**SRI Cultivation in Andhra Pradesh: Achievements, Problems and Implications for GHGs and Work**

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**I**

**System of Rice Intensification (SRI): Evidence for its Superiority**

***1.1 Introduction***

Rice is one of the most important staple food-grains, and ranks third in production among food-grain crops in the world next to maize and wheat. It is also the most irrigation-intensive crop in the world: more than two-thirds of irrigated area is under rice cultivation. However, it is the only cereal crop that can grow under both flooded and dry conditions. The practices of rice cultivation have undergone changes over time from simple broadcasting to systematic transplantation. Though an enduring feature of rice is water intensity, it is cultivated not only in the humid and high rainfall areas but also in semi-arid regions, by tapping ground water resources.

However, the increasing demand and the resulting pressure on scarce water resources, particularly ground water, calls for water use efficiency in agriculture, semi-arid tropical rice in particular. Water efficiency has also become an important issue in the context of climate change and the rising emission of greenhouse gases (GHGs). The major greenhouse gases are carbon dioxide (CO2), methane and nitrous oxide. Many anthropogenic activities contribute to the release of these greenhouse gases. Agricultural activities in general and rice cultivation -following the conventional flood or submerge method in particular - contribute to emissions(see Gathorne-Hardy 2013). In the submerge method, standing water in the rice fields generates water evaporation, methane and nitrous oxide; fertiliser generates nitrous oxide. Especially in semi-arid regions, ground water is lifted using energy generated through the combustion of fossil fuels which are powerful emitters of carbon dioxide (CO2).

Strategies and solutions to meet the challenges of GHGs call for new methods and technologies. Potential options for the rice industry sector to contribute to the mitigation of, and adaptation to, climate change by increasing rice production in a physically sustainable manner are attracting growing research interest. One such area of interest is the new method of rice cultivation: the System of Rice Intensification (SRI). SRI is an innovative approach to rice cultivation but not a technology as such. Unlike conventional rice cultivation methods that use flooding/submergence and are prone to the emission of greenhouse gases, the SRI method requires substantially less water, resulting in important energy savings from pumping. In turn this not only improves water use efficiency but also increases yields and - with less seed, water, pesticides and chemical fertilizers - results in reduced costs of cultivation as will be evident from the data presented later in this paper. The net effect is that SRI is able to improve household incomes and food security while reducing the negative environmental impacts of rice production, and making food production more resilient (Africare\_OxfamAmerica\_WWF-ICRISAT Project, 2010).

The evolution of the SRI technique of rice cultivation has shown that the core components of the Green Revolution – high doses of fertilisers, pesticides and water - are not necessary to achieve increased yields (Uphoff, ud 1).The principles of SRI contest the belief that rice plants do better in saturated soils, and prove that rice plants can grow in soils under modest moisture condition without being continuously flooded. The development of SRI also established that farmers are not always at the receiving end of science and technology developed by research establishments, for farmers themselves have been shown to make innovations in farming methods and practices.

***1.2 The Shift to SRI: Readjustments in Agronomic Practices and Operational Methods***

The shift from conventional rice cultivation to SRI involves changes in some agronomic practices. For instance certain studies identify the use of single seedlings per hill, transplanting younger seedlings of less than 15 days, square planting (25 x 25 cm) and cona-weeding as the four core SRI-practices (Laulanie, 1992 & 2011, Palanisami et.al. 2013). Timely scheduling acquires considerable significance so will bediscussed briefly here.

Unlike transplanting relatively older (30 to 45 days) seedlings oat th density of three or four per hill as is the convention, for SRI, the seedlings are young (8 to 14 days old at the two-leaf stage) and single seedlings are transplanted in a wider square grid laid out with the help of a marker. The sparse transplanting of single seedlings under SRI reduces the seed requirement to an eighth to a tenth of that of conventional transplanting, and reduces labour requirement by almost half. But the transplanting of single, young seedlings is a delicate operation, requiring skill gained through experience. Transplanting continues to be an operation confined to women, but with reduced numbers and improved skills, which women acquire without difficulty.

Weeding is a second SRI operation differing from conventional cultivation practices in a number of respects. First, for SRI, manual weeding is displaced by a mechanical weeder. Whereas under conventional rice production, weeding is an entirely female operation, in SRI it is evolving into male work, though there are exceptional instances of female labour. Then, SRI requires early and more frequent weeding, from the tenth day after transplanting, and followed by three or four iterations with a gap of ten days in between. Early and frequent mechanical weeding crushes tender weeds into the soil to serve as a green manure, enriching both the soil and the crop. One observation often heard at the field level, is that mechanical weeding is arduous and monotonous, especially when a lone worker is engaged in it.

The most critical aspect of transition from the conventional system to SRI is the need for timely and intensive crop management. While conventional practices cope with the need for flexibility at all stages of growth, right from the possibility of transplanting older seedlings (30 to 45 days), through random and relatively thick transplanting (by using five or six seedlings at a spot and inundating the field with irrigation water without any need to drain it. By contrast, SRI requires early and more systematic transplanting, timely and frequent weeding and ‘alternate wetting and drying’ instead of flooding.

***1.3 SRI and Greenhouse Gases (GHGs)***

As mentioned above, the greenhouse gases with high global warming potentials (GWP) in the atmosphere are, in order of their importance, Carbon Dioxide (CO2), Methane (CH4), and Nitrous Oxide (N2O). The contribution of each gas to the greenhouse effect depends on the quantity emitted, the radiative force and their atmospheric life-time. Rice cultivation under conditions of flooded irrigation is one of the major man-made sources of these GHGs..

There is a considerable debate over the global warming potentials (GWP) of rice cultivation under different irrigation and water management systems (Jayadev et al, 2009; Quin et al, 2010; and Peng et al, 2011). A recent study in China found that under controlled irrigation, the GWP of rice cultivation is relatively low (Peng et al, 2011a&b). Global warming potentials of methane and nitrous oxide are 62.23gCO2 m−2for rice-paddy under controlled irrigation, 68.0% lower than for rice grown under irrigation by flooding (Peng et al, 2011). Due to large reductions in seepage and surface drainage under efficient conditions of irrigation and drainage and compared with ‘traditional’ practices, the Chinese research found nitrogen and phosphorous losses through leaching were reduced by 40.1% and 54.8%, and nitrogen and phosphorous losses through surface drainage by 53.9% and 51.6%. Nitrogen loss through ammonia volatilization was reduced by 14.0%. The Chinese study shows how efficient irrigation and drainage management helps to mitigate greenhouse gases emissions, nitrogen and phosphorus losses and their pollution on groundwater and surface water (ibid). In the context of challenges due to metereological variability, the principles and practices of SRI have other strengths like drought-coping capacities (SDTT, 2009).

***1.4 Evidence for Yield and Cost Advantages***

Studies of SRI cultivation in various parts of the world, in Andhra Pradesh, the site of our field studies, and elsewhere in India have shown that both yield rates and water use efficiency have improved (see for instance Uphoff, ud1; Lin et al, 2011; Kassam et al, 2011, Thakur et al, 2011, Ravindra and Laxmi, 2011, V & A Programme, 2009). SRI cropping methods can outperform the conventional management of rice in flooded, wetland paddy agriculture - whether evaluated in terms of output (yield), productivity (efficiency), profitability, or resource conservation (Kassam et al, 2011).. A macro-level study covering 13 major rice-growing states in India, indicates that fields with SRI have 22.4 percent higher average yield compared to non-SRI fields. However the superiority of SRI yields varies across the states from 12 percent in Assam to 53.6 percent in Gujarat (Palanisami et.al. 2013). SRI’s advantages also accrue to income and reduced costs. On average, the gross earnings from SRI are 18 percent higher than non-SRI, and average per hectare costs are 29 per cent less in SRI than for non-SRI production. Further, yield levels vary positively with the variation in the extent to which the core practices of SRI are adopted.

Evidence from Andhra Pradesh also supports the observations of higher yield rates of rice under SRI cultivation (Rao, 2011; Ravindra and Laxmi, 2011; and V & A Programme, 2009). A study of the economics and sustainability of SRI and traditional methods of paddy cultivation in the North Coastal Zone[[4]](#footnote-4), concludes that the benefit-cost ratio (BCR) was higher for SRI (1.76) than for traditional methods (1.25) for the same crop variety. (Rao, 2011). It also found a 31 per cent yield gap between SRI and traditional methods. Operating practices had a stronger effect than input use (20.15% versus 10.85%) in explaining this gap.

Field studies have also shown that water use efficiency varies with different rice cultivation systems. Compared to the conventional methods, water use/consumption under SRI is substantially lower and water use efficiency is higher (Ravindra and Laxmi, 2011; Reddy et al, 2006). These relationships hold for both tank and tube/shallow well based irrigation systems. The use of other inputs such as chemical fertilisers and pesticides is substantially lower for SRI[[5]](#footnote-5) (Ravindra and Laxmi, 2011; V & A Programme, 2009). With the savings in water and other inputs, and the consequent reduction in cultivation costs, the overall gains of SRI cultivation are found to be substantially higher than for conventional modes of cultivation (Ravindra and Laxmi, 2011; V & A Programme, 2009).

The Andhra Pradesh Agricultural University (ANGRAU) conducted demonstration trials across the state over a period of five years from 2003-04 to 2007-08 and the results show that yield levels in SRI plots were higher compared to conventional cultivation in all seasons during these years, ranging from 18.6 per cent to 41.5 per cent (Table 1).

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| **Table 1: Rice Yield Rates under SRI and Conventional Methods** | | | | | | |
| Year | Season | Number of  Demonstration  plots organised | Yield in  SRI Paddy kg/ha | Yield in conventional  Paddy/kg ha | SRI yield difference over conventional | |
| ***Kg/ha*** | ***%*** |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** |
| 2003-04 | Kharif | 69 | 8,358 | 4,887 | 3,471 | 41.5 |
| Rabi | 476 | 7,917 | 5,479 | 2,438 | 31.8 |
| 2004-05 | Kharif | 599 | 7,310 | 5,561 | 1,749 | 24 |
| Rabi | 311 | 7,310 | 5,777 | 1,533 | 21 |
| 2005-06 | Kharif | 2,864 | 7,476 | 5,451 | 2,025 | 27 |
| Rabi | 12,277 | 7,390 | 5,620 | 1,770 | 24 |
| 2006-07 | Kharif | 7,653 | 6,724 | 5,005 | 1,719 | 25.6 |
| Rabi | 6,201 | 6,830 | 5,558 | 1,272 | 18.6 |
| 2007-08 | Kharif | 1334 | 6179 | 4965 | 1214 | 24.45 |
| Rabi | 1293 | 6650 | 5225 | 1425 | 27.2 |
| **Note**: The results are from the demonstration farms in A.P. Information after 2007-08 is not available.  **Source**: Department of Agriculture, Government of Andhra Pradesh. | | | | | | |

**1.5 Preliminary Findings of a Field Study in Andhra Pradesh**

As a part of larger research project[[6]](#footnote-6) a field survey was conducted in the Janagaon region of Warangal District, Andhra Pradesh, with a sample of 25 SRI farmers and 10 control group non-SRI farmers from nine villages[[7]](#footnote-7) Data was collected from the sample households by a detailed questionnaire designed to suit the life cycle approach to the computation of GHGs, that would also capture all the processes involved, inputs used and practices followed in rice cultivation beginning from seed bed preparation to rice harvesting and sales. The field work was conducted over three months during June-August 2012. Information relating to the previous agriculture year (2011-12), for both the Khariff and Rabi seasons, was collected from the sample farmers using their recall.

**Table 2: Yield, Labour Use and GHG Difference of SRI and Non-SRI Rice**

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| **Rice System** | **GHG – CO2 EQ (Per Hectare)** | **Labour Use**  **(Hrs. Per Hectare)** | **Yield**  **(Kgs. Per Hectare)** |
| SRI | 9902.3 | 1222 | 7323 |
| Non-SRI | 12008.5 | 2075 | 4598 |
| % Difference of SRI compared to Non-SRI | - 21.26 | - 69.8 | 59.26 |

**GHG – CO2 EQ:** Green House Gas Emissions in Carbon-di-Oxide Equivalent

Source: Field Study in Janagaon, A.P.

Table 2 presents some of the preliminary results relating to the difference in GHG emissions, labour use and yield level of SRI in comparison with non-SRI rice production. The CO2 equivalent of GHG emissions under SRI cultivation is 21.3 per cent less than non-SRI or conventional practices. SRI also involves 70 per cent less labour while yielding 59.3 per cent more output per hectare compared to conventional rice cultivation. Since SRI appears to be established as a superior cultivation technology across a number of dimensions, the question arises: how has this innovation diffused in India? The institutions involved in the spread of SRI have been very different from those of the original Green Revolution (Farmer, 1977). We turn to consider its history.

**II**

**The Origin and Spread of SRI**

The synthesis of locally advantageous rice production practices known as SRI started accidentally in 1983 in a desperate drought in Madagascar, and developed thereafter with continued experimentation under the constant observation of a small work-study school, established by Fr. Henri De Laulanie, a French priest with a background in agriculture. Overtime the principles of SRI were perfected and results showed very high yields. The Association of Tefy Saina (ATS), an NGO, established in 1990, is credited with the propagation/promotion of SRI in Madagascar as well as in the outside world (Prasad, 2006). Laulanie considers SRI as a practical revolution in farming methods as well as a ‘cultural revolution’ in the minds of rice farmers (Laulanie, 2011). It is also an interesting case of rural innovations developed outside the formal rice research establishments (Prasad, 2006).

However, until 1994, SRI was unknown to the rest of the world until the Cornell International Institute for Food, Agriculture and Development (CIIFAD) mounted a collaborative project with ATS to propagate the Madagascar innovations. In particular, credit is due to Dr. Norman Uphoff of Cornell[[8]](#footnote-8) for bringing SRI to the notice of others. Following his three-year study of Malagassy farmers, Uphoff carried the idea to Asian farmers and from 1997 started to promote SRI in Asia (V & A Programme, 2009). Since 1999, with the efforts of CIIFAD efforts, the local phenomenon grew to a global movement with farmers in 50 countries, especially in semi-arid regions, attempting to adopt SRI to varying degrees (V & A Programme, 2009). In Asia, along with India, Sri Lanka, the Philippines, Malaysia and Vietnam have made notable progress.

2.***1 SRI in India***

In India rice cultivation occupies around one-fourth of the total cropped area. It is the largest crop produced in the country, accounting for two-fifths of total food grains production. The green revolution technology intensified rice cultivation in India using irrigation and other inputs such as chemical fertilisers and pesticides. Around 60% of the rice cultivation in India takes place in irrigated areas - one-third of total irrigated area in India is down to rice (GoI, 2011). Innovations in rice production have been led by a combination of state and market. The origins of SRI were different.

Initially brought to India through a pamphlet carried by a tourist visiting Pondicherry in 1999, SRI trials were immediately conducted in Aurovelli there. Later a scientist from Tamil Nadu Agricultural University participated in an international seminar dealing with innovations in rice cultivation, and after his return in 2002 a modified version involving principles of SRI was experimented with in Tamil Nadu (Prasad, 2006).

Initially SRI principles and practices were subject to experiments by progressive farmers and promoted by civil society organisations (national and international NGOs). Over the years, state organisations (research establishments, relevant Departments and Ministries) have promoted SRI (Prasad, 2006). At an All-India level, the National Food Security Mission (NFSM) promoted SRI in several states, joined more recently by NABARD. Several Indian states have responded positively to the adoption of SRI practices – but *at a very slow pace.* So far there has not been a policy framework that disseminates SRI nationally

Of the 600 plus districts in India, more than a third have instances of where farmers were initiated into SRI, but there is no information on how much of it has been sustained. Civil society groups have made the case for including SRI in the National Rural Employment Guarantee Scheme (NREGS) programme. The proposal is to use the innovative institutional mechanisms established for NREGS to support the transition of rice production to SRI by providing incentives to both farmers and workers/labourers to learn the necessary skills and using NREGS to buffer the transition to new methods. Rather than giving a direct labour subsidy to farmers practising SRI (NCS, 2012), the NREGS programme would pay labourers helping small or medium SRI farmers to practise these new SRI transplanting and weeding methods...

Andhra Pradesh is among the several states considered as ‘SRI-adopting’ so its diffusion process is of scientific interest. We move in the following sections to contextualise the position and problems of rice in the agricultural economy of Andhra Pradesh (section III), then to analyse critically the place of SRI in the context of the rice economy (section IV) before turning to a case study of best practice within SRI (section 4.3) and the lessons that may be learned from it. We conclude by assessing some institutional and policy developments that would improve the prospects for SRI in Andhra Pradesh.

**III**

**Performance of Agriculture and Rice Cultivation in Andhra Pradesh**

***3.1 Agriculture in Andhra Pradesh’s Economy***

Andhra Pradesh is the fifth largest state in India in terms of population, and the fourth largest in terms of geographical area. It is the fourth largest economy in India next to Maharashtra, Uttar Pradesh and Tamil Nadu. With respect to value-added in agriculture it ranks second, after Uttar Pradesh. While accounting for 7% of the population, AP contributes approximately 11% of India’s total agricultural GDP. It is the fourth largest state in terms of area under cultivation and irrigated area, the third largest in food-grain production and the second largest in terms of the value of livestock production. Andhra Pradesh is one of the states which adopted the green revolution from the earliest stages. In 2008-9, it was the fourth largest state in terms of area under rice cultivation, next to Uttar Pradesh, West Bengal and Orissa. And about a quarter of the total value of output from crop production in the state is from paddy. In recent years agricultural GSDP in the state has been growing at 5% per annum, considerably above the All-India average. However, Table 3 shows that the share of agriculture and allied activities in the GSDP of the state and the share of crop sector within agriculture have been on a trend of decline. Here we analyse basic physical and economic parameters of rice production in the state before turning to the problems and challenges arising from them.

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| **Table 3: Share of Agriculture and Allied Activities in GSDP**  **in Andhra Pradesh** | | | |
| Year | % to GSDP | | % Crop within AA |
| AA | Crop |
| ***1*** | ***2*** | ***3*** | ***4*** |
| 1999-00 | 27.9 | 17.4 | 62.4 |
| 2000-01 | 29.1 | 18.6 | 63.9 |
| 2001-02 | 27.5 | 16.5 | 59.9 |
| 2002-03 | 24.8 | 12.7 | 51.3 |
| 2003-04 | 26.0 | 14.5 | 55.7 |
| 2004-05 | 25.1 | 14.1 | 56.3 |
| 2005-06 | 24.3 | 13.9 | 57.2 |
| 2006-07 | 22.3 | 12.8 | 57.3 |
| 2007-08 | 23.3 | 14.0 | 60.0 |
| 2008-09 | 22.0 | 12.8 | 58.1 |
| 2009-10 | 21.0 | 11.7 | 55.6 |
| 2010-11 | 20.8 | 11.7 | 55.9 |
| 2011-12 | 19.2 | 9.8 | 51.2 |

***3.2 Size class of holdings***

As in the rest of the country, the share of small-marginal farmers in agrarian structure of the state has been on the rise. They constitute over 80 per cent of operational holdings and account for almost 50 per cent of the operated area.

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| **Table 4: Changing Size Class Distribution of Landholdings in Andhra Pradesh by Size Class** | | | | | | | | | | | |
| **Year** | **Share in Number of Holding** | | | | | **Share in Operated Area** | | | | | **Avg Size** |
| Marginal | Small | Semi- Medium | Medium | Large | Marginal | Small | Semi- Medium | Medium | Large |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** | ***11*** | ***12*** |
| 1955-56 | 38.6 | 18.3 | 17.7 | 16.7 | 8.7 | 7.9 | 9.7 | 16.1 | 28.1 | 38.2 | 2.43 |
| 1970-71 | 46.0 | 18.5 | 17.4 | 12.7 | 4.3 | 8.0 | 11.3 | 19.2 | 30.8 | 30.7 | 2.51 |
| 1980-81 | 49.3 | 20.9 | 16.0 | 9.1 | 2.1 | 13.1 | 16.2 | 23.3 | 28.7 | 18.7 | 1.94 |
| 1990-91 | 56.0 | 21.2 | 14.5 | 6.9 | 1.3 | 16.4 | 19.6 | 25.2 | 26.1 | 12.8 | 1.50 |
| 2000-01 | 60.9 | 21.8 | 12.4 | 4.3 | 0.6 | 21.6 | 24.8 | 26.4 | 19.8 | 7.5 | 1.25 |
| 2005-06 | 61.6 | 21.9 | 12.0 | 4.0 | 0.5 | 22.7 | 25.8 | 26.5 | 19.0 | 6.1 | 1.20 |
| **Note**: **1**. Refers of operational land holdings only; **2**. Size classes: ***Marginal*** – 0 to 1 hectare; ***Small*** – 1 to 2 has; ***Semi-medium*** – 2 to 4 has; ***Medium*** – 4 to 10 has; and ***Large*** – 10 and above has; **3**. ***Avg Size*** - Average Size of the Holding (in hectares).  **Source**: Directorate of Economics and Statistics (DES), GoAP, Hyderabad. | | | | | | | | | | | |

***3.3 Land Use Pattern and Irrigation Systems***

Of the total 27.5 million hectares of territory in the state, the net sown area (NSA) accounts for a stable 40 per cent or about 10.6 million hectares.. About 2.7 million hectares or about 25 per cent of NSA is cultivated more than once in an agricultural year.[[9]](#footnote-9) The state’s cropping intensity is one of the lowest, on a slow-paced increase. (Table 5). In turn, about 4.6 million hectares or about 40 per cent of the net sown area (NSA) is irrigated. Another 1.7 million hectares are irrigated more than once and thus the gross irrigated area in the triennium ending 2009-10 was about 6.3 million hectares.

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| **Table 5: Cropped Area and Irrigated Area in Andhra Pradesh**  (Lakh ha.) | | | | | | |
| Triennium Ending | Area in lakh Hectares | | | | Intensity (%) | |
| NAS | GSA | NIA | GIA | Crop Int. | Irg. Int. |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** |
| 1960-61 | 109.07 | 119.50 | 29.03 | 34.98 | 110 | 120 |
| 1970-71 | 113.88 | 129.83 | 30.73 | 39.97 | 114 | 130 |
| 1980-81 | 108.73 | 125.61 | 34.48 | 44.25 | 116 | 128 |
| 1990-91 | 110.42 | 132.00 | 42.83 | 54.21 | 120 | 127 |
| 2000-01 | 105.24 | 129.01 | 44.83 | 59.18 | 123 | 132 |
| 2009-10 | 106.29 | 133.19 | 45.60 | 62.63 | 125 | 137 |
| **Note**: TE – Triennium Ending; NAS – Net Sown Area; GSA – Gross Sown Area; NIA – Net Irrigated Area; GIA – Gross Irrigated Area; Crop Int – Crop Intensity; IrgInt – Irrigation Intensity.  **Source**: Directorate of Economics and Statistics, GoAP, Hyderabad. | | | | | | |

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| **Table 6: Source-wise Area Irrigated in Andhra Pradesh** | | | | | | | | | |
| T E | Area in lakh Hectares | | | | | Source-wise Share (% ) | | | |
| Tank | Canal | Wells | Others | Total | Tank | Canal | Wells | Others |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** |
| 1960-61 | 11.99 | 12.90 | 3.07 | 1.07 | 29.0 | 41.3 | 44.4 | 10.6 | 3.7 |
| 1970-71 | 9.85 | 14.87 | 4.93 | 1.08 | 30.7 | 32.1 | 48.4 | 16.0 | 3.5 |
| 1980-81 | 9.30 | 16.71 | 7.47 | 1.00 | 34.5 | 27.0 | 48.5 | 21.7 | 2.9 |
| 1990-91 | 10.33 | 18.76 | 12.15 | 1.60 | 42.8 | 24.1 | 43.8 | 28.4 | 3.7 |
| 2000-01 | 7.30 | 16.39 | 19.17 | 1.98 | 44.8 | 16.3 | 36.6 | 42.8 | 4.4 |
| 2009-10 | 5.22 | 15.75 | 22.98 | 1.65 | 45.6 | 11.4 | 34.5 | 50.4 | 3.6 |
| **Note**: TE – Triennium Ending.  **Source**: Directorate of Economics and Statistics, GoAP, Hyderabad. | | | | | | | | | |

Surface water sources like tanks and canals which accounted for substantial shares of irrigation are on the decline, even in absolute terms. Ground water sources of irrigation, through shallow or tube-wells, are on the increase (Table 6). Negligent management of surface-water minor irrigation systems in the state has threatened irrigation from tanks. According one estimate, out of 77,472 tanks, around 24,000 are presently defunct. Others have had their command areas compromised and function at reduced capacity (CAD, 2008; Ravindra and Laxmi, 2010). Heavy and increasing project costs and inter-state water disputes have also constrained the expansion of surface irrigation systems through major dams and distributaries. The emergence of ground water as a major source of irrigation has also resulted in growing dependence of agriculture on diesel and electricity. According to one estimate agriculture consumes about a quarter of the State’s total electricity (GoAP, 2010) which is in turn increasingly dependent on thermal sources, particularly fossil fuels.

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| Table 7: Changes in Cropping Pattern in Andhra Pradesh, 1958-2011 (%) | | | | | | |
| **Crop** | **Triennium Averages** | | | | | |
| **1955-58** | **1965-68** | **1980-83** | **1990-93** | **2002-05** | **2010-11** |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** |
| Rice | 23.1 | 26.3 | 29.1 | 29.6 | 24.4 | 30.8 |
| Jowar | 20.8 | 19.9 | 16.8 | 8.5 | 4.9 | 2.2 |
| Maize | 1.6 | 1.8 | 2.6 | 2.4 | 5.2 | 5.8 |
| Bajra | 5.0 | 4.7 | 4.1 | 1.5 | 0.9 | 0.4 |
| Ragi | 2.5 | 2.6 | 2.0 | 1.2 | 0.6 | 0.3 |
| ***Cereals*** | ***53.1*** | ***55.3*** | ***54.5*** | ***43.1*** | ***35.9*** | ***39.9*** |
| ***Pulses*** | ***10.1*** | ***10.1*** | ***11.0*** | ***12.2*** | ***16.4*** | ***14.3*** |
| ***Food grains(sub-total)*** | ***63.2*** | ***65.3*** | ***65.5*** | ***55.4*** | ***52.3*** | ***54.1*** |
| Groundnut | 10.5 | 10.1 | 11.2 | 18.5 | 13.2 | 12.2 |
| Gingelly | 2.2 | 1.9 | 1.4 | 1.3 | 1.3 | - |
| Sunflower | - | - | - | 2.5 | 3.8 | 3.0 |
| Castor | 2.6 | 2.2 | 2.2 | 2.4 | 2.2 | 1.3 |
| ***Oil Seeds(sub-total)*** | ***15.2*** | ***14.3*** | ***14.7*** | ***24.1*** | ***20.5*** | ***19.4*** |
| Sugarcane | 0.6 | 1.0 | 1.3 | 1.5 | 1.8 | 2.7 |
| Cotton | 3.1 | 2.4 | 3.5 | 5.5 | 7.7 | 10.0 |
| Tobacco | 1.3 | 1.5 | 1.6 | 1.4 | 1.0 | 1.2 |
| Chillies | 1.3 | 1.4 | 1.3 | 1.7 | 1.9 | 1.6 |
| Onion | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 |
| Fruit & vegetable | - | - | - | 4.5 | 6.7 | 7.5 |
| **Total** | **84.9** | **86.0** | **88.0** | **89.8** | **85.4** | **80.4** |
| **Note:** Percentage in Gross Cropped Area under major crops.  **Source:** Subramanyam and Aparna (2009). | | | | | | |

***3.4 Cropping Pattern and the Paramount Importance of Rice***

Over the years, particularly since the 1980s, there has been rapid change in Andhra’s cropping pattern. The share of cereals has come down drastically largely due to decline in millet production, but the share of rice has actually increased. As the single largest crop in Andhra it accounts for about 4.0 million hectares8[[10]](#footnote-10) out of 13 million hectares or about 30 per cent of the total gross cropped area.

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| **Figure 1: Trends in Area, Production and Yield of Rice in Andhra Pradesh** | |
| a) Area and Production | b) Yield Rate |
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| **Note**: Area is in lakh hectares and Production is in lakh tonnes; and yield rate is Kgs per Hectare.  **Source**: Directorate of Economics and Statistics, GoAP, Hyderabad. | |

Andhra has four rice agro-ecosystems: irrigated rice, rain-fed lowland and upland rice, and a flood-prone rice ecosystem. However, rice cultivation in AP is more water intensive and irrigated than elsewhere in India. Put differently, of the total area under rice cultivation in the state, around 95% of it is under irrigation. Of the total irrigated area in the state, around two-thirds of it is under rice cultivation.

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| **Table 8: Area, Production and Yield (APY) of Rice in Andhra Pradesh** | | | | | | |
| T E | A P Y in Volume | | | Growth (%) | | |
| Area | Production | Yield | Area | Production | Yield |
| 1960-61 | 30.17 | 37.54 | 1244 | - | - | - |
| 1970-71 | 32.80 | 42.08 | 1283 | 0.8 | 1.1 | 0.3 |
| 1980-81 | 36.83 | 69.17 | 1878 | 1.2 | 5.1 | 3.9 |
| 1990-91 | 41.54 | 100.78 | 2426 | 1.2 | 3.8 | 2.6 |
| 2000-01 | 41.91 | 116.58 | 2781 | 0.1 | 1.5 | 1.4 |
| 2010-11 | 41.93 | 130.66 | 3116 | 0.0 | 1.1 | 1.1 |
| **Note**: TE – Triennium Ending; Area is in lakh hectares and Production in lakh tonnes; and yield rate is Kgs per Hectare.  **Source**: Directorate of Economics and Statistics, GoAP, Hyderabad. | | | | | | |

Rice cultivation in the state takes place in both production seasons, about 60% in Khariff and 40% in Rabi. Very sporadically, in the third ‘summer’ season, rice is cultivated in some parts of the state. While in Khariff, 95 percent of the crop is irrigated (and the rest rain-fed), in Rabi and the shorter summer season, it is entirely irrigated.

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| **Table 9: Season-wise Area, Production and Yield of Rice in Andhra Pradesh** | | | | | | | | | | | | | |
| Sno | Details | 2008-2009 | | | 2009-2010 | | | 2010-11 | | | TE 2010-11 | | |
| Khariff | Rabi | Total | Khariff | Rabi | Total | Khariff | Rabi | Total | Khariff | Rabi | Total |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** | ***11*** | ***12*** | ***13*** | ***14*** |
| 1 | Area  (in lakh hectares) | 28.03 | 15.84 | 43.87 | 20.63 | 13.78 | 34.41 | 29.22 | 18.3 | 47.52 | 25.96 | 15.97 | 41.93 |
| 2 | Production  (in lakh tons) | 83.8 | 58.61 | 142.41 | 59.56 | 48.82 | 108.38 | 75.1 | 69.1 | 144.2 | 72.82 | 58.84 | 131.66 |
| 3 | Yield (kgs/hectare) | 2990 | 3700 | 3246 | 2887 | 3543 | 3150 | 2570 | 3776 | 3035 | 2805 | 3684 | 3140 |
| **Note**: T E - Triennium Ending.  **Source**: Directorate of Economics and Statistics, Government of Andhra Pradesh, Hyderabad. | | | | | | | | | | | | | |

Tables 8 and 9 show the area under rice cultivation in the state has shown a steady increase. The yield and production levels experienced a quantum jump beginning with the late 1970s and 80s under the spell of Green Revolution with the advent of HYV seeds and rising application of other inputs. Currently more than 80% of Andhra’s rice cultivation uses HYV seeds. With an annual production of about 120 to 140 lakh tonnes amounting to around 12-15 per cent of the total rice production in India, the state is now the second largest producer of rice in India, next only to West Bengal. Production and yield rates disaggregated by season show that the Khariff rate is lower than that of other seasons, while the Rabi season share in production is higher than its share in Andhra’s rice cultivation area.

However, since the 1990s, rate of growth of rice yield in India in general, and Andhra Pradesh in particular, *have been experiencing a deceleration*. As the area under rice cultivation is almost stable, the deceleration in growth rate of yields has resulted in a slowing of growth in total rice production.

***3.5 Problems and Challenges of Rice Cultivation in A.P.***

While the area under rice has increased over the years, rice cultivation is fraught with problems. One problem is the emergence of *water-logging* in the Krishna-Godavari delta region. A second is the increase in the *cultivation costs* in general, but rice in particular (GoAP, 2011, Laxminarayana et al, 2011; Ramana Murthy, 2011)[[11]](#footnote-11). Then third, the national minimum support *price* (MSP) is much lower than the cost of cultivation according to farmers in the State. There have been widespread protests by the farmers and threats of a ‘crop holiday’ in which farmers stop producing the crop for market (GoAP, 2011, Laxminarayana et al, 2011). Fourth, there is increasing *pressure on ground-water resources* especially in the semi-arid region of Andhra where rice is cultivated by water-lifting. SRI has the potential to mitigate problems of lower yield and higher water consumption and thus address some of these environmental and economic problems.

**IV**

**SRI in Andhra Pradesh**

To see how SRI might mitigate the serious agricultural challenges in AP, we examine the history of the transfer of this technology and the institutions involved in its adoption, adaptation and spread (Table 9). Despite the neo-liberal era, it is the state and civil society, not the market, that have pioneered the propagation of SRI.

**4.1 Agencies Propagating SRI in A.P**

In Andhra Pradesh, SRI was initiated in Khariff 2002 by a progressive organic farmer, Narayan Reddy of Karnataka, who experimented with it on his farm prior to sharing his experience with a civil society organisation, Timbaku Collective, in Anantapur district. The Timbaku Collective began introducing SRI to a few pioneering farmers in Anantapur district. Prior to these activities, as early as 2001, Ajay Kallam, the Commissioner of Agriculture, Government of Andhra Pradesh had published an article on SRI in ***Padipantalu***, a magazine published by the State Government on matters relating to agriculture. But his effort was limited to diffusing knowledge of the method through the popular press and sharing the ideas with other officials but not to direct trials of SRI (Prasad,2006).

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| **Table 10: Organisations involved in Promoting SRI in Andhra Pradesh** | | |
| Sno | Category of Actors | Organisations |
| 1 | State Bodies | WALAMTARI, NABARD, NFSM, CMSA, Agros, I&CAD, DRR, ATMA |
| 2 | Research Institutes | AcharyaRanga Agricultural University (AP), CRRI, IRRI, DRR, ICRISAT, IWMI, Rice Research Station (Warangal), KVKs, RSS, |
| 2 | Non-State bodies: National | CSA, CWS, SDTT |
| 3 | Non-State bodies: International | WWF, Oxfam, SIDA, SDC |
| 4 | Local Organisations: NGOs in AP | Timbaku Collectives, WASSAN, CROPS, RDT, APDAI, , JalaSpandana, Laya, many other local NGOs at grassroot level |
| 5 | Individuals (officials and progressive farmers) | Ajay Kallam, Narayana Reddy, Mandava Krishna Rao, |
| **Note**: For expansion of abbreviated names of organisations see Annexure of Acronyms at the end of the paper.  **Source**: Authors’ compilation. | | |

The Acharya N.G. Ranga Agricultural University (ANGRAU), a premier agricultural research institute in Andhra Pradesh, played a crucial role in scaling-up SRI principles and practices, first conducting about 250 on-farm trials in 22 districts in Khariff 2003. Since then ANGRAU involved other civil society organisations in its project promoting SRI. At the district level the Krishi Vignana Kendras9[[12]](#footnote-12) (KVKs) and District Agricultural Advisory and Transfer of Technology10[[13]](#footnote-13) (DAATT) Centres associated with ANGRAU worked as a frontline SRI demonstration units. ANGARU has itself conducted field demonstrations of SRI practices. The Directorate of Rice Research (DRR) stationed at Hyderabad joined the endeavour through field trials and research experiments monitoring costs of cultivation and yield rates. Since 2006, the Government of Andhra Pradesh initiated measures for promoting SRI principles and practices. From 2007-08, ANGARU focussed on capacity-building handing over front-line promotional activity to the Department of Agriculture, Government of Andhra Pradesh. But with this change of agency there was decline in field trials and demonstrations for which the Department was ill suited.

Certain international agencies like ICRISAT, WWF, Oxfam and others have been party to the promotion of SRI in India and AP. Local level NGOs scattered across the state also operate to promote SRI with the support of the national and international organisations. Since 2004-05, an ICRISAT-WWF project has also promoted SRI in AP and further afield in India (Prasad, 2006). Thanks to ICRISAT-WWF and ANGARU, the SRI methodology has been evaluated for its potential in saving water and in increasing productivity under different agro-climatic conditions and irrigation sources. Results show that yields under SRI are higher by 20-40 per cent. Two important State-level intermediary civil society organisations (NGOs) - WASSAN and CSA – are working with the farmers to spread the practice of SRI in different parts of the country and Andhra Pradesh (Prasad 2006).

**3.2 Coverage of SRI**

As pointed out earlier, since 2003-04, Andhra’s Department of Agriculture has organized SRI demonstrations, and since Rabi 2005-06, at least one demonstration was targeted for every Gram Panchayat. In 2007-08, in a prominent policy initiative, the state government allocated around Rs. 4.0 crore for state-wide demonstrations and SRI trials. Moreover, since early evaluations had stressed the importance of timeliness of irrigation for SRI, the state government announced an uninterrupted and continuous supply of electricity to areas under SRI.

Under the National Food Security Mission (NFSM), 1680 SRI demonstrations were targeted for 2008-09 (1272 in Khariff and 408 in Rabi) with a financial outlay of Rs.5.0 million (Rs.3000 per demonstration) and further grants of Rs. 3000 were awarded for the purchase of ‘cono-weeders’11.[[14]](#footnote-14) In 2008-9, in 11 non-NFSM districts of East Godavari, West Godavari, Prakasam, Kurnool, Ananthapur, Kadapa, Chittoor, Warangal, Rangareddy, Nizamabad, and Karimnagar, a total of 4,446 one-acre demonstrations were planned under Work Plan (Rice) with an outlay of Rs.26.7 million.

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| **Table 11: Extent of SRI Paddy in Andhra Pradesh** | | | | | | |
| **Year** | **Rice area covered (in 000Hec)** | | | **Area underSRI(in Hec)** | | |
| Kharif | Rabi | Total | Kharif | Rabi | Total |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** |
| 2003-04 | 2,109 | 866 | 2,975 | 28 | 190 | 218 |
| 2004-05 | 2,215 | 871 | 3,086 | 240 | 2,451 | 2,691 |
| 2005-06 | 2,526 | 1,456 | 3,982 | 1,127 | 6,306 | 7,433 |
| 2006-07 | 2,641 | 1,337 | 3,978 | 3,061 | 2,480 | 5,541 |
| 2007-08 | NA | NA | NA | NA | NA | NA |
| 2008-09 | 2,803 | 1,584 | 4,387 | NA | NA | NA |
| 2009-10 | 2,063 | 1,378 | 3,441 | NA | NA | NA |
| 2010-11 | 2,922 | 1,830 | 4,752 | 44,794 | 46,664 | 91,458 |
| 2011-12 | NA | NA | NA | 49,496 | 72,320 | 1,21,815 |
| **Note:** ‘NA‘ not available.  **Source:** Department of Agriculture, Government of Andhra Pradesh. | | | | | | |

SRI has also been promoted by Community Managed Sustainable Agriculture (CMSA)12[[15]](#footnote-15) which is part of the SHG-based Indira Kranthi Patham (IKP) Programme promoted by the Society for Elimination of Rural Poverty (SERP)13[[16]](#footnote-16) in Andhra Pradesh (Table 12). Under the CMSA programme SRI has been encouraged through women’s self-help groups (SHGs). In 2008-09, SRI was implemented in around 1000 acres across districts in the state. Targets were given to the districts based on the number of weeders available: 3 acres of SRI paddy per weeder. Table 11 shows the slow but steady progress achieved in SRI under the CMSA from about 1100 acres in 2008-09 to about 16000 acres in 2011-12.

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| **Table 12: Acreage Covered under CMSA SRI Programme across District in Andhra Pradesh** | | | | | |
| Sno | District | 2008-09 | 2009-10 | 2010-11 | 2011-12 |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** |
| 1 | Adilabad | 18.0 | 80.0 | 43.0 | 233.0 |
| 2 | Ananthapur | 182.0 | 70.0 | 572.0 | 1487.0 |
| 3 | Chittoor | 6.0 | 73.0 | 273.0 | 1826.2 |
| 4 | East Godavari | 0.0 | 0.0 | 45.0 | 217.0 |
| 5 | Guntur | 2.0 | 25.0 | 162.0 | 808.0 |
| 6 | Kadapa | 18.0 | 65.0 | 55.0 | 603.2 |
| 7 | Karimnagar | 30.0 | 92.0 | 85.0 | 1240.0 |
| 8 | Khammam | 19.5 | 60.0 | 114.0 | 924.0 |
| 9 | Krishna | 0.0 | 0.0 | 23.0 | 23.0 |
| 10 | Kurnool | 5.0 | 50.0 | 91.0 | 238.0 |
| 11 | Mahabubnagar | 265.0 | 510.0 | 2247.0 | 0.0 |
| 12 | Medak | 297.0 | 975.0 | 1200.0 | 1599.0 |
| 13 | Nalgonda | 9.5 | 80.0 | 8.0 | 529.0 |
| 14 | Nellore | 0.0 | 170.0 | 172.0 | 142.0 |
| 15 | Nizamabad | 14.5 | 65.0 | 632.0 | 685.0 |
| 16 | Prakasam | 0.0 | 10.0 | 23.0 | 81.0 |
| 17 | Ranga Reddy | 2.5 | 50.0 | 130.0 | 38.0 |
| 18 | Srikakulam | 7.5 | 60.0 | 139.0 | 567.0 |
| 19 | Vishakapatnam | 24.0 | 65.0 | 186.0 | 2767.0 |
| 20 | Vizianagaram | 44.4 | 85.0 | 211.0 | 540.0 |
| 21 | Warangal | 152.0 | 600.0 | 800.0 | 674.0 |
| 22 | West Godavari | 0.0 | 20.0 | 85.0 | 677.0 |
| ***AP*** | | ***1096.9*** | ***3205.0*** | ***7296.0*** | ***15875.4*** |
| **Note**: 1. Figures in acres; 2. CMSA – Community Managed Sustainable Agriculture.  **Source**: CMSA, Government of Andhra Pradesh. | | | | | |

Since 2010-11, NABARD, under its Farmers’ Technology Transfer Fund (FTTF), has promoted the spread of SRI in 14 states including Andhra Pradesh. Of the All-India total of 150 projects14[[17]](#footnote-17) (Rs. 2568.0 lakh) 17 of them (amounting to Rs. 282.9 lakh) are in AP15..NABARD collaborates with the local NGOs in the implementation of these projects over a period of three years (Table 13).

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| **Table 13: Details of NABARD’s FTTF Targets for SRI** | | | |
| Sno | Details | India | AP |
| ***1*** | ***2*** | ***3*** | ***4*** |
| 1 | No of Projects | 150 | 17 |
| 2 | No of Farmers Targeted for SRI | 84000 | 9240 |
| 3 | Target Area (in Hec) under SRI | 28800 | 3172 |
| 4 | No of Villages | 2400 | 334 |
| 5 | FTTF Grant (lakhs) | 2568.00 | 282.85 |
| **Note**: FTTF - Farmers’ Technology Transfer Fund.  **Source**: NABARD Regional Office, Hyderabad. | | | |

Arguably, in Andhra Pradesh there has developed a *unique kind of partnership between state and civil society* which has formed the institutional ecology conducive to the adoption of SRI. Andhra Pradesh is also unusual in adopting SRI *throughout all its districts*. According to Prasad (2006), results from trials are significant. First, the highest ever yield rate (17.2 tonne per hectare) has been recorded in SRI in AP. Second, SRI rice has also been found to mature earlier than conventional varieties. Because of thicker stems and root systems SRI withstands flooding and cyclones. It is associated with better quality of grain which fetches higher prices. Lastly, higher yields have been observed in drier regions.

Over and above its institutional ecology, Andhra Pradesh is also notable in terms of the *agency and technical expertise of individual farmers*. For instance, the Mandava Marker16[[18]](#footnote-18), a simple tool to mark the lines for row-transplantating, developed in the state, is very popular with SRI farmers both in Andhra and elsewhere. Similarly the innovative agricultural engineering of weeders by ANGARU and the adaptations of SRI practices to local conditions based upon feedback from farmers are two further examples of agricultural innovations by civil society organisations in a variety of sites in the State. However, in spite of all these efforts to popularise SRI, its *coverage remains very low*. As recently as in 2011-12, only about two per cent of the total area under rice in the State was under SRI. There are a number of factors that hinder its sustained adoption.

***4.2 Problems of SRI in AP***

Debates about the adoption of SRI practices focus on SRI’s being more-*labour intensive* than conventional methods. Labour intensity here does not refer to labour per unit of output, rather to labour being timely and skilled. In SRI crop production, labour costs are relatively lower than those of conventional practices. But SRI is a more rigorous and exact regime that needs precision-timed operations and constant supervision. The modern factory-like production regime of SRI struggles to penetrate a culture of flexible and less precise practices associated with rice cultivation. There is also a certain *physical agility needed for the use of weeders, line markers and for the transplanting single seedlings*. The intensity of labour requires male/female labour with sufficient physical energy to use the weeder and skills in the use of the marker while female labour also requires new skills for transplanting. Since its invention, the weeder has been improved to make it move with less friction, and it was observed in the field that the employment of two labourers weeding together reduces the fatigue and isolation associated with the monotony of working alone.

There appear to be no clear specifications regarding the designs of markers and weeders appropriate to different soil types. Labourers are slow to take to SRI practices, particularly in using weeders in their currently designed forms. So farmers face operational difficulties in adopting SRI especially on larger areas.

Of the three critical stages/operations of SRI cultivation (nursery, transplantation and weeding), a study of the economics of SRI observed that the most important constraint in SRI cultivation is *‘nursery to transplanting management’* (Rao, 2011), because this stage is relatively labour-intensive, and needs certain management skills and constant supervision. The preparations of the nursery need co-ordination with those of the plot awaiting transplanting. Small farmers balance their limited ground-water resources against rainfall but the Khariff rains frequently confound this balancing act. With meagre ground water, producers prepare their nursery expecting the monsoon to help them ready the main plot. If the rain fails or is delayed, the nursery seedlings will cross the 8 to 15 days threshold beyond which older seedlings are inappropriate for SRI. The older practice of flexible transplanting between 25 to 45 days accommodates the vagaries of the weather but SRI does not. R & D to evolve varieties that would reduce the vulnerability of seedlings to their transplanting age is urgently needed.

Another major concern is that *dis-adoption rates exceed those of adoption* (Reddy et al, 2006). In many cases when supported by civil society organisations or other organisations encouraging SRI, farmers adopt SRI with an eye to *support measures* such as free fertilisers. Once this is stopped they tend to switch to conventional system. Indeed, there are many instances of withdrawal from SRI once the agency sponsorship end.

Despite Andhra Pradesh’s vigorous initiatives, the diffusion of SRI is now lagging behind that of the neighbouring state of Tamil Nadu. One of the factors behind the faster progress of SRI paddy in Tamil Nadu is that the state government provides a *financial incentive* of Rs. 4,000 per hectare for a farmer adopting SRI. TN’s *promotional methods* also differ. For instance, neither the state government, research bodies nor civil society organisations insist on strict adherence to all the SRI principles and practices. Instead SRI principles are followed flexibly. In Andhra Pradesh there is no financial incentive to producers and the extension advice is rigid.

**4.3 The Case of an NGO (‘CROPS’) in promoting SRI in Andhra Pradesh**

Here we present a case study of a civil society organisation (NGO), CROPS17,[[19]](#footnote-19)working to propagate SRI principles mainly among farmers in Janagaon division of Warangal District of Andhra Pradesh but also further afield. CROPS is a registered non-profit, non -religious, non-governmental, social development grass-root organization established in 1991.

In the dry-land agriculture of Janagaon division, the only irrigated crop is paddy, mostly grown using ground-water. When the traditional system of dry land farming shifted to modern technology with the use of chemical pesticides, the cost of cultivation increased and so did farmers’ environmental problems such as soil and water contamination with chemical residues. Over-use of these chemical inputs resulted in reduced soil fertility and increased resistance to pests. Pesticide consumption peaked when the cropping pattern shifted from coarse cereals to cotton cultivation. It was at this stage, in the mid 1990s that CROPS, supported by the Centre for World Solidarity (CWS) started to promote non-chemical pesticide management techniques18.[[20]](#footnote-20).

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| **Box 1: CROPS Activities related to Sustainable Agriculture**   * Dry land agriculture in 20 villages - Supported by AEI, Luxembourg * Promotion of NPM in 3 Mandals - Centre for Sustainable Agriculture (CSA), Hyderabad, India * Promotion of permaculture in 1 village - Deccan Development Society (DDS), Andhra Pradesh * BtVs Non Bt study in Warangal district - Deccan Development Society * Implementation of 10 RIDF watersheds - DWMA, Nalgonda and Warangal * Promotion of Organic Cotton in 4 villages - Oxfam India * Promotion of sustainable agriculture practices under the flagship of Telangana Natural Resource Management Group (TNRMG) in 25 villages - SDCIC * Promotion of community based Tank Management in 5 Villages - SDCIC * Implementation of 10 RIDF watersheds - DWMA, Nalgonda and Warangal * Promotion of NPM in 30 villages of 3 Mandals - SERP - IKP, Government of Andhra Pradesh * Promotion of IPM, Chilly in 2 Mandals - Spices Board, Secunderabad   **Source**: CROPS. |

With the support of two leading civil society organisations (CWS and CSA), CROPS’ efforts in sustainable agriculture (by which is meant chemical-free organic agriculture) are remarkable. The organisation is developing a model organic farming village, Enabavi, in Warangal District19.[[21]](#footnote-21). A feather in its cap is that for the year 2007-8 an Enabavi farmer and Grass Root Motivator, Sri. Ponnam Mallaiah from Enabavi, was chosen along with his village, for the **Krishi Gaurav Award** by Pathanjali Trust20,[[22]](#footnote-22),Haridwar. All the practices leading to reduced chemical use in agriculture either SRI or other types of organic farming in the informal sense, are promoted by civil society organisations like CROPS.

Most of the crop agriculture in the area of Janagaon that CROPS selected was limited to traditional, non-hybrid and non-GM, dry land cereal crops (jowar, redgram, maize etc). Since the 1990s, the area under cotton cultivation has recorded a rapid increase in this region. Increasing cotton cultivation also meant greater use of fertilisers and pesticides which in turn increased the cost of cultivation to unviable levels.. CROPS developed the goal of non-pesticide management (NPM) for dry land crops to lower the cost of cultivation.

Moreover, the availability of, and access to, bore well technology over the last two decades, increased the number of bore wells, in turn increasing the area under irrigated crops particularly rice. Prior to the 1990s, rice was not a major crop sold in the local grain markets. But from 1990s onwards, it came to prominence along with cotton and maize. The volume of rice traded in the local grain market increased from 3000 to 30,000-40,000 quintals per day over the last fifteen years. Twenty commercial rice mills, mostly parboiling mills, were established. The procurement of rice by the Food Corporation of India (FCI) has also increased. The first FCI godown in this area, Janagaon, was established in 2002 with a capacity of 30,000 MT. A second godown with a capacity of 1,50,000 MT started working in 2009. The phenomenal increase in rice trading is due to local increase in rice production, due to expansion in area as well as yield.

Most of the rice cultivation in this area has become ground-water dependent, through bore wells. Historically rice cultivation was confined to a limited area with tanks as the main source of water. In a few cases rice was cultivated to a limited extent and for home consumption with open wells constrained by the availability of water.. Changes in the last two decades mean that even the rice fields under tank irrigation are watered from bore wells replenished from tanks. Many farming communities under the tank command areas agreed to abandon the tank for direct irrigation. While tanks allowed the cultivation of rice only in the Khariff season, irrigation using ground water permits rice to be grown in both main seasons. Iirrigstion with bore-wells or open-wells also facilitates the water control sometimes associated with better yields. However, the increased reliance on ground-water has depleted subterranean water resources and has increased energy consumption (mostly electricity) by lift irrigation. Water and energy saving methods of rice cultivation are therefore needed in the region.

As regards SRI cultivation methods, in Janagaon division since Rabi 2007-8 CROPS21[[23]](#footnote-23) has taken up certain initiatives for SRI (Table 14). CROPS is one of the collaborators involved with the ICRISAT-WWF Project to develop SRI in AP as well as All-India. Under the WWF project, for seven continuous seasons, CROPS has spread SRI cultivation to seven villages in two mandals (Bachannapet and Maddoor) in Janagaon division. And with the support of ICRISAT, it introduced SRI in 26 more villages in three other mandals22[[24]](#footnote-24) (Lingal Ghanpur, Janagaon and Devaruppala). Under these two projects, the number of farmers and acreage under SRI cultivation promoted by CROPS increased gradually. But both the WWF and ICRISAT support was limited to a few seasons until Rabi 2010-11. After that the number of farmers and acreage under SRI drastically declined. Under the NABARD support, CROPS implemented SRI in 16 more villages in two mandals (Janagaon and Lingal Ghanpur) for the two seasons Khariff 2011 and Rabi 2011-12. The NABARD project then was extended to two further years with increased targets for farmers and acreage.

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| **Table 14: Coverage of SRI under CROPS in Jangaon Division of Warangal District in Andhra Pradesh** | | | | | | | | |
| Season | No of Farmers and Area under different projects | | | | | | | |
| WWF | | ICRISAT | | NABARD | | Total | |
| Farmers | Area | Farmers | Area | Farmers | Area | Farmers | Area |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** |
| Rabi 2007-08 | 120 | 86 | - | - | - | - | 120 | 86 |
| Kharif 2008 | 143 | 110 | - | - | - | - | 143 | 110 |
| Rabi 2008-09 | 466 | 354 | 96 | 77.5 | - | - | 562 | 431.5 |
| Kharif 2009 | 334 | 201.5 | 98 | 65.5 | - | - | 432 | 267 |
| Rabi 2009-10 | 649 | 407.5 | 212 | 117 | - | - | 861 | 524.5 |
| Kharif 2010 | 674 | 353.75 | 1142 | 371 | - | - | 1816 | 724.75 |
| Rabi 2010-11 | 906 | 540 | 1928 | 1022 | - | - | 2834 | 1562 |
| Kharif 2011 | - | - | - | - | 460 | 230 | 460 | 230 |
| Rabi 2011-12 | - | - | - | - | 800 | 600 | 800 | 600 |
| **Note**: 1 Farmers in number; Area in acres; 2. ‘-‘ indicates none.  **Source**: CROPS, Jangaon, Warangal District, Andhra Pradesh. | | | | | | | | |

A high spot in the promotion of SRI by CROPS was the participation of a 38-year-old woman farmer Duddeda Sugunamma from Katkur village in a global event organised by World Food Prize Foundation at Iowa, (USA), in October 2011. She presented her experience of rice cultivation before and after SRI. Initially motivated by CROPS, she has been propagating SRI in among fellow farmers in her village and locality (Deccan Herald, 201123).[[25]](#footnote-25)). Box 2 shows that CROPS has also made notable local modifications to the process of SRI.

In response to the experience of monotony in mechanical weeding when SRI labour is alone, CROPS has experimented successfully with multiple weeding teams.

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| **Box 2: SRI Promoting Activities of CROPS**   * Motivation of farmers; * Educated and enthusiastic farmers have been trained to act as master trainers for farmer groups and Farmer Field Schools. Each master trainer is attached to a group of 25-30 farmers * Organising training programs on the principles and practices involved in SRI method of paddy cultivation; * Organising exposure visit; * As part of communication strategy in the newly identified project villages wall writings at the important public places have been done with messages of SRI practices, SRI extension material published with the support of supporting organisation (WWF-ICRISAT project, NABARD) has been distributed; * Films on SRI have been screened for spreading the awareness on SRI practices; * ***Kaljatha*** (local folk media) programs were organized in the villages to promote BMP and disseminate information about SRI paddy; * Data on water, fertilizer and pesticide application was collected regularly; * Strengthening of linkages established with local government agriculture staff. * Creating awareness among all the family members about SRI method and among the school children, though pamphlets/booklets and other IEC material.   **Source**: CROPS. |

However, once WWF and ICRISAT project extension support finished, *dis-adoption rates were very high*. In one particular village visited in 2012, the highest number of farmers adopting SRI with WWF project support had been about 180. Thereafter it had dwindled to only 30.

Based on CROPS’ data on SRI farming we found that most adopters are small farmers (see Figure 2). For the most part, even among small and marginal farmers, *only a small part of the total area* used for rice cultivation was kept on trial for SRI. So far, no farmer has adopted SRI completely (Table 15).

|  |
| --- |
| **Figure 2: Distribution of SRI farmer by Size of the Holding** |
|  |
| **Note**: Total including all years and seasons.  **Source**: CROPS. |

Although the range between the minimum and maximum area under SRI varied with season and year, *the average SRI area per farmer never exceeded one acre* during the last five years (Table 16). Very few farmers experimented with SRI on more than two acres.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 15: Percent of area under SRI in the total area under rice cultivation by size of the holding – CROPS’ Sample Farmers** | | | | | | | | | | |
| Size of the Holding | % of rice area in total cultivated land | | | | | % of SRI area in total area under rice | | | | |
| Khariff 2008 | Rabi 2007-8 | Rabi 2008-9 | Rabi 2009-10 | All | Khariff 2008 | Rabi 2007-8 | Rabi 2008-9 | Rabi 2009-10 | All |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** | ***11*** |
| Below 1 acre | 100 | 73.3 | 66.7 | 93.0 | 91.3 | 41.7 | 141.7 | 91.7 | 80.6 | 80.3 |
| 1 – 2 acres | 62.1 | 54.6 | 56.0 | 69.0 | 66.2 | 52.3 | 68.2 | 71.3 | 47.8 | 51.7 |
| 2 – 4 acres | 42.3 | 40.8 | 51.4 | 74.3 | 59.5 | 51.0 | 56.9 | 55.6 | 31.8 | 43.2 |
| 4 – 6 acres | 39.5 | 34.2 | 38.5 | 70.5 | 44.8 | 45.8 | 42.9 | 42.5 | 25.4 | 39.9 |
| 6 – 10 acres | 32.8 | 31.4 | 34.3 | 75.0 | 36.0 | 34.9 | 38.9 | 38.8 | 13.4 | 36.0 |
| 10 acres above | 0 | 14.6 | 20.8 | 33.3 | 20.8 | 0 | 37.5 | 41.7 | 50.0 | 41.7 |
| **Note**: 1. Size of the holding implies the total operational holding of the farmer; 2. For sample size of SRI farmers see Col. 9 in Table 4.3 below.  **Source**: CROPS. | | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 16: Size of the Farm Holdings under SRI Paddy Cultivation among the CROPS’ Sample Farmers** | | | | | | | | |
| **Season/Year** | Area under SRI (acres) | | | % of SRI Farmers by Size of SRI Area | | | | Total SRI Farmers |
| Minimum | Maximum | Average | Below 0.5 acre | 0.5 to less than 1 acre | 1 to 2 acres | 2 acres and above |
| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** |
| Rabi 2007-08 | 0.50 | 1.0 | 0.73 | 49.2 | 50.8 | 0.0 | 0.0 | 120 |
| Kharif 2008 | 0.25 | 2.0 | 0.78 | 48.3 | 44.8 | 7.0 | 0.0 | 143 |
| Rabi 2008-09 | 0.25 | 3.0 | 0.89 | 38.8 | 51.2 | 9.1 | 0.8 | 121 |
| Kharif 2009 | - | - | - | - | - | - | - | - |
| Rabi 2009-10 | 0.20 | 3.0 | 0.62 | 58.0 | 27.8 | 14.0 | 0.2 | 457 |
| Karif 2010 | 0.20 | 2.5 | 0.84 | - | - | - | - | - |
| Rabi 2010-11 | - | - | - | - | - | - | - | - |
| Kharif 2011 | 0.25 | 3.0 | 0.50 | 0.7 | 31.1 | 33.9 | 34.3 | 460 |
| Rabi 2011-12 | 0.25 | 1.5 | 0.70 | - | - | - | - | - |
| **Note:** ‘ - ’ Not Available.  **Source:** CROPS. | | | | | | | | |

The experience of CROPS with SRI is similar to the ones obtained in other studies discussed earlier. It shows that to reduce dis-adoption, SRI needs a *continuous follow-up programme* for at least five years. *Incentives* are needed to scale-up the proportion of adopters in a given village. A *critical mass of adopters* would make it possible to have a larger pool of farmers and labourers familiar with the skills of SRI type transplanting and weeding and the synergies that result from ‘clustering externalities’.

**V**

**Concluding Observations**

The causes of climate change are increasingly apparent in that more or less all forms of production processes, including agriculture, contribute to global warming. The challenge is to identify the sources of greenhouse gases (GHGs), understand the processes through which these are generated and intervene in ways that reduce GHGs.

It is widely believed that one of the world’s major staple foods, rice, is also one of the larger contributors to GHGs (Jayadev et al, 2009; Quin et al, 2010). The search for alternative ways of growing rice, in a manner that substantially reduces GHGs has resulted in the identification of SRI as one of the important alternative. By reviewing the results of some of the studies across the globe and the experience in Andhra Pradesh in India, we find that there is in controvertible evidence, including the preliminary result from our own field study, that SRI uses less water and fewer inputs including energy; reduces costs substantially and results in higher yields compared with conventional cultivation practices (See for e.g. Lim et al, 2011; Kassam et al, 2011; Thakur et al, 2011; Ravindra and Laxmi, 2011; Rao, 2011 and Palanisami et.al. 2013). There is substantial net reduction in GHGs in SRI rice cultivation under a controlled water regime as compared to conventional practice (Quin et al, 2011). In addition, SRI is also well-suited for the water – scarce semi-arid tropics and for the economic conditions of small-marginal farmers who depend more on family labour.

In spite of these outstandingly positive findings, not only validated at the field level in our own research which corroborates that of other scientists, but also widely recognised by national, state and local governments, civil society organisations and small-marginal farmers themselves, *the spread of SRI to rice growing areas is extremely slow*, if not retarded. It has failed to make any significant dent on conventional practices and technologies.

Obstacles like the need to follow rigid, time-bound practices, the shift to relatively monotonous isolated work like mechanical weeding, are shown to be *not* insurmountable. Ingenious modifications to tools and practices have been invented. But a further array of factors such as :

1. the lack of resources for research and development in breeding appropriate varieties to overcome the rigid short-duration transplanting schedule,
2. the appropriate type of weeder including simple mechanised ones that would remove the psychological strain from using the current designs of weeders,
3. the failure to develop a major agricultural extension programme for SRI and
4. political resistance to adopt a framework to integrate training in SRI practices with NREGS so as to overcome certain perceived skill deficiencies,

all show that the role of the state in promoting SRI leaves much to be desired. Unlike the agri-technologies for hybrids, GMOs, the design of combine harvesters, and other agricultural machinery, the *corporate sector does not see a profitable market in the promotion of SRI*. On the contrary, there may be corporate lobbies preventing the state from launching major programmes for SRI. The next-step *seems to be in public mobilisation in favour of increased public investment and in the design of appropriate strategies for the spread of SRI*. Another sensible strategy is *to pay attention to the varying ways farmers try to adopt SRI depending on their local conditions*. It is evident now that only 20 percent of adopters of SRI take to all the four core practices of SRI, and the rest of the 80 percent are either partial or low adopters (Palansami et.al. 2013). So finally, farmers need encouragement to adopt incrementally those specific components of SRI that suit them while also helping to increase yields, reduce costs and in so doing generate the co-benefit of lower greenhouse gases.

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**Abbreviations**

ATA - Association of TefySaina

ANGRAU - Acharya N G Ranga Agricultural University

ATMA - Agricultural Technology Management Agency

CIIFAD - Cornel International Institute for Food, Agriculture and Development

CMSA - Community Managed Sustainable Agriculture

CROPS - Centre for Rural Operations Programme Society

CRRI - Central Rice Research Institute

CSA - Centre for Sustainable Agriculture

CWS - Centre for World Solidarity

DAATT - District Agricultural Advisory and Transfer of Technology

DRR - Directorate of Rice Research

FTTF - Farmer’s Technology Transfer Fund

ICRISAT - International Crop Research Institute for Semi-Arid Tropics

IIED - International Institute for Environment and Development

IRRI - International Rice Research Institute

KVK - KrishiVignana Kendra

MSSRF - M S Swaminathan Research Foundation

NABARD - National Bank for Agriculture and Rural Development

NADP - National Agricultural Development Programme

NGO - Non-Governmental Organisation

NFSM - National Food Security Mission

NREGS/A - National Rural Employment Guarantee Scheme/Act

PRADAN - Professional Action Development Action Network

SDC - Swiss Agency for Development and Cooperation

SDTT - Sir Dorabji Tata Trust

SIDA - Swedish International Development Cooperation Agency

SRI - System of Rice Intensification

TNAU - Tamil Nadu Agricultural University

WASSAN - Watershed Support Services and Activities Network

WWF - Worldwide Fund for Nature

1. €Professor, S R Sankaran Chair (Rural Labour), NIRD, Hyderabad. [↑](#footnote-ref-1)
2. £Junior Research Officer, S R Sankaran Chair, NIRD, Hyderabad. [↑](#footnote-ref-2)
3. ¥The authors are grateful to Prof. Barbara Harriss White for her helpful comments on earlier drafts of the paper. (This is one of the background papers of the project “Measuring Materiality in Informal Production-Distribution Systems”). [↑](#footnote-ref-3)
4. The reference agriculture year is 2008–09 and based on the data of costs and returns of crop. The analytical methods used included budgeting techniques, benefit-cost ratio (BCR), yield gap analysis, sustainability index and response priority index. [↑](#footnote-ref-4)
5. It is due to the practice weeding using rotary/conoweeder coverts the weeding into organic fertilizer and wider space between plants allows soil aeration and improves the soil biota. The wider space between rice plant hills is relatively aerated and allows sunrays and thus reduces the chances of pest attack. [↑](#footnote-ref-5)
6. “Measuring Materiality in Informal Production–Distribution Systems”, School of Interdisciplinary Area Studies, Oxford University, Oxford. [↑](#footnote-ref-6)
7. Field Study villages are: Katkuru, Chinna Ramancherla, Pedda Ramancherla, Nidigonda, Fateshapur, Ibrahimpur, Kasireddy palle, Dabbakuntapalle and Patelgudem. [↑](#footnote-ref-7)
8. Cornell International Institute for Food and Agriculture (Ithaca, USA). [↑](#footnote-ref-8)
9. The total cropped area or gross sown area (GSA) in the state is 13.3 million hectares. [↑](#footnote-ref-9)
10. 8Both in Khariff and Rabi seasons. Khariff refers to the monsoon season. Rabi refers to dry season. [↑](#footnote-ref-10)
11. These will be supplied when they have been computed from field data gathered in the project ‘Measuring Materiality in Informal Production-Distribution Systems” – see Hema 2013. [↑](#footnote-ref-11)
12. 9There are 34 KVKs in the state. Of which 23 are operated under ANGRAU, 3 are directly associated with ICAR and 8 are operated by civil society organisations (NGOs). These KVKs are grass root level institutions devoted for imparting need based skill oriented short and long term vocational training courses to the agricultural clientele. Besides conducting on farm research for technology assessment and refinement, KVKs demonstrate latest agricultural technologies through front line demonstrations. [↑](#footnote-ref-12)
13. 10There are about 22 DAATT Centres one for each rural district in Andhra Pradesh and associated with ANGRAU. [↑](#footnote-ref-13)
14. 11Cono-weeder is a mechanical rotary instrument used for weeding in SRI. [↑](#footnote-ref-14)
15. 12The thrust of CMSA is to promote non-chemical pesticide agriculture with an emphasis on soil rejuvenation

    and multiple cropping especially in dryland areas. [↑](#footnote-ref-15)
16. 13SERP is a state sponsored civil society organization, with Chief Minister as the Chairman, with objective of

    social mobilization of women through self-help groups (SHGs). [↑](#footnote-ref-16)
17. 14There are four clusters in each project with each cluster consisting of four villages: thus 16 villages in each

    project. The 150 projects cover 2400 villages all over India. [↑](#footnote-ref-17)
18. 16It is a iron frame marker, to draw vertical and horizontal lines in the field ready for transplantation, developed by an innovative farmer Mandava Krishnarao, hailing from Mandava village in Khammam district of Andhra Pradesh. It is now widely used in Andhra Pradesh. Prior to that ropes were used to get marks of horizontal and vertical lines. [↑](#footnote-ref-18)
19. 17An acronym for Centre for Rural Operations Programme Society (CROPS). [↑](#footnote-ref-19)
20. 18Besides, the organisation is also involved in formation of thrift groups of women called Sanghams at village level. **Sri Shakti** is a registered **Mutually Aided Cooperative Society (MACS)** for Women, initiated by CROPS. Under this programme the whole village is a unit, *Sangham*. Sri Shakti Women MACS was established in the year 1995 with merely 5 groups and 40 members and in due course it developed to 44 groups and 5,467 members. Women in more than 40 villages formed as *Sangham* thrift groups facilitated by the CROPS. Presently there are 7,467 women actively involved in 74 groups. The savings worth Rs. 91.93 lakhs were pooled from these members and against this credit worthiness Messrs. Andhra Bank has sanctioned loan worth of Rs. 1.3 lakhs to SRI SHAKTI MACS and also total loans amounted to Rs. 363.27 lakhs have been issued to these members for various productive purposes. [↑](#footnote-ref-20)
21. ***19Enabavi***, the hamlet of the Kalyanam Revenue village, Lingala Ghanapur Mandal, Warangal District, Andhra Pradesh has created history in organic farming in India. The entire village involving about 55 families, 300 acres constituting the hamlet population of about 200 has become fully organic. Hence ‘organic’ is used in an informal sense to include farming free of pesticides, chemical fertilisers and genetically-modified crops. It is the first village in the country to declare itself, chemical free and GM free (CROPS from <http://www.crops.co.in/enabavi.html>). [↑](#footnote-ref-21)
22. 20The Trust gives annual awards to innovative farmers who work towards practices that reduce farming risks. [↑](#footnote-ref-22)
23. 21With the support of the WWF project. [↑](#footnote-ref-23)
24. 22Mandals, which cover population of about 30,000, are administrative units below District Administration. In Andhra Pradesh erstwhile Taluks/Blocks were replaced with Mandals in the early 1980s. [↑](#footnote-ref-24)
25. 23Accessed through [http://www.deccanherald.com/content/110687/she-has-become-villagers-envy.html#](http://www.deccanherald.com/content/110687/she-has-become-villagers-envy.html) [↑](#footnote-ref-25)