to the existing flood method of rice cultivation. Since then, Government and Non Government Organizations took several initiatives to promote SRI in the state.

However, still farmers are having their own difficulties/reasons for not taking 'SRI' on large scale, in spite of many advantages. The doubts regarding economic viability of the technology, its ability in improving the yield, lack of knowledge regarding improved practices in it & economic constraints might be some of the reasons for slow adoption. But, once the farmers are convinced about the Technology's abilities to give guarantied returns both in yield and monetary terms, there is no doubt about adopting this technology in particular or in fact any technology in general. Hence a study has been under taken with the objective of assessing the yield and economic sustainability of 'SRI' method Vis-a-Vis the conventional method of cultivation of Paddy**.** Yield Sustainability of the technology has got Macro – economic importance i.e., sustained yield levels among farming community will ensure stable production and in turn food security where as economic sustainability has got micro – economic importance i.e., sustained economic returns would encourage the farmers to adopt the technology ('SRI' cultivation) over time and space.

MATERIAL AND METHODS

For estimating the sustainability index, for the purpose of evaluating the frontline demonstrations of oil seed production technologies for economic sustainability, Kiresur *et al.* (1996) suggested methodology in their paper entitled "A model for estimation of the economic sustainability of improved oilseeds crop production technologies". This method suits for data in the present work, which were extracted from the edited book of *viz. Experiances in 'SRI' cultivation* published by Acharya N.G. Ranga Agricultural University and WWF-ICRISAT Project, Hyderabad Girirao& PunnaRao, 2007. Conventional method was considered as farmer's practice (FP) and 'SRI' method followed by farmers as improved technology (IT). The estimation procedure is indicated below.

Let there be "n" situations in which farmers are practicing IT i.e 'SRI' method of paddy cultivation and let Yi (i=1 to n) be the yield from the i^{th} farmer's field adopting IT and Y_m be the mean yield of all such farmers adopting IT in a given cropping system. Let Xi (i = 1to n) be the corresponding yields by the adoption of FP (farmers practice) from each farmers field that corresponds to each yi (i =1to n), X_m be the mean yield of all such cropping systems adopting FP (farmer's practice). Then, for each X_i a site index is computed as Ei= $(X_i - X_m)$. Let "b" be the estimated regression coefficient of Y_i on E_i. The desirable yield level of IT for the i^{th} field was given by Di = Yi +bS where, S is the mean of the lowest and the highest site index. In other words $S = (E_{max} + E_{min})/2$, E_{max} and E_{min} being the maximum and minimum values of the site indices respectively for a given crop growing situation. In fact, S reflects the symmetry of site indices. The standard error of D_i was computed as the square root of $(1/n + S^2 / \sum Ei^2)$ MSE, where n is the no. of corresponding farmers fields adopting FP and IT, S is the symmetry of site indices, $\sum Ei^2$ is the sum of squares of the site indices for a given crop growing situation and MSE is pooled within situation mean square of IT yields in the analysis of variance. In addition to that, standard yield level of IT was defined for that particular crop growing situation as $Ds = Y_m + S$. By computing the Di and Ds values, the expected yield level for each field adopting IT (Di) can be tested against the standard yield level (Ds) and the sustainability of the given IT can be calculated as the percentage of those Di's which are statistically on par or greater than the Ds values.

In each crop growing situation, the site index for each farmer field was worked out as the deviation of respective field adopting FP from the mean of all such fields. The regression of IT net returns of corresponding site index was worked out for each crop growing situation. For each farmer's field the desirable yield level of the IT (Di) and for a given crop growing situation the standard yield level of IT (Ds) were computed. The detailed steps involved in the computation of sustainability index are furnished below.

$Ei = (X_i - X_m)$ where,
E_i = Site index
X_i = Yield level of FP for i^{th} field
X_m = Mean yield level of FP for the crop growing situation.

$Y_i = a + b E_i$ Where,
Y_i = Yield level of IT for i^{th} farmer
a = Regression constant (intercept)
b = Regression coefficient = $COV (E_i Y_i) / Var E_i$

$S = (E_{max} + E_{min})/2$ where,
S = symmetry of site indices
E_{max} = Maximum value of E_i
E_{min} = Minimum value of Ei

$D_i = Y_i + bS$ where,
D_i = Desirable yield level of IT for i^{th} farmer.

$D_S = Y_m + S$ where,
D_S = Standard yield level of IT for the crop growing situation.
Y_m = Mean yield level of IT for the crop growing situation.

The expected yield level for each farmer adopting IT (D_i) was tested against the standard yield level (D_S) by conducting't' test value given by

't' $= D_i - D_{S} / SE(D_i)$ where,
$SE(D_i)$ = square root of $(1/n+S^2/ \sum Ei^2)$ MSE where,
n = sample size (no. of paired fields of IT and FP)
MSE = Error sum of squares (E.S.S) / n-2
ESS = TSS-RSS where,
$TSS = SS(Y_i) = \sum Y_i^2 - (\sum Y_i)^2/n$
$RSS = SS(b) = [\sum X_i Y_i - (\sum X_i \sum Y_i/n]^2 / \sum X_i^2 - (\sum X_i)^2 / n$

Sustainability index (SI) is given by
$SI = D_i >^s = D_s /n$,
SI = Sustainability index.
$(>^s=)$ = significantly greater than (or) equal to$(^s<)$ = significantly lower.

RESULTS AND DISCUSSION

The impact (or) potential of any improved technology is generally assessed based on the magnitude of the differences in the mean yields (or) net economic returns (or) benefit-cost ratios of the improved technology (IT) and those of a comparable sample of fields with the traditional or existing farmers practices (FP). In general the yields or returns from IT exceed those from FP and there is no set standard for assessing whether the improved technology can really be called sustainable. Hence there is a need for a more objective methodology for assessing the viability or the potential of the IT ('SRI' method of Rice cultivation) vis-à-vis the existing range of variation in the fields adopting FP (Conventional method of Rice cultivation) as also against the standard yield level (D_s) for a given crop growing situation (Andhra Pradesh). In the present investigation a model that uses both the actual yield of IT as well as a regression coefficient, is examined in each farmer's field. The 'SRI' technology is evaluated against a standard (or) hypothetical yield to assess its economic sustainability in terms of yield and net returns. Further, the yield and net returns (Y_i) were adjusted for their regression on a site index (E_i) and they were compared against standard yield and net returns (D_s) for any significant differences. The sustainability index was computed as the percentage of farmers that stood on par or exceeded the standard yield and net returns level (D_s) in a given set of farmer's fields in Andhra Pradesh state having specific agro ecological situation. The results on the computation of yield and net returns sustainability index for the 'SRI' technology in comparison with Conventional method of Rice cultivation system were discussed below.

Yield Sustainability

The results on the computation of sustainability index for the farmers of 'SRI' technology, along with the values of Di and Ds as well as the yield levels of IT and FP are presented in Table 1. The Yield levels of the farmers with 'SRI' technology were greater than the Yield levels of farmers with Conventional method. This was due to presence of positive regression (b = 1.14) and a positive symmetry of site index. The Yield levels of IT adjusted for regression (Di) were more than their actual Yield levels. Hypothetical (or) standard Yield levels (Ds) of the 'SRI' technology which determined whether the Di values were in fact sustainable was estimated as Rs. 3173 kg ac^{-1}. Out of 36 farmers, seventeen farmers had Di values that were significantly lower than Ds there by the sustainability index for yield of the 'SRI' technology in Andhra Pradesh could be worked out as 52 per cent.

The results on the computation of sustainability index for the farmers of 'SRI' technology in Andhra Pradesh during 2006-2007 crop season along with the values of Di and Ds as well as the net returns of IT and FP are presented and discussed in Table 2. The net returns of farmers with 'SRI' technology were greater than the Conventional method of Rice cultivation. Due to positive regression (b=1.50) and a positive symmetry of site index (S=2255), the net returns of IT adjusted for regression (Di) were greater than their actual net returns. The hypothetical or standard net returns (Ds) of the 'SRI' technology, which determined whether the Di values were in fact sustainable, were estimated as Rs.15649. In Thirteen out of Twenty eight farmers the D_i values were greater than D_s and the remaining were lower. None of the farmers had D_i values that were significantly lower than D_s. Therefore the sustainability index for the 'SRI' technology in Andhra Pradesh could be worked out as 46 per cent.

The above discussion on results of sustainability indices of 'SRI' technology revealed that even though the net returns of farmers adopting the 'SRI' technology were correspondingly greater than Conventional method, the sustainability indices of the 'SRI' technology against Conventional method varied from 63 per cent to 154 per cent in case of yield & 47 per cent to 227 per cent in case of Net Returns. Wherever the symmetry of the site indices was closer to zero, irrespective of the regression of IT net returns on site index, the mean net returns of IT was closer to the corresponding standard yield level (Ds) indicating that in such cases, the mean net returns of IT could be used for assessing the sustainability of the IT. A perusal of the results clearly indicate that the magnitude of the net returns realised from those farmers of the IT *per se* did not have a direct bearing on the sustain ability index for a given situation. As is seen from the tables, inverse relationship could be observed between the variations in the situation wise sustain abilityindices and the overall sustainability of the technology. This situation is not contradictory, as the model takes care of variations in the site indices (symmetry). The lower values of sustainability index may also suggest that there could be short falls in the implementation of package of practices for the 'SRI' technology (IT) in a given situation.This technology would be superior if appropriate package of practices are followed, during crop growing period. These results are corroborative with the results obtained by Kiresur *et al.* (1996) who reported that

Table 1. Actual yield levels and sustainability index of ‘SRI’ Technology in Andhra Pradesh (2006-07).

S.No.	‘SRI’ yield (Kg ac^{-1}) (IT)	Conventional yield (Kg ac^{-1}) (FP)	Di (Kg ha^{-1})	(Di Ds^{-1})*100 (=SI)
1	2730	1950	2755*	86.83
2	3750	2625	3755	118.34
3	2575	1900	2600*	81.94
4	3400	2700	3425	107.94
5	3300	2925	3325	104.79
6	3300	2025	3325	104.79
7	2400	1950	2425*	76.43
8	2850	2592	2875*	90.61
9	2375	1950	2400*	75.64
10	3750	2625	3775	118.97
11	2375	1950	2400	75.64
12	2520	1750	2545*	80.21
13	3300	2450	3325	104.79
14	2362	2300	2387*	75.23
15	5175	2725	5200	163.88
16	3600	1750	3625	114.25
17	2107	2200	2132*	67.19
18	2700	2350	2725*	85.88
19	3150	2400	3175	100.06
20	2512	2150	2537	79.96
21	2960	2965	2985*	94.08
22	3650	3000	3675	115.82
23	3825	2550	3850	121.34
24	3225	2450	3250	102.43
25	3500	3300	3525	111.09
26	4050	2100	4075	128.43
27	2800	1275	2825*	89.03
28	3000	1875	3025	95.34
29	1972	2220	1997*	62.94
30	2900	2156	2925*	92.18
31	3080	2250	3105*	97.86
32	3075	1923	3100*	97.70
33	2625	2500	2650*	83.52
34	3200	3500	3225	101.64
35	4250	3500	4275	134.73
36	4875	3375	4900	154.43
Mean	3151	2366		

Note: FP = Farmers practice, IT = Improved technology; Di = Yield level of IT adjusted for regression; Ds = Standard yield level of IT for the village = 3173 Kg ac^{-1}, SI = Sustainability Index. Regression coefficient b = 1.14, Symmetry of site indices S =21.5 ; *significantly lower at 1% level of probability.

Table 1. Net return levels and sustainability index of 'SRI' Technology in Andhra Pradesh (2006-07).

S.No.	Net returns of SRI cultivation (Rs ac^{-1}) (IT)	Net returns of conventional rice cultivation (Rs ac^{-1}) (FP)	Di (Rs ac^{-1})	(Di / Ds)*100(=SI)
1	10020	5510	13403 NSL	85.65
2	11785	6675	15168 NSL	96.93
3	17030	12750	20413 NSH	130.44
4	13744	9460	17127 NSH	109.44
5	10055	6745	13438 NSL	85.87
6	19125	17384	22508 NSH	143.83
7	10053	7003	13436 NSL	85.86
8	9880	5870	13263 NSL	84.75
9	10009	3660	13392 NSL	85.58
10	16376	11800	19759 NSH	126.26
11	8025	5865	11408 NSL	72.90
12	32200	9815	35583**	227.38
13	19350	13044	22733 NSH	145.27
14	4535	3925	7918 NSL	50.60
15	4932	10906	18315 NSH	117.04
16	9590	7300	12973 NSL	82.90
17	14576	8442	17959 NSH	114.76
18	19725	14049	23108 NSH	147.66
19	21000	15300	24383 NSH	155.81
20	11506	9434	14889 NSL	95.14
21	10325	7655	13708 NSL	87.60
22	11580	4810	14963 NSL	95.62
23	4066	2190	7449 NSL	47.60
24	5516	4207	8899 NSL	56.87
25	22825	12570	26208 NSH	167.47
26	13030	6800	16413 NSH	104.88
27	9880	9260	13263 NSL	84.75
28	13922	9127	17305 NSH	110.58
Mean	13394	8267		

Note: FP = Farmers practice, IT = Improved technology; Di = Yield level of IT adjusted for regression; Ds = Standard yield level of IT for Andhra Pradesh = Rs.15649 ha^{-1}, SI = Sustainability Index. Regression coefficient b = 1.50, Symmetry of site indices S = 2255; NSH: Non significant higher, SH = significantly higher, SL = significantly lower; NSL: non significant lower ** Significantly higher at 1% level of probability

the improved crop production technologies for oil seeds are fairly sustainable as indicated by the sustainability indices ranging from 67 to 93 per cent in terms of net economic returns and 50 to 100 per cent in terms of yield across the agro-ecological and crop growing situations and over the study period.

Conclusions

'SRI' technology for Rice cultivation was fairly sustainable as indicated by the sustainability indices ranging from 47 to 227 per cent in terms of net economic returns and 63 to 154 per cent in term of yield across the agro-ecological and crop growing situations in Andhra Pradesh.

Suggestions

Location specific improvement of package of practices is needed for increasing the yield & economic sustainability of 'SRI' technology.

Efforts to educate the farmers of Andhra Pradesh about the package of practices of 'SRI' technology are also needed.

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