Conservation Agriculture – Sustainable Agriculture: A Case from the Tribal Regions of Madhya Pradesh and Gujarat

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1. Introduction

It would be a cliché to mention that Indian agriculture is largely characterized by rain dependent farming of subsistence nature. A substantial share of this rain-fed subsistence farming falls in tribal regions spread across central and north-eastern India. The two regions - Dangs of Gujarat and Nimar of Madhya Pradesh (MP) are among the regions inhabited by Warli, Bhil, Barela and Bhilala tribes. The region is synonymous with undulating topography, dependency on forest for non-timber forest produce, high intensity rainfall during the monsoon and dry spells in summers. The two regions are highly vulnerable to the vagaries of climate – torrential rains and extreme temperatures. Harsh summers followed by monsoons with heavy runoff make earning livelihoods difficult for the people. Common crops such as rice, pulses, maize, soybean, groundnut etc. are all cultivated on minimal external inputs like hybrid seeds, fertilizers, and pesticides.

The native tribal population of the region finds it difficult to eke a living out of agriculture. A large population migrates to places such as Surat, Ankleshwar, Indore, Ahmedabad and Saurashtra for seasonal wage employment as the returns from agriculture do not fulfill the consumption needs of the family. In such a scenario, Aga Khan Rural Support Programme - India has been working to enhance the livelihood of the farmers through a combination of approaches that include watershed management, agriculture-based livelihood promotion, microfinance and promotion of social enterprises. Moreover the changes caused due to climate change pose the risk of pushing the community to higher levels of distress if not dealt with holistically. For increasing profitability for farmers, AKRSP-India has been working on promoting methods such as System of Rice Intensification, integrated pest/nutrient management, irrigation support, crop bio-diversification and more recently Conservation Agriculture (CA), along with facilitating market linkages. CA is an innovative sustainable agriculture method that helps the farmers overcome the problems of low production and high costs; besides, it results in amelioration of soil health leading to resilience to climate change anomalies. This case presents the impacts of

conservation agriculture programmes among the farmers of Nimar region of MP and Dangs in Gujarat, which were initiated in 2014 and 2015 respectively. The case tries to look at how the techniques promise sustainable production of crops with a better Cost-Benefit Ratio, along with added advantages of climate change adaptation and sustainable soil, ecosystem services and agro-ecology.

2. Location Of The Case

MP and Gujarat are home to 8.6% and 14.7% of the tribal population of the country respectively, comprising of Bhil, Bhilala and Warli tribes. The Dangs and Nimar region of Gujarat and MP are two such areas where the tribal population is almost 98%.

2.1 The Dangs

The Dangs has hilly and undulating terrain. Fifty five per cent of the region is under forest cover. The climate of the area is characterized by general dryness, except during the southwest monsoon season and hot summers. The average rainfall of this region varies from 400 mm to 1800 mm. The soil of this region is rocky alluvial soil, but black and red soils can also be found at places. Large areas are occupied by rice, pulses and groundnut, followed by finger millet. The Dangs has major challenges such as food insecurity, high distress migration (60-80%), low crop productivity, lack of soil and land management, highly erratic rainfall patterns, lack of irrigation facilities, uncertain income due to dependence on monsoon, price fluctuation in cash crops and no access to institutional credit resulting in very high rates of interest on loans on up to 100% interest rates. The region also lacks infrastructure facilities such as access to potable drinking water and poor road connectivity to many villages, which worsens in the rainy season leading to distress selling of agricultural commodities. It is low on health indicators like high infant mortality rates. Social issues such as rampant liquor consumption leading to domestic violence are also prevalent.

2.2 Nimar Region

The second region Nimar is in south-western Madhya Pradesh in west-central India. The region lies south of the Vindhya Range, and consists of two portions of the Narmada and Tapti river valleys, separated by a section of the Satpura Range, about 24 km in stretch. The region has a subtropical climate, like most of north India. It has hot dry summers (April–June) followed by monsoon (July–September) and a cool and relatively dry winter. The average rainfall is about 1,000 mm (39.4 in) or less. Cotton crop is grown on 30% of the total cultivable area and soybean, which is the second largest crop in terms of area, on 14% of the total cultivable area. The cropping pattern followed by

the farmers in the Nimar region during the Kharif rain-fed season (summer-monsoon season) is: soybean (intercropped with maize in the ratio 1:10) – red gram, cotton (intercropped sorghum) – wheat, cotton – red gram. In the Rabi season (winter season), wheat and gram are cultivated on irrigated land. The area has low agricultural productivity due to soil erosion, low organic content in soil, poor irrigation facilities, erratic rainfall, spurious agriculture inputs, poor knowledge base among farmers particularly for cash crops, inadequate credit facilities, and absence of knowledge extension system. The farmers are forced to rely on market traders for all aspects of agriculture like inputs, knowledge and market for their produce.

3. The Available Alternatives

Aga Khan Rural Support Programme-India has been working towards sustainable livelihood by intensively working on conservation of natural resources – soil, water and forest, providing extension services to the households so as to ensure cushion against external environmental shocks, bolstering food security for the household so as to enhance livelihood opportunities. To overcome the challenges mentioned above the first and foremost intervention which the organization has taken up is to overcome the challenge of production which will lead to not just food security but will also generate surplus food grains to be sold in the market.

4. The Innovation

These two regions had a pertinent need for a suitable method which can keep the soil sustainable and yet productive.

4.1 Conservation Agriculture

The of method Conservation Agriculture (CA) is an innovative solution that serves a resource-saving agricultural production system, presenting better returns from sustained production levels without damaging the environment and adapts to climate change anomalies such as torrential rains, longer gaps in rainfall, high temperatures led evapo-transpiration in drought situation of Dangs and Nimar. CA has three main principles – (i) continuum zero or minimum mechanical soil disturbance (minimum/zero tillage); (ii) permanent organic soil cover – green or dry (surface mulch); and (iii) diversified crop rotations for annual crops or plant associations for perennial crops.

It has been widely adopted by farmers across the world as an alternative to conventional tillage-based agriculture. The technique promises a win-win situation for farmers as it reduces their costs of production (without reducing

their productivity), enhances soil health, safeguards the environment, and adapts the crops for climate change. The seed is sown directly into the soil with the help of special implements – jab planters, no-till implements, happy seeder etc. and year after year the soil is left untilled or minimally disturbed. The biodiversity of the cropping system makes it resilient to the risk factors and also adds to the ecosystem services in the field.

Farmers of Dangs (Gujarat) and Nemar (MP) region were the key decision makers of this initiative. The process followed for the adoption included need analysis, concept seeding through training and exposure, planning and implementation along with periodic monitoring – technical and economic, and feedback process. The intervention was first introduced in MP in June 2014 (Kharif, 2014) and in Dangs in September, 2015 (Rabi, 2015). The proposed timeline was one year duration for each phase namely introduction, uptake pilot scaling, mass scaling and mainstreaming. The ideal method which was followed was first adoption of testing sites on the fields of the farmers where the farmer will learn for one season and test the intervention of zero tillage. The soil was tilled only once before the intervention (later to be left untilled and directly sowing seeds year after after) when the sowing was done and was covered by mulch cover for the first time. The standard operating procedures were developed for the intervention so as to avoid failure in the results.

4.2 The Strategy Adopted in Nimar

4.2.1 Need analysis: Focused Group Discussions were conducted during which farmers' problems were understood, some new options of crop practices were explored like System of Crop Intensification, use of on-farm crop and weed residue for mulching, minimum disturbance of soil and reducing seed quantity etc. The benefits of CA like increased soil retention were also discussed.

4.2.2 Concept briefing to the focus group: Next, the concept of CA was introduced along with its need, process and benefits.

4.2.3 Planning and strategy: Thereafter reliable farmers were identified through an area selection process in all operational areas. Initially demonstration sites were chosen in which four separate plots were taken:

- Conventional Farmer Practice (Conventional Tillage)
- Conventional Farmer Practice + System of Crop/Root Intensification.
- Conservation agriculture with traditional crop spacing.
- Conservation agriculture + System of Crop/Root Intensification.

4.2.4 Implementation and Monitoring: According to the above strategy, the selected plots were monitored as per the crop cycle.

4.2.5 Impact analysis: Impact analysis has been carried out after a year of implementation for getting feedback so that improvements can be carried out.

4.3 The Strategy for Dangs

There were seven farmers who adopted CA testing plots for the Rabi 2015 season for three different crops: chickpea, onion and okra. Out of seven farmers, five farmers had sown chickpea. For chickpea and onion, 25x25 cm spacing was kept while for okra it was 50x50 cm, thus making CA and System of Crop/Root Intensification (SCI /SRI) go hand in hand. The area of test sites for control and CA+SCI was 100 square meter (0.03 acres) as landholdings are small in the region. All the conditions of the two testing sites i.e. control/conventional and CA+SCI, were kept uniform except for the mulching added as a part of the CA methodology and equally-distant sowing. No special treatment was done in any of the two testing sites except for the addition of mulch and raised bed cultivation in CA+SCI. Sowing was done on the raised bed with the help of an iron-frame dibbler, while in traditional cultivation broadcasting was done for chickpea. For onion, transplanting was done in 25x25 cm while with traditional management, random placement was done. In the case of okra, 50x50 cm spacing was kept in CA while in the traditional sites line-to-line spacing was kept at 50 cm, while no row-to-row spacing was maintained for uniformity.

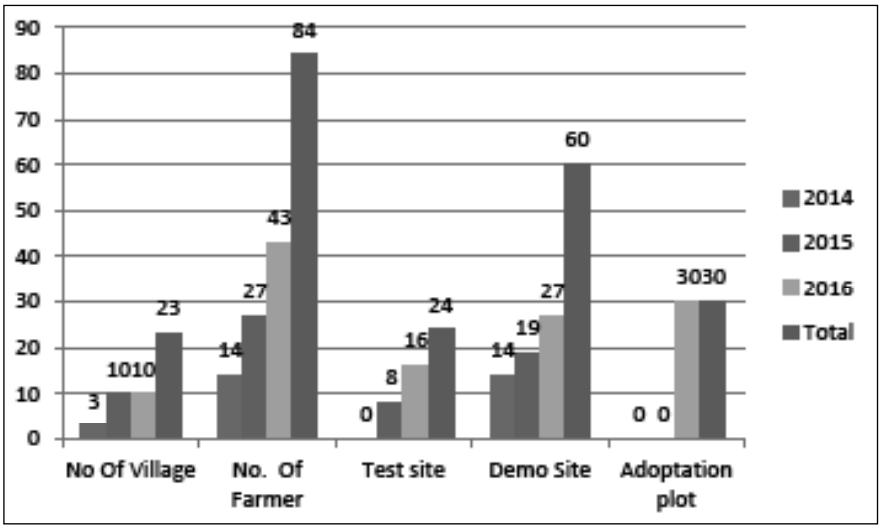
5. Impact Of Intervention

The impact of the adoption of conservation agriculture intervention is different in the regions. The descriptions of the two regions are as follows:

5.1 Nimar Region

Between June 2014 to Kharif 2016 there is a continous growth in involvment of farmers practicing CA. The following table shows the coverage of farmers under CA practises:

Figure 1: Number of Farmers Under Testing Sites, Demo Site, Adoption Site



Impact has been analyzed after one year in 2015 on two parameters divided broadly in two categories:

1. Assessment of agronomic and economic performance of different crops grown in the pilot areas under Conservation Agriculture and conventional agriculture. The impact of Conservation Agriculture has been analysed on two crops (maize and gram).

2. Assessment of soil health which covers biological, chemical, hydrological and physical properties.

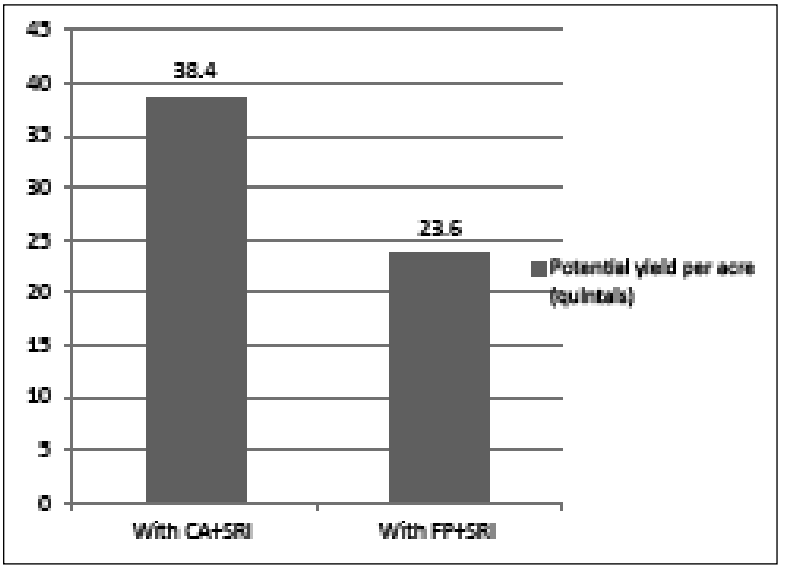
Data was collected and analyzed from seed treatment till harvesting of crops from the two types of fields, those which were under CA, and those which practice maize and gram cultivation in the traditional/conventional way. The results are discussed below with graphical representation, and data is shared in Annexure.

5.2 Comparative Results Between Sample CA and Traditional System for 9 Farmers in Maize Crop

The details of the results seen in the testing plots of the farmers with whom the interventions were done. The results are of the sampled farmers under testing plots of maize.

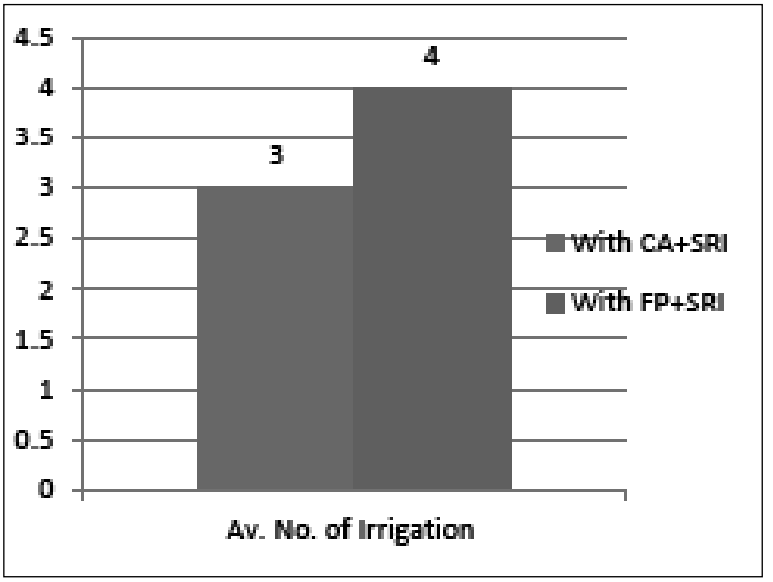
5.2.1 Average potential yield per acre (quintals): The collected data shows that potential yield per acre in CA recorded 38.4 qt, and in conventional plot 23.6 qt. So we can see that the average yield potential per acre was 62.71% higher in the CA+SRI fields than the FP+SRI one

Figure 2: Comparison between Traditional and CA Productivity in Maize



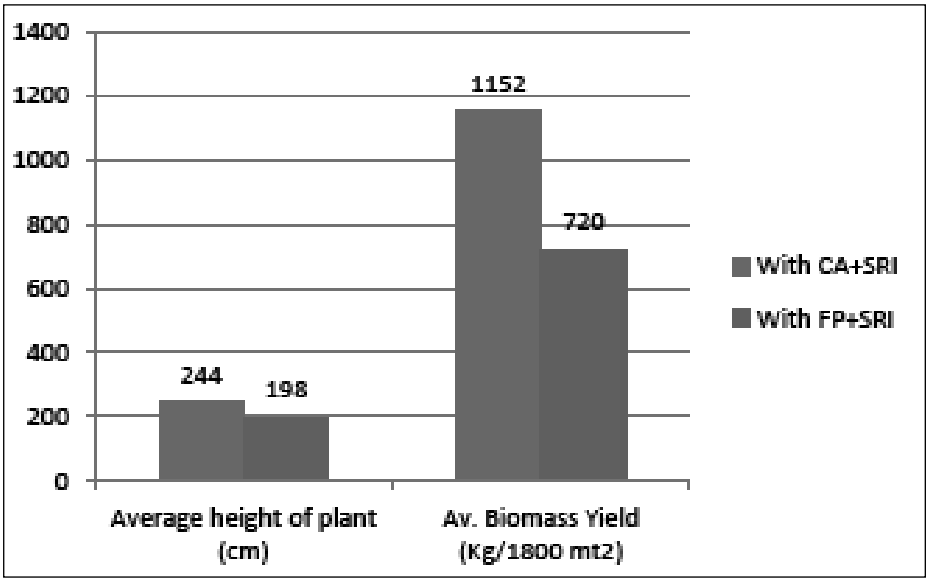
5.2.2 Average Number of Irrigation: The graphical representation shows that average number of irrigation in CA is 3 times and in conventional plot 4 times. This is due to the increase in the soil moisture in CA plot by 9.10% than conventional plot and requirement of water during the critical stages for irrigation for maize crop.

Figure 3: Comparison between Average Number of Irrigation Required for Traditional vs. CA in Maize



5.3.3 Average height of plant & biomass yield: There is an increase in the height of plant by 23.23% in comparison to the conventional plot. On the other hand, increase in the level of biomass yield by 60% in comparison to farmer practice plot were observed.

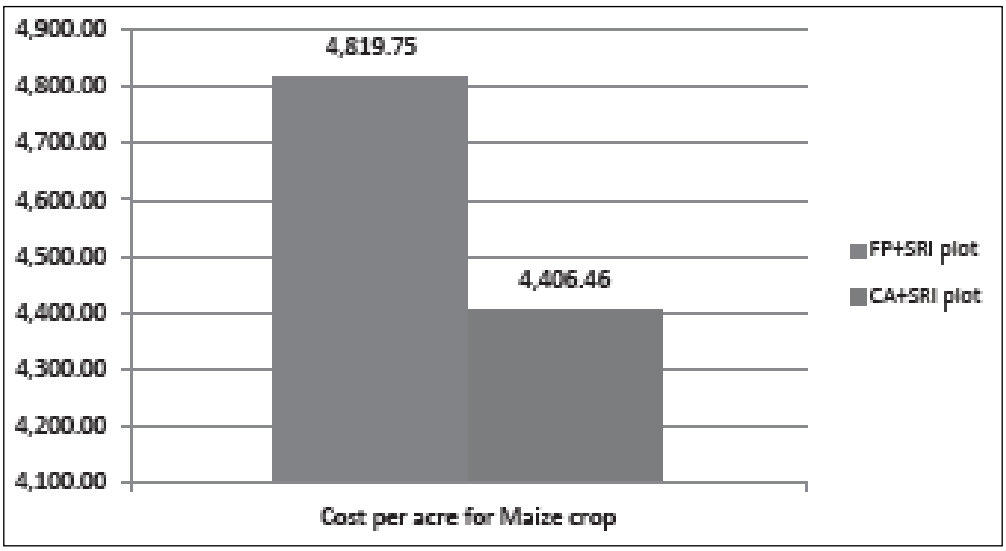
Figure 4: Comparison between Traditional and CA in Maize on Height and Biomass Yield



5.3.4 Cost of production

Apart from the production results of the sampled farmers, the cost benefit ratio of conservation agriculture was also seen to be high (Annexure 5). Differences in cost have been observed for input cost (land preparation and other intercultural operation like weeding, irrigation etc are included), while other activities remain the same for both CA+SRI plot and CT+SRI plots as such seed rate, variety, date of sowing and treatment for plant protection were followed. Different aspects of the costs were calculated including sowing, land preparations, irrigation, interculture operations. In the comparison it was seen that the total cost is less in the CA+SRI fields. If we compare the total cost per acre, we find that the cost for the CA+SRI plot is 9.38% lower than the CT+SRI one.

Figure 5: Comparison between Cost of Production for CA and Traditional in Maize

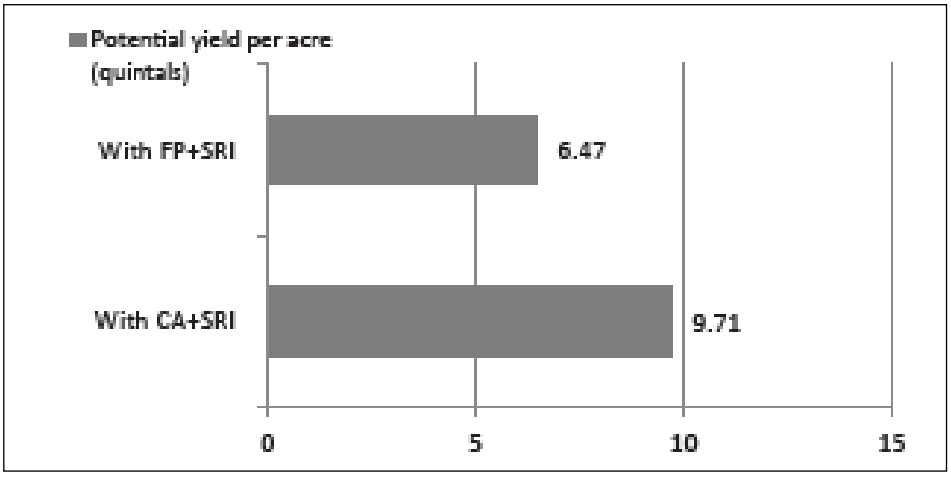


5.3. Results for the Sample Farmers Growing Gram under CA testing plots

5.3.1 Average Potential Yield per Acre (quintals)

The collected data shows that potential yield per acre in CA recorded 9.71 qt, and in conventional plot, 6.47 qt. Therefore, it can be seen that the average yield potential per acre was 50% higher in the CA+SRI fields than the CT+SRI one.

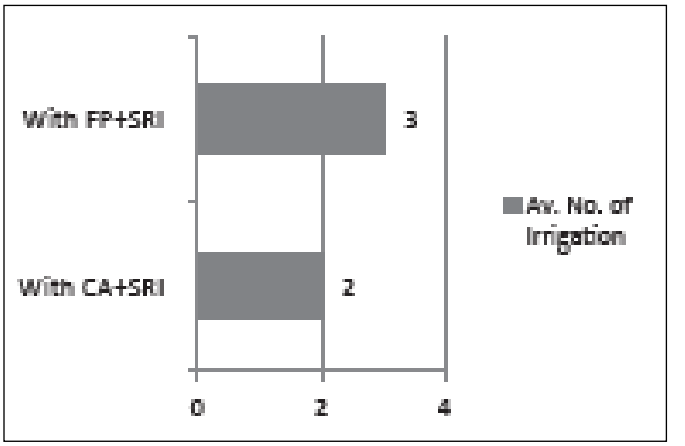
Figure 6: Yield comparison between CA and Traditional in gram



5.3.2 Average Number of Irrigation

The collected data shows that the average number of irrigation in CA is 2 times and in conventional plot 3 times. This is due to the increase in the soil moisture in CA plot by 9.10% than conventional plot and requirement of water during the critical stage of irrigation for Gram crop.

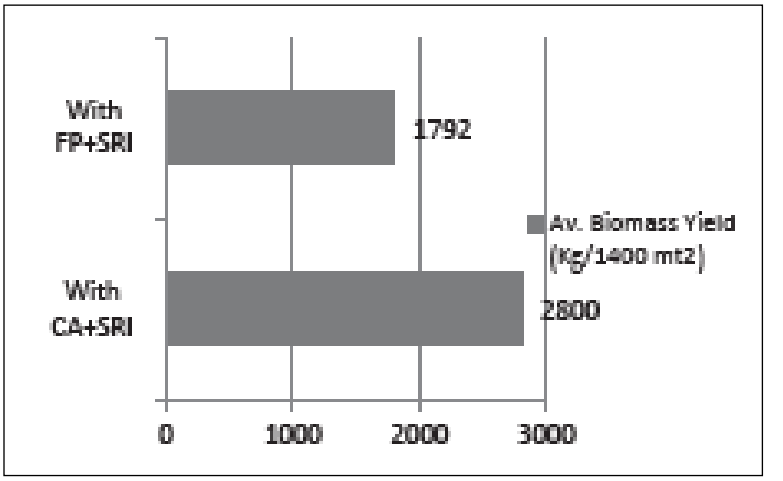
Figure 7: Comparison between Average Number of Irrigations in Traditional vs. CA in Maize



5.3.3 Biomass yield

There is an increase in the level of biomass yield by 56.25% in comparison with farmer practice plot.

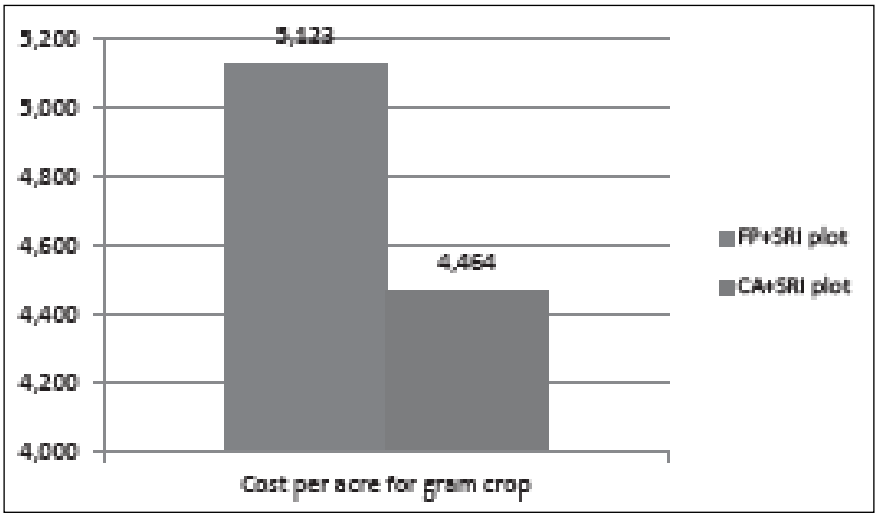
Figure 8: Comparison of Biomass Yields in CA and SRI in Gram



5.3.4 Cost of Production:

The total cost is less in the CA+SRI fields. If we compare the total cost per acre, we find that the cost for the CA+SRI plot is 14.76 % lower than the CT+SRI one (Aee Annexure 6).

Figure 9: Comparison of Cost of Production in Traditional vs. CA in Gram



6. Soil Health Indicators

6.1 Soil Moisture

Soil moisture in CA plots was 19.4%, and in conventional plot it was 17%. So, there is an increase in the level of soil moisture by 9.10% in CA plot in relation to conventional plot in the first year itself.

6.2 Bulk Density

Soil bulk density in CA was recorded as 1.25 g/cm^3 and in conventional plot it was 1.28 g/cm^3. There is a decrease in the level of soil bulk density by 2% in CA plot in relation to the conventional plot.

6.3 Soil aggregate stability

Soil aggregate stability in CA was recorded as 42.4%, and in conventional plot it was 32.4%. there was an increase in the level of soil aggregate stability by 30.6% in CA plot in relation to conventional plot.

6.4 Water infiltration

Soil water infiltration in CA was recorded as 23.5 litre/h/m^2 and in conventional plot it was 14.1 litre/h/m^2. There is an increase in level of soil water infiltration by 66.6% in CA plot in relation to conventional plot of the farmers.

6.5 Soil organic matter content

Soil organic matter content in CA was recorded as 0.55%, and in conventional plot it was 0.39%. There was an increased level of soil organic matter content by 41.2% in CA plot when compared to conventional plot.

6.6 Mineralizable nitrogen

MN content in CA was recorded as 0.014%, and in conventional plot it was 0.012%. There was increase in level of PMN content by 22.6% in CA plot in relation to conventional plot.

6.7 Macro and micro-nutrient level

The collected data shows that the major nutrient levels are higher in the CA plot than in non-CA plot. There is an increase in the level of N by 28.1%, by 12.1% in P and by 19.1% in K.

7. Results From Dangs District

The results from the Dangs were limited to one season of crop so not much technical analysis was done for the soil health and cost of production. As the team is evolving in CA practice, data related to yield was captured from the field and is presented further.

Figure 10: Yield Comparison in CA+SRI vs. Traditional Cultivation in Chickpea (in kgs)

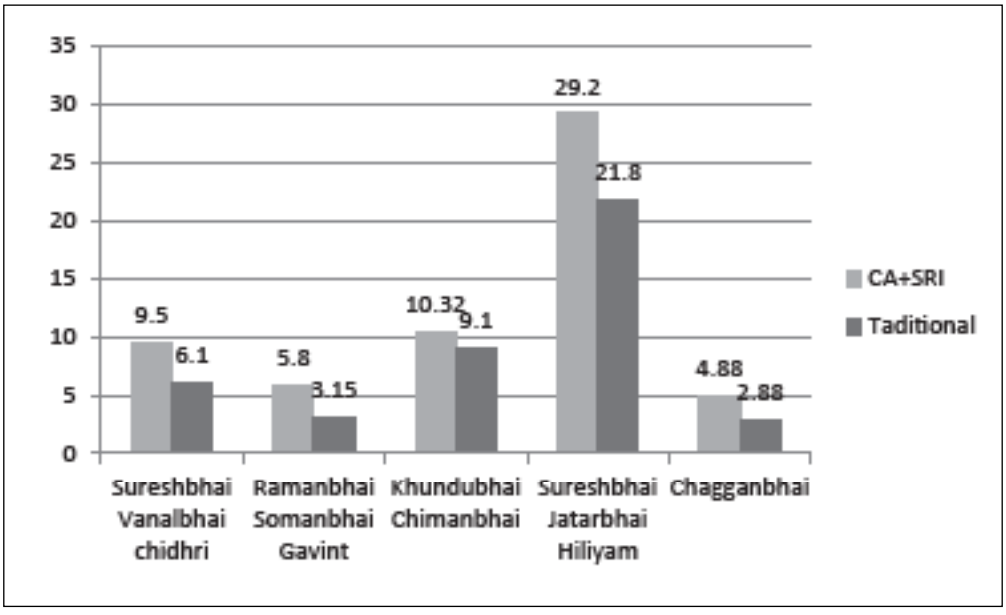
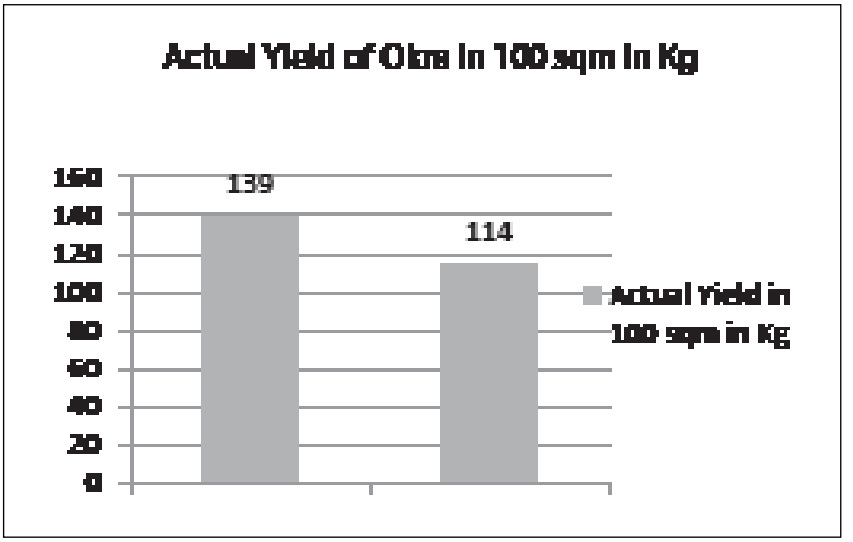


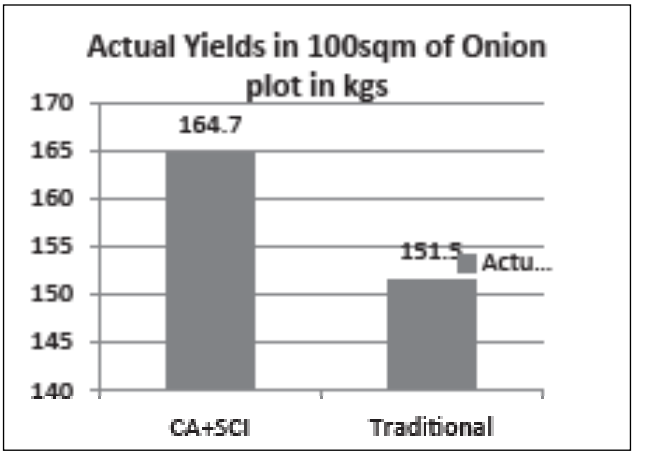
Figure 11: Yield Comparison of Onion production (CA and traditional from left to right)



The test site results have shown (Figure 10) that all the farmers who cultivated chickpea with CA+SCI methods could get higher yield. In all the testing sites, there was an appreciation in yield which went as high as 184% as observed with Ramanbhai of Raochond village, while the minimum increment of the yield was 113%, as seen with Khundubhai in village Godvahal. The average increase in yield was 51.3%. Overall, the adoption of the CA+SCI test sites gave confidence to all the small farmers that the new method can work well from the first year onwards. It was also seen that the seed rate of the CA+SCI testing sites was also less when compared to traditional sites as the seeds were placed in the designated spacing. Farmers believe that there are still chances of reducing the seed rate with this method even more.

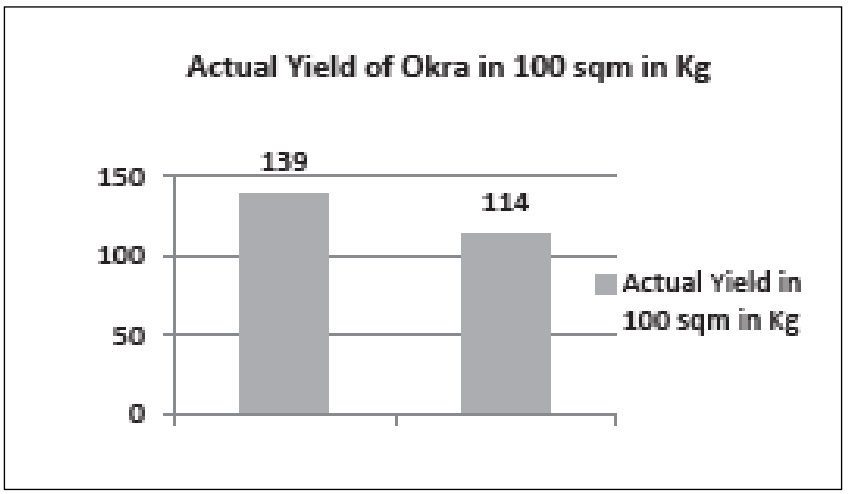
The field results for the onion crop were encouraging too, as the measured yield for CA+SCI testing site was higher when compared with traditional methods. Apart from the good yield of the crop, this farmer was able to apply one less flood irrigation with the CA+SCI crop. The farmer also observed that the color of the onions was redder and they were larger in size when compared to the traditional practice.

Figure 12: Yield Comparison of Onion production



In case of Okra, the production was 21% higher in case of conservation agriculture. The farmer could get an extra 95 kilogram of okra from his field (See Table 3) and being a crop with premium price, he was convinced of the method.

Figure 13: Yield Comparison in OKRA



7.1 Note on Observations from the Farmer's Field

- Yield: In all the cases, the production on the test sites was seen to be higher. This is one of the driving force for farmers to overcome their apprehensions on adoption of new methods.

- Seed rate: Though SCI combined with CA led to lower seed rates, there is scope to reduce the seed rate further and to standardize optimum rates

for a particular crop and variety. This will happen over a period of time, through co-learning with the farmer.

- Phenotypic observations: The crops themselves were fairly superior when compared to the traditionally-grown crops as reported by the farmers and the field team. There was profuse flowering in chickpea and okra, while onions had better bulb formation.

- Weeds: There was reduced need for efforts by farmers to manage weeds as the soil was covered with mulch.

- Labor: There had to be an initial greater investment of labor in the adoption of Conservation Agriculture, but it will only be a challenge in initial years until the system itself generates sufficient mulch or organic matter which is now being brought from outside. The farmers recognized that there is a higher need for labor (although on a one-time basis) for making beds and mulching, but this can be compensated by no-till practice. It is being planned to reduce labor by the introduction of a bullock-driven bed-maker made by a local fabricator and by introducing seed-sowing implements.

- Irrigation: As the crops cultivated were done on residual moisture, the factor is irrelevant here.

8. Challenges Faced

- **Traditional paradigm of agriculture**: Years of tillage-based cultivation of crops have fostered the belief that cultivation of crops is not possible without tillage. The idea was therefore rejected by farmers. Only after regular trainings and exposure to other locations, the farmers accepted that they can produce sustainably. It takes sustained effort and time to overcome their behavioral issues.

- **Infestation of rodents in mulch (rats and squirrels)**: Ratss and squirrel ate up the seeds of Gram planted in the field. *Gliricidia* was recommended to the farmers as a pest repellant in their field, which saved the crop from rodent attacks. It becomes imperative that farmers adopt *Gliricidia*, which can act as a repellent for mice. It is also quality green manure which, when added to the beds, will lead to an increase in soil nitrogen.

- **Lack of implements:** The scale of intervention is largely dependent on the implements – bullock or tractor will help sow the seeds directly in the soil without disturbing it. It was a tedious task for the farmers to adopt the sowing of crops. So, customized zero till implements can slowly be

developed and given to a group of farmers until such time that they are mass produced for adoption and promotion with a larger number of farmers.

- **Availability of mulch:** The CA system is such that it generates mulch, which is needed for soil cover. But there is a challenge in introducing mulch in the initial year of introduction of the CA intervention. The farmers find it difficult to mobilize mulch from other sources when fodder is not easily available. It also reflects in initial years of cost of production. Once the adoption of cover crops or *Gliricida* is done, it will not only add nutrients to the soil in the form of green manure but will also act as soil mulch, thus suppressing weeds of all kinds.

- **An initial higher labor involved**: Mulch collection and spreading is laborious work in intial years as it requires time and energy to set up the testing sites for the farmers. This lead to improper mulch cover and later weed infestation in the field.

- **Germination issues:** A few farmers had also seen improper germination in the field due to the mismanagement of soil mulch in the field. The inabiliy of the sunlight to reach the ground and infestation from birds has led to seed germination failure.

9. Scale And Sustainability Of Intervention

The innovation of Conservation Agriculture is currently in a testing stage although some of the farmers have started to adopt it on their own after seeing the results. To help this technique reach more farmers, there is imminent need of introduction of the CA implements such as Jab Planters, no-till planters mounted on bullock or small tractors seeing the needs of the region. There are some implements such as Happy Seed Planter which can sow seeds directly into the soil without disturbing the soil, but seeing the uneven terrain of Nimar and Dangs that implement is not of much use. Some implements which FAO has also endorsed in Africa and can be introduced if locally fabricated, in order to scale CA adoption by the farmers. Aga Khan Rural Support Programme-India is currently looking towards such alternates in order to scale the successful intervention in the field. One such intervention can also be seen in the region of *Saguna Baug* in Raigadh district in Maharashtra, where zero tillage has been practiced since four years, albeit with high usage of herbicides rather than engaging cover crops in the field. AKRSP-India is learning along-with the farmers about the scale of the intervention in its three different states i.e. Gujarat, M.P. and Bihar.

10. Conclusion

Conservation agriculture promises to be a win-win situation for a farmer by cutting down cost of production without harming productivity; besides it is good for soil, for the environment, for sustainable production of food, and adaptation to and mitigation of climate change adversities. Looking at them one by one, soil health enhances with increase in SOC, which is on the decline in different soils due to frequent tillage, lower availability of farm yard manure due to mechanization of farming (IARI, 2012) and field crop burning (LW Johannes, 1965). Soil with high organic matter is higher in productivity than the soil where the organic matter is poorly managed (Alan Sundermeier et. al, 2005). The proposed system ensures there is an increase in SOM by addition of residue year after year as also seen in this case study. Carbon sequestration is enhanced by CA as more and more carbon can be restored in the soil while in conventional tillage agriculture, the release of CO_2 is accelerated since release of CO_2 from soil is directly proportional to the volume of the soil which is loosened by activities like tillage and inter-cultivation (T. Bhattacharyya et al., 2010). This makes it suitable for climate change mitigation. As also seen in the case, the production of the farmers has increased to a great extent without harming the environment. Conservation Agriculture not only enhances the organic matter in the soil, make it less vulnerable to soil erosion which is also an imminent problem in the region, and also is cost efficient for farmers who can save their cost of production of tilling the land thus making CA a cost friendly technique (U.K. Behera, 2014). The farmers, especially the small and marginal ones, who are struggling with mounting costs of inputs/production can look forward to this practice to reduce the cost of production and yet increase their productivity in a sustainable manner. The only possible way to scale the innovation will be to overcome the site specificity of the innovation and also introudce implements which are needed for the reduction of drudgery of the farmers in activities such as bed making, seed sowing, and management of weeds that occur in the field.

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U.K. Behera, S. B. (2014). Conservation agriculture in India – Problems, prospects and policy issues. *International Soil and Water Conservation Research, Vol 2, No. 4*, 1-12.

Annexure

Annexure 1: List of Farmers under the CA Intervention

Sl. No	Name of Village	Name of farmer	Crops
1	Dawali	Raadhu /Roomalsingh	Maize
2	Dawali	Heera Singh /Sheetaram	Maize
3	Dawali	Bishram /Saanu	Maize
4	Dawali	Chandarsingh /Sukharam	Maize
5	Dawali	Ramkishan / Moutiram	Maize
6	Dawali	Premsingh/Lotiya	Maize
7	Sajni	Ramsingh / Babu	Maize
8	Dawali	Aasharam /Roomalsingh	Maize
9	Dawali	Mangilal /Sekadiya	Maize
10	Dawali	Ramesh /Mugalsingh	Gram
11	Dawali	Amarsingh / Mouti	Gram
12	Dawali	Suneel / Shaimal	Gram
13	Dawali	Shivram /Saanu	Gram
14	Dawali	Munshi /Omkaar	Gram
15	Dawali	Anil / Ramlal	Gram
16	R-Kala	Bashantkumar /Kanhaiyalal	Gram

Annexure 2: No of Farmers under the CA Innovation in Nemar Region of MP

Particulars	2014	2015	2016	Total
No. of Villages	3	10	10	23
No. of Farmers	14	27	43	84
Test site	0	8	16	24
Demo Site	14	19	27	60
Adaptation plot	0	0	30	30

Annexure 3: Different Indicators which were Measured under the CA Intervention

Indicator	Maize	Gram	Wheat
No. of Irrigation			
Seeds rate			
Number of branches per plant	–		–
Number of leaves per plant		–	–
Number of tillers per plant	–	–	
No. of healthy plants per mtsq			
No. of unhealthy plants per mtsq			
Yield (Kg/m^2)			
Height of plant (cm)			
Production per 200 Sq. mt. (Kg)			
Above Ground Biomass (g/ plant)			
Av. Biomass Yield (Kg/200 ^{mt2})			
Total cost			
Total income			
Net income			

Annexure 4: Average Cost Incurred in Maize Production by the Farmers

Process	CT+SRI plot	CA+SRI plot
Sowing	960	960
Land preparation	78	50
Irrigation	200	144
Intercultural Operation	667.22	567.22
Harvesting and threshing	238.5	238.5
Total incurred cost (Rs)	2143.72	1959.72
Cost/acre (Rs)	4,819.75	4,406.46
Total selling price @ Rs. 1200/qt (rs)	1428	2304
Cost- Benefit ratio @ selling price of Rs. 1200/qt	1:0.66	1:1.17
Total selling price @ Rs. 1650/qt (rs)	1963.5	3168
Cost- Benefit ratio @ selling price of Rs. 1650/qt	1:0.91	1:1.61

Annexure 5: Cost of Production in Gram

Process	CT+SRI plot	CA+SRI plot
Sowing	802	802
Land preparation	78	0
Irrigation	150	100
Intercultural Operation	583.25	483.25
Harvesting and threshing	159	159
Total incurred cost (Rs)	1772.25	1544.25
Cost/acre (Rs)	5,123	4,464
Total selling price @ Rs. 4000/qt (rs)	1280	1920
Cost- Benefit ratio @ selling price of Rs. 4000/ qt	1:0.72	1:1.24
Total selling price @ Rs. 4600/qt (rs)	1472	2208
Cost- Benefit ratio @ selling price of Rs. 4600/ qt	1:0.83	1:1.42

Annexure 6: Detail of the Okra Vegetable under CA

S. No.	Method	Name of farmer	Village	Variety	Seed rate, in kg	% difference in seed rates	Actual yield of 100 sq. m. in kg	Representative yield (kg/acre)	% change in yield
1	CA+SCI	Ishwarbhai Babubhai Patel	Holipada	Samrat	0.50	71.4	139.9	5595.2	122.7
	Control			Samrat	0.70	100.0	114.0	4560.0	100.0

Annexure 7: Details of Onion under CA

S. No.	Method	Name of farmer	Villagew	Variety	Actual yield of 100 sq. m. in kg	Representative yield (kg/acre)	% change in yield
1	CA+SCI	Ramanbhai Ganaptbhai Chidhri	Amsarpada	Traditional	164.7	6588	108.7
	Control			Traditional	151.5	6060	100.0

Annexure 8: Field Results of Gram in Different villages

S. No.	Method	Name of farmer	Village	Variety	Seed rate, in kg	% difference in seed rates	Actual yield of 100 sq.m.	Representative yield (kg/acre)	% change in yield
1	CA+SCI	Sureshbhai Vanalbhai chidhri	Gaurya	GG 1	0.31	45.6	9.50	380.0	155.7
	Control			GG1	0.68	100.0	6.10	244.0	100.0
2	CA+SCI	Ramanbhai Somanbhai Gavint	Raochond	GG 1	0.25	66.7	5.80	232.0	184.1
	Control			GG1	0.38	100.0	3.15	126.0	100.0
3	CA+SCI	Khundubhai Chimanbhai	Ghodvahal	GG 3	0.30	85.7	10.32	412.8	113.4
	Control			GG 3	0.35	100.0	9.10	364.0	100.0
4	CA+SCI	Sureshbhai Jatarbhai Hiliyam	Jharan	GG 3	0.30	42.9	29.20	1168.0	133.9
	Control			GG 3	0.70	100.0	21.80	872.0	100.0
5	CA+SCI	Chagganbhai	Machaddi	GG 1	0.25	37.9	4.88	195.2	169.4
	Control			GG1	0.66	100.0	2.88	115.2	100.0

Annexure 9: Details of Intervention in Dangs for Different Crops in Rabi - 2015

Particulars	**Traditional**	**CA+SCI**	**Traditional**	**CA+SCI**	**Traditional**	**CA+SCI**
Crop	Okra		Onion		Chickpea	
Sowing on	Flat bed	Raised bed	Flat bed	Raised bed	Flat bed	Raised bed
Sowing method	Random point placement	Square geometry sowing	Random transplanting	Square geometry transplanting	Broadcasting	Square geometry sowing
Planting/Sowing space	60*5-15 cm	50*50 cm	15-20*7-12cm (no symmetry)	25*25cm	Broadcasting	25*25
Seedling age	NA	NA	30 days	30 days	NA	NA
Seed treatment	Not done	Amrit Pani with 1 % solution	Not done	Seedling root treatment with 1% Amrit Pani	not done	Amrit Pani with 1 % solution
Mulching Material	NA	Dry leaves of local trees	NA	Rice Husk	NA	Rice straw
Nipping*	NA	30 days	NA	NA	Not done	25 and 45 DAS

Note: FP = Farmer's Practice; CA= Conservation Agriculture, SRI= System of Root Intensification