Knowledge and Adoption of Conservation Agriculture Technologies by the Farming Community in Different Agro-Climatic Zones of Tamilnadu State in India

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Abstract

Tamilnadu State in India is one of the earlier beneficiaries of Green Revolution which contributed to multifold increase in agricultural productivity. Though the State has been progressive, it has also experienced the ill effects of over exploitation of natural resources through intensive agriculture. There is an urgent need to shift its focus from over exploitative intensive farming to more sustainable farming with optimal use of resources without causing imbalances. Conservation Agriculture (CA) offers potential solution which not only enhances the productivity but also maintains the environmental safety and ecological sustainability. With this at the backdrop, the present study was conducted during 2013-2014 in all the seven agro-climatic zones of Tamilnadu State in India covering 350 respondents to understand the knowledge and adoption levels of Conservation Agriculture among the farming community in the State. Three Conservation agricultural technologies namely, Minimum Tillage, Crop Rotation and Permanent Soil Cover were identified. Knowledge of the farmers about these technologies and their adoption by the farmers were studied. As regards the awareness and knowledge level of respondents majority of them do not have knowledge on minimum tillage (72.6%) and permanent soil cover (75.1%) but a vast majority is knowledgeable on crop rotation (71.1%). Farmer characteristics such as age, educational status and innovativeness of farmers played a significant impact on the knowledge levels of CA whereas number of years of experience in farming and land holding pattern did not have significant influence on the knowledge levels of farmers on CA. Among the knowledgeable farmers only 11.5% of farmers adopted minimum tillage, 27.6% of farmers adopted permanent soil cover and 78% adopted crop rotation. None of the farmers adopted CA as a whole comprising all the three components.

Keywords: minimum tillage, permanent soil cover, crop rotation, knowledge, adoption, conservation agriculture, agro-climatic zones, Tamilnadu, India

1. Introduction

The urge to increase the food grain production to feed the growing population has led to Intensive agriculture in India through Green Revolution. While the agriculture productivity increased multifold, the associated problems like over exploitation of natural resources, environmental degradation and imbalance in biodiversity etc have caused serious concerns about sustainability of such production systems. Moreover, there has been a paradigm shift from mere sustenance and production oriented agriculture in early 60's and 70's to systems oriented agriculture after 2000. A search for alternative solution which is environmentally safe, ecologically sustainable and yet economically profitable was made by all the stakeholders like farmers, scientists, government and civil society organizations. A set of soil-crop-nutrient-water-landscape system management practices known as Conservation Agriculture (CA) offers potential solution which not only enhances the productivity but also maintains the environmental safety and ecological sustainability. Conservation Agriculture (CA) is an approach to manage agro eco systems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment (FAO, 2011).

The key elements or practices which characterize CA include: (i) minimum soil disturbance by adopting minimum tillage and traffic for agriculture operations (ii) leave and manage the crop residues on the soil surface and (iii) adopt spatial and temporal crop sequencing/crop rotations to derive maximum benefits from inputs and minimize adverse environmental impacts (Abrol & Sangar, 2006). The adoption of CA practices however faces many barriers viz., mindset, know how, machineries and policies (Derpsch et al., 2012).

Tamilnadu state, one of the earlier adopters of intensive agriculture through Green Revolution has also become a victim of it in terms of environmental degradation, loss of natural resources and the other associated ill effects. There is an urgent need to correct this in order to ensure the long term sustainability of farming for which CA offers potential solution. Though CA is relatively new concept, it has found an important place in global agriculture including India. It has also been practiced extensively in Indo Gangetic Plains which was the seat of success of Green Revolution. Similarly CA is relevant to Tamilnadu, which was one of the early adopters of Green Revolution. However, not much of work has been reported on CA in Tamilnadu. In view of the above, the present study was intended to explore the penetration of CA technologies among the farming community across Tamilnadu State and also to study the Knowledge of Conservation Agriculture technologies as a package, its suitability and adoption at all the seven agro-climatic zones of Tamilnadu.

2. Methodology

Tamilnadu State has been classified into seven agro-climatic zones. The study was conducted in all the seven agro-climatic zones covering entire Tamilnadu State which included North Eastern Zone, North Western Zone, Western Zone, Cauvery Delta Zone, Southern Zone, High Rainfall Zone and Hilly Zone. It is assumed that CA is common irrespective of different agro-climatic zones and is hypothesized that there has not been much awareness and knowledge on CA in Tamilnadu and the present study is intended to investigate the same. Since, each of the agro-climatic zones is characterized by unique climate, rainfall, cropping systems and cropping patterns the present research was intended to study the knowledge and adoption of conservation agriculture. The study was conducted in 2013-2014. The study area was selected in such a way that in each of the agro-climatic zones, the blocks where annual crops are predominantly cultivated were selected as conservation agriculture is more applicable and relevant to those cropping pattern where intensive agriculture throughout the year is practiced.

From the selected blocks, study villages were selected by simple random sampling. Since the cropping pattern was almost uniform across each of the agro-climatic zones as per the secondary data, one block per agro-climatic zone was randomly selected irrespective of the number of blocks present in the zone. The respondents were selected using simple random sampling method. Totally three hundred and fifty respondents were randomly selected in seven agro-climatic zones at fifty respondents in each of the agro-climatic zone.

Data was collected with the use of a well structured and pre- tested interview schedule. The data thus collected were statistically analysed using SPSS package.

2.1 Brief about the Study Area

The districts where the study was conducted in each of the agro-climatic zones is summarized below.

2.1.1 Kancheepuram District–North Eastern Zone

Kancheepuram district is situated on the North East coast of Tamil Nadu. It lies between 11°00′ to 12°00′ latitudes and 77°28′ to 78°50′ longitudes. The district has a total geographical area of 4,43,210 hectares and a coastline of 57 km. the district has the maximum temperature of 45 °C and a minimum of 21.1 °C during summer and a maximum of 28.7 °C and a minimum of 14 °C in winter. The district is mainly dependent on the monsoon rains. During normal monsoon, the district receives a rainfall of 1200 mm.

2.1.2 Dharmapuri District–North Western Zone

Dharmapuri district is situated in the North western Corner of Tamil Nadu. It is located between latitudes N 11°47′ and 12°33′ and longitudes E 77°02′ and 78°40′. The total geographical area of Dharmapuri District is 4497.77 Sq Kms. The climate of the Dharmapuri District is generally warm with the maximum temperature touching 38 °C. and minimum of 17 °C. On an average the District receives an annual rainfall of 895.56 mm. The District economy is mainly agrarian in nature. It has a total gross cropped area of 1.69 lakh hectares. Millets, pulses and Paddy are the main crops

2.1.3 Theni District–Western Zone

The district lies at the foot of the Western Ghats between 9°39′ and 10°30′ North latitude and between 77°00′ and 78°30′ of East Longitude. In the plains, the temperatures range from a minimum of 13 °C to a maximum of 39.5 °C. In the hills the temperatures can range from as low as 4-5 °C to 25 °C. The district is known for its salubrious climate, hills and lakes. Its economy is mostly agricultural. Utilization of land area for cultivation in Theni district is 40.33%. The principal crops include sugarcane, cotton, paddy, millets and pulses.

2.1.4 Sivaganga District–Southern Zone

The district of Sivagangai, extending over an area of 4468.11 Sq. Km, is situated in the southeastern portion of the state. The district lies between 9°43′ and 10°2′ north latitude and 77°47′ and 78°49′ east Longitude. Temperature is low during the month of January and the lowest mean daily temperature is 19.8 °C. The hottest month in the district is July during which period the maximum temperature is 33.83 °C. Mean humidity varies from 65% in July to 77% in November. The average rainfall of the District is below 800 mm. The principal crop of Sivaganga district is paddy. The other crops that are grown are millets, cereals, pulses, sugarcane, and groundnut.

2.1.5 Thanjavur District–Cauvery Delta Zone

Thanjavur District lies in the East Coast of Tamil Nadu. It is located between 90°50′ and 110°25′ of the northern latitude and 70°25′ and 78°45′ of the Eastern longitude. In Thanjavur district brown coloured soil was the maximum constituting nearly 65%. Red soil and black soils were found in 19.30 and 15.97 percent of the area respectively. The climate of Thanjavur can be termed as a fairly healthy one like other coastal areas. The South-West monsoon sets in June and continues till September followed by North-East monsoon in October upto January. The total gross cropped area is 2.41 lakh hectares. The major crops of the district are Paddy, Pulses, Sugarcane, Groundnut, Gingelly, Cotton and Coconut.

2.1.6 Dindigul District–Hilly Zone

Dindigul District is located between 10°05′ and 1°09′ North Latitude and 77°30′ and 78°20′ East Longitude.The district has a net sown area of 2.53 lakh hectares. The major crops of the district are Paddy, Maize, Sugarcane, Pulses and Cotton.

2.1.7 Kanyakumari District–High Rainfall Zone

The district lies between 77°15′ and 77°36′ of the eastern longitudes and 8°03′ and 8°35′ of the northern latitudes. The district has a gross cropped area of 0.92 lakh hectares. The major soil type in the district is Red soil (65,608 ha), which constituted about 67% of the total cultivated area. Lateritic soil (20,003 ha) is the next major soil type, which formed 22% of the total cultivated area in the district.

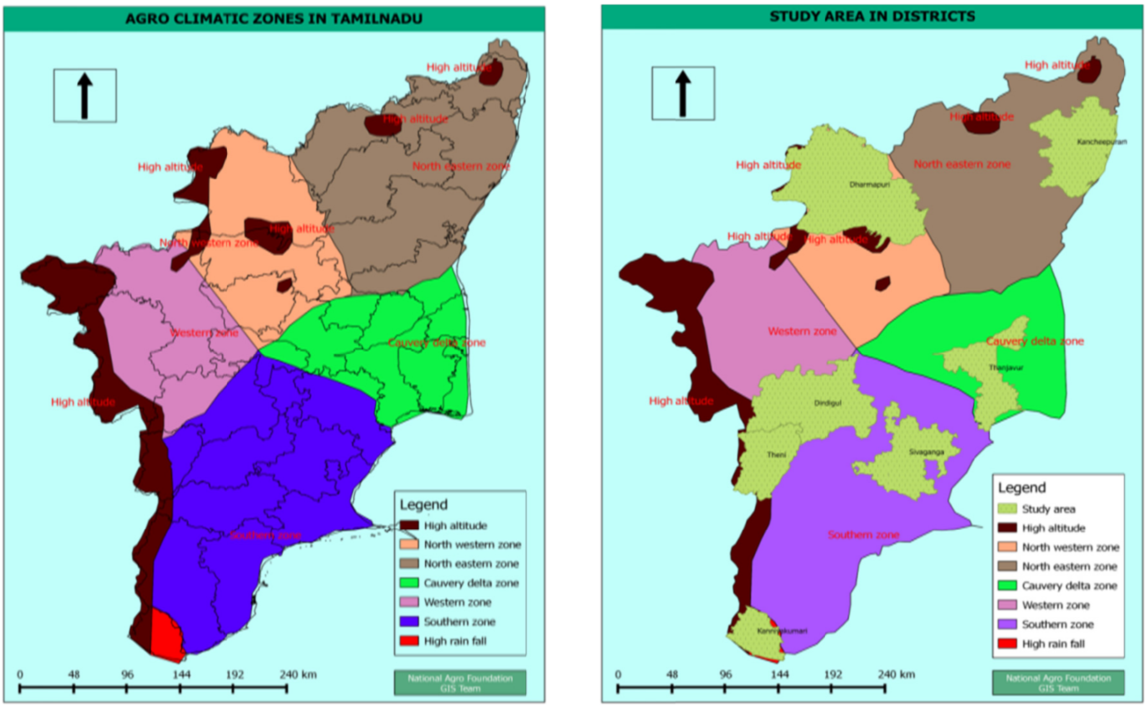

Figure 1. Map of agro-climatic zones of tamilnadu and study area districts

Table 1. Agro-climatic zone wise distribution of districts and the blocks

S No	Name of the agro-climatic zone	Districts covered	No. of blocks
1	North Eastern Zone	Kancheepuram, Tiruvallur, Cuddalore, Vellore, Villupuram and Tirunvannamalai	100
2	North western Zone	Dharmapuri, Krishnagiri, salem and Namakkal (Part)	53
3	Western Zone	Erode, Coimbatore, Tiruppur, Theni, Karur (part), Namakkal (part), Dindigul, Perambalur and Ariyalur (part)	60
4	Southern zone	Madurai, Sivagangai, Ramanathapuram, Virudhunagar, Tirunelveli and Thoothukudi.	78
5	Cauvery Delta Zone	Thanjavur, Nagapattinam, Tiruvarur, Trichy and parts of - Karur, Ariyalur, Pudukkottai and Cuddalore	74
6	Hilly zone	The Nilgiris and Kodaikanal (Dindigul)	5
7	High rainfall zone	Kanyakumari	9

Table 2. Agro-climatic zone wise distribution of districts and the blocks under study

S No	Name of the agro- climatic zone	Name of the district under study	Name of the block under study
1	North Eastern Zone	Kancheepuram	Chitamur block
2	North Western Zone	Dharmapuri	Pappireddypatti
3	Western Zone	Theni	Vadugapatti and Cumbum
4	Southern Zone	Sivaganga	Thirupathur
5	Cauvery Delta Zone	Thanjavur	Ammapettai
6	Hilly Zone	Dindigul	Poomparai
7	High Rainfall Zone	Kanyakumari	Karungal

Note. The map of the study area is depicted in Figure 1.

2.2 Selection of Dependent and Independent Variables

The critical analysis of the study, its meaningful interpretation and relevant conclusion could be brought out only when relevant dependent and independent variables are selected and the measurement of variables is appropriately followed. By reviewing the literature, discussion with extension scientists, freewheel discussions conducted and by observations made by the researcher in the initial stages twenty three independent variables which may influence the dependent variables of the study were selected. A letter was sent to ten extension scientists of the State Agriculture Universities for the selection of relevant variables. The judges were requested to indicate the relevancy rating on a three-point continuum. The scores of 3, 2 and 1 were assigned for the "More relevant", "Relevant" and "Irrelevant" responses respectively.

Based on the rating and judgments by the judges, the mean and coefficient of variation were worked out for all the independent variables. The overall mean and coefficient of variation were also worked out. The individual variables with mean scores greater than the overall mean score were selected. Thus five independent variables were finally selected and included for the study. The dependent variables selected for the study were knowledge and extent of adoption.

2.3 Measurement of Variables

2.3.1 Age

The chronological age of the respondents during the time of interview was operationalized as age. The age of the respondents in completed years was considered for analysis. The classification developed by Arunmozhidevi (2004) and adopted by Vijayalakshmi (2012) was followed.

Table 3. Age

S No	Category	Score
1	Young (18-35 years)	1
2	Middle (36-50 years)	2
3	Old (above 50 years)	3

2.3.2 Educational Status

It referred to the level of literacy of the respondent during the interview. The categories were illiterate, functionally literate, primary education, middle education, secondary education and college education. The respondents who could not read and write were categorized as illiterate. The respondents who could read and write were considered as functionally literate. Primary education refereed to the formal school education upto fifth standard. Middle education referred to formal school education upto eighth standard. Secondary education referred to the formal education upto plus two or junior college level. Collegiate education meant the education as diploma/degree after schooling. The following scoring procedure developed by Mansingh (1993) was followed to arrive at a score on educational status of the respondents.

Table 4. Educational status

S No	Category	Score
1	Illiterate	1
2	Functionally literate	2
3	Primary education	3
4	Middle education	4
5	Secondary education	5
6	College education	6

2.3.3 Experience in Farming

It was operationalized as the number of years of experience in farming possessed by the respondents during interview. The scoring procedure adopted by Puthiraprathap (2003) was used.

Table 5. Experience in farming

S No	Category	Score
1	Upto 10 years	1
2	11 – 20 years	2
3	Above 20 years	3

2.3.4 Farm Size

Farm size referred to the extent of land cultivated by an individual at the time of enquiry. The area was directly taken as a measure and categorized into three by using the following scoring procedure as adopted by Puthirapratap (2003).

Table 6. Farm size

S No	Category	Area	Score
1	Marginal farm	Less than 2.5 acres	1
2	Small farm	Between 2.51-5.0 acres	2
3	Big farm	More than 5.0 acres	3

2.3.5 Innovativeness

Innovativeness was operationalized as the degree to which an individual is relatively earlier in adopting a new idea or technology. The scoring procedure developed by Singh (1972) and used by Santhi (2006) was followed to measure innovativeness.

Table 7. Innovativeness

Question: When would you prefer to adopt any improved technology?		
S No	**Answer**	**Score**
1	As soon as it was brought to my knowledge	3
2	After seeing other farmers have done it successfully	2
3	I prefer to wait and take my own time	1

3. Results and Discussion

3.1 Profile of the Respondents

3.1.1 Age

Table 8. Distribution of respondents according to their age (n = 350)

S No	Category	Frequency	Percentage
1	Young (< 35 years)	74	21.1
2	Middle (35-45 years)	101	28.9
3	Old (> 45 years)	175	50.0
4	Total	350	100.0

The categorization of respondents as per their age is presented in Table 8. The respondents were categorized as young (18 to 35 years of age), middle aged (36-45 years) and old aged (more than 45 years of age). Old aged farmers form the majority (50%) closely followed by middle aged (28.9%). Young farmers were only 21.1% which shows that majority of the youth are not attracted to farming.

3.1.2 Educational Status

Table 9. Distribution of respondents according to their educational status (n = 350)

S No	Category	Frequency	Percentage
1	Functionally Literate	63	18.0
2	Primary	113	32.3
3	Middle	88	25.1
4	Secondary	52	14.9
5	Graduate	34	9.7
	Total	350	100.0

The categorization of respondents according to their educational status is presented in Table 9 as educational status tend to influence the knowledge and adoption of new technologies like CA. Accordingly, majority of the respondents had primary education (32.3%) followed by middle level education (25.1%). The proportion of respondents under secondary and college education category was 14.9% and 9.7% respectively.

3.1.3 Experience in Farming

Table 10. Distribution of respondents according to their experience in farming (n = 350)

S No	Category	Frequency	Percent
1	Low (up to 10 years)	86	24.6
2	Medium (10-20 years)	90	25.7
3	High (> 20 years)	174	49.7
	Total	350	100.0

Experience in farming is an important farmer characteristic which helps farmers in evaluating the usefulness of any new technology based on their past experiences and thus influences the decision making of farmers about a particular technology. The categorization of respondents according to their experience in farming is presented in Table 10. Accordingly, about half of the farming community (49.7%) had rich experience of farming over 20 years. Respondents with low and medium level of farming experience were almost equal which is 24.6% and 25.7% respectively.

3.1.4 Land Holding Pattern

Table 11. Distribution of respondents according to their farm size (n = 350)

S No	Category	Frequency	Percent
1	Marginal & Small (< 2.5 ac)	164	46.9
2	Medium (2.5-5 ac)	109	31.1
3	Large (> 5 ac)	77	22.0
	Total	350	100.0

The categorization of respondents as per the land holdings are presented in Table 11. Accordingly, majority of the respondents (46.9%) fall under the category of marginal farmers with land holding upto 2.5 acres whereas 31.1% of the respondents were under medium land holding category of 2.51-5.0 acres. Big farmers formed only 22.0%.

3.1.5 Innovativeness

Table 12. Distribution of respondents according to their innovativeness (n = 350)

S No	Category	Frequency	Percentage
1	Low	177	50.6
2	Medium	124	35.4
3	High	49	14.0
	Total	350	100.0

Innovativeness is a key farmer characteristic which influences the degree of speed with which a new technology is acknowledged and adopted by a farmer. Mostly, innovativeness is an inherent character of the farmer which further decides the risk taking ability as well as decision making ability. Table 12 presents the distribution of respondents based on their innovativeness. It shows that more than half of the respondents (50.6%) had low level of innovativeness as they preferred to take their own time to adopt a new technology. Only 14.0% of the respondents had high level of innovativeness as they wished to adopt any new technology as soon as they knew about it.

The low level of innovativeness may be due to the fear of failure of adoption of innovative technologies. Moreover, since majority of them are small and marginal farmers with agriculture being the prime occupation, the respondents tend to take minimum risk, which is also one of the reasons for low level of innovativeness.

3.2 Knowledge and Adoption of CA

3.2.1 Knowledge Level of the Respondents on Conservation Agriculture Practices

CA Being a new technology, the present study attempted to capture information on level of knowledge of respondents on individual components of CA as well as CA as a whole. The findings of the study are presented below.

1) Knowledge level on minimum tillage

The following table presents the findings on the distribution of respondents based on the knowledge level of minimum tillage as a conservation agriculture practice.

Table 13. Distribution of respondents according to their knowledge level on minimum tillage (n = 350)

S No	Level of knowledge	Frequency	Percentage
1	No Knowledge	254	72.6
2	Knowledgeable	96	27.4
	Total	350	100.0

The data presented above indicate that about three fourth of the respondents (72.6%) had low or no knowledge level on minimum tillage practices. About 27.4% of the respondents had medium level of knowledge on minimum tillage. The respondents with medium level of knowledge were predominantly followers of sustainable agriculture and organic farming practices.

Majority of the respondents followed conventional farming with intensive tillage and they continue to practice the same as they do not have any knowledge on minimum or zero tillage. Usharani and Neelu (2011) had earlier reported similar views with low level of knowledge on minimum tillage.

2) Knowledge of permanent soil cover

The level of knowledge of the respondents on permanent soil cover is presented in below.

Table 14. Distribution of respondents according to their level of knowledge on permanent soil cover (n = 350)

S No	Level of knowledge	Frequency	Percentage
1	No knowledge	263	75.1
2	Knowledgeable	87	24.9
	Total	350	100.0

The results of the data from the above Table reveal that about 24.9% of the respondents had medium knowledge on permanent soil cover with stubbles and crop mulches. A very high proportion of respondents (75.1%) did not have proper on permanent soil cover. Only a small proportion of respondents followed mulching as they were predominantly sugarcane growers and covering the soil with sugarcane trashes as advised by the sugar mills. A portion of respondents were also growers of perennial crops like mango who normally had some cover crops in the initial stages to control the weeds as well as to earn income during the initial gestation periods of the perennial crops.

The reason for very low levels of awareness and knowledge on minimum tillage and permanent soil cover may be due to the fact that these were relatively new technologies and no agency had ever introduced these technologies to them. However, these findings were in contrast with the findings of Mazvimavi et al. (2010).

3) Crop rotation

The level of knowledge knowledge of the respondents on crop rotation is presented in the below.

Table 15. Distribution of respondents according to their knowledge on crop rotation (n = 350)

S No	Level of knowledge	Frequency	Percentage
1	No knowledge	101	28.9
2	Knowledgeable	249	71.1
	Total	350	100.0

As far as the third conservation agriculture practice viz., crop rotation is concerned, the data from Table 15 shows that a vast majority of respondents (71.1%) expressed that they are knowledgeable about crop rotation. However, it was also observed that about one fourth (28.9%) of the respondents did not have knowledge on crop rotation.

The reason for high level of knowledge on crop rotation may be due to the fact that crop rotation has been an age old practice in the study area and is being followed for generations together. Moreover, farmers expressed that following crop rotations is beneficial for maintaining the soil fertility and management of pests. These findings are in line with the findings of Nyanga et al. (2011).

4) Overall knowledge on conservation agriculture

The distribution of respondents based on their knowledge levels on conservation agriculture as a whole is presented below.

Table 16. Distribution of respondents according to their overall knowledge on CA (n = 350)

S No	Category	Frequency	Percentage
1	Low	164	46.9
2	Medium	96	27.4
3	High	90	25.7
	Total	350	100.0

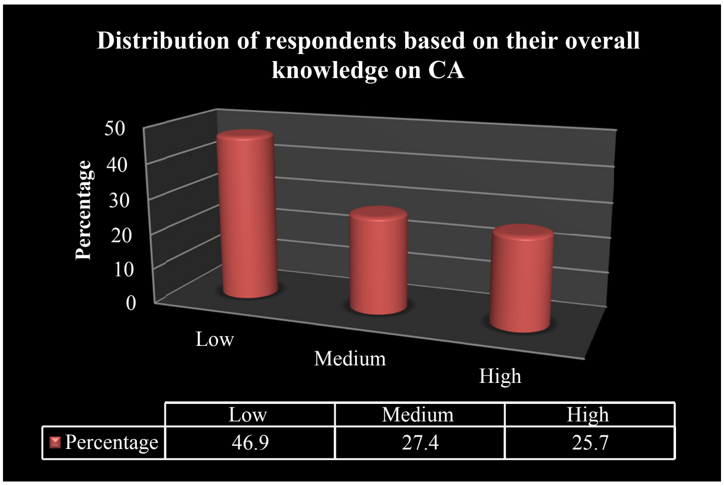

Figure 2. Distribution of respondents based on their overall knowledge on CA

The findings from the Table above give a picture of overall knowledge of respondents on CA comprising minimum tillage, permanent soil cover and crop rotation as a whole. It indicates that about 46.9% of the respondents have low level of knowledge on CA. While 27.4% of the respondents have medium level of knowledge on CA, about 25.4% of the respondents have high knowledge level on CA. The findings presented above clearly indicate that about half of the respondents had only lower levels of knowledge on CA. Only one fourth of the respondents had higher levels of knowledge on CA. Though majority of the respondents do not have knowledge on minimum tillage and permanent soil cover, the high level of knowledge on crop rotation reflects on the overall knowledge on CA as a whole with about 53.1% of respondents knowledgeable about it. These findings find support from the findings of Usharani and Neelu (2011).

3.3 Relationship between the Socio-Economic and Psychological Characteristics of the Respondents and Their Knowledge Level on CA

The following section deals with the relationship of socio-economic and psychological characteristics of respondents and their knowledge level of conservation agriculture.

3.3.1 Distribution of Respondents Based on Their Socio-Economic and Psychological Characteristics and Knowledge Level

1) Age

The age wise distribution of respondents based on their knowledge on CA practices is presented in the Table below.

Table 17. Age wise distribution of respondents based on knowledge level of CA

S No	Category of age	Level of Knowledge on CA			Total	Chi square value	P value
		Low	Medium	High			
1	Young	33 (44.6%) [20.1%]	24 (32.4%) [25.0%]	17 (23.0%) [18.9%]	74	12.607	0.013*
2	Medium	50 (49.5%) [30.5%]	35 (34.7%) [36.5%]	16 (15.8%) [17.8%]	101		
3	Old	81 (46.3%) [49.4%]	37 (21.1%) [38.5%]	57 (32.6%) [63.3%]	175		

Note. The value within ( ) refers to Row Percentage; The value within [ ] refers to Column Percentage; ** denotes significance at 1% level; *denotes significance at 5% level.

The results from the above table shows that P value is significant at 5% indicating that there exists a relationship between age and level of knowledge of CA. About 44.6% of young farmers had low level of knowledge on CA whereas 32.4% and 23.0% of young farmers had medium and high level of knowledge on CA. Among middle aged farmers, 49.5% had low, 34.7% had medium and 15.8% had high level of knowledge of CA. About 46.3% of old aged farmers had low level of knowledge on CA whereas 21.1% and 32.6% had medium and high level of knowledge on CA.

Among various categories of farmers, old aged farmers had significantly higher level of knowledge on CA than other categories at 5% level. This may be due to the fact that the some of the CA practices like crop rotation were part of the traditional Indian agriculture and since majority of the farmers were old aged, their knowledge levels on traditional agriculture would be high and so the knowledge on CA.

Hussain et al. (2010) and Mugo (2012) had reported similar views in the past as that of current findings.

2) Educational status

The distribution of respondents on knowledge of CA based on their educational levels is summarized in the Table below.

Table 18. Distribution of respondents based on their educational status and level of knowledge on CA

S No	Educational Category	Level of Knowledge on CA			Total	Chi square value	P value
		Low	Medium	High			
1	Functionally literate	29 (46.0%) [17.7%]	18 (28.6%) [18.8%]	16 (25.4%) [17.8%]	63		
2	Primary	63 (55.8%) [38.4%]	31 (27.4%) [32.3%]	19 (16.8%) [21.1%]	113		
3	Middle	42 (47.7%) [25.6%]	25 (28.4%) [26.0%]	21 (23.9%) [23.3%]	88 (100.0%)	17.985	0.021*
4	Secondary	20 (38.5%) [12.2%]	15 (28.8%) [15.6%]	17 (32.7%) [18.9%]	52 (100.0%)		
5	Graduate	10 (29.4%) [6.1%]	7 (20.6%) [7.3%]	17 (50.0%) [18.9%]	34 (100.0%)		

Note. The value within ( ) refers to Row Percentage; The value within [ ] refers to Column Percentage; ** denotes significance at 1% level; *denotes significance at 5% level.

The data from the Table 18 above indicate that there existed an association between educational status of the respondents and their level of knowledge on CA, since the P value is significant at 5%. Among the functionally literate group of farmers, 46.0% had low level of knowledge on CA whereas 28.6% had medium and 25.4% had high level of knowledge on CA.

Among the respondents with primary education, 55.8% had low level of knowledge on CA and 27.4% and 16.8% had medium and high level of knowledge on CA respectively. Among the respondents with middle level of education 47.7% had low, 28.4% had medium and 23.9% had high level of knowledge in CA. Among the group of respondents with secondary education, 38.5% had low level, 28.8% had medium and 32.7% had high level of knowledge on CA. Among the graduate farmers 29.4% had low, 20.6% had medium and 50.0% had high level of knowledge on CA. The results also indicated that the respondents with higher educational status had significantly higher level of knowledge on CA than the other categories.

Education tended to improve the knowledge level of any new technologies as they get access to information through various sources like print media. Moreover, better educational status of the respondents was likely to increase their contacts with various sources of information like extension agencies. In addition to this, with increased educational levels, farmers tended to explore various sources of information with their inherent ability to assimilate new technologies. This might have resulted in higher knowledge of CA with respect to higher educational status of the respondents though the proportion of highly educated respondents is low. These findings were in line with the findings of Hussain et al. (2010), Chiputwa et al. (2011), Uaiene (2011), and Mugo (2012).

3) Experience in farming

The study on relationship of respondents with respect to their experience and level of knowledge on CA was analysed and respondents were categorized accordingly. The categorization of farmers with respect to their level of knowledge and their experience in farming is presented in the following Table.

Table 19. Distribution of respondents based on their experience in farming and level of knowledge on CA

S No	Category of experience	Level of Knowledge on CA			Total	Chi square value	P value
		Low	Medium	High			
1	Low	42 (48.8%) [25.6%]	29 (33.7%) [30.2%]	15 (17.4%) [16.7%]	86	7.513	0.111
2	Medium	45 (50.0%) [27.4%]	25 (27.8%) [26.0%]	20 (22.2%) [22.2%]	90		
3	High	77 (44.3%) [47.0%]	42 (24.1%) [43.8%]	55 (31.6%) [61.1%]	174		

Note. The value within ( ) refers to Row Percentage; The value within [ ] refers to Column Percentage; ** denotes significance at 1% level; *denotes significance at 5% level.

It could be understood from the data presented in Table 19 that among those respondents with lesser experience in farming, 48.8%, 33.7% and 17.4% of the respondents have low, medium and high level of knowledge on CA respectively. 50.0%, 27.8% and 22.2% of the respondents with medium experience in farming have low, medium and high level of knowledge on CA respectively. Among farmers with rich experience in farming, 44.3% have low level of knowledge on CA whereas 24.1% and 31.6% have medium and high level of knowledge on CA. Since the P value is insignificant (0.111) at all levels, it could be inferred that there is no significant association between experience in farming and level of knowledge on CA among various categories of the respondents. The findings of FAO (2001) which was confirmed by Mugo (2012) are in line with the observations of the current study.

4) Land holding pattern

The distribution of respondents with respect to their knowledge on CA among various categories of respondents based on their land holding pattern is presented in the following Table 20.

Table 20. Distribution of respondents based on their landholding and level of knowledge on CA

S No	Category of farmers	Level of Knowledge on CA			Total	Chi square value	P value
		Low	Medium	High			
1	Marginal	87 (53.0%) [53.0%]	49 (29.9%) [51.0%]	28 (17.1%) [31.1%]	164	18.600	0.163
2	Small	51 (46.8%) [31.1%]	29 (26.6%) [30.2%]	29 (26.6%) [32.2%]	109		
3	Big	26 (44.3%) [15.9%]	18 (24.1%) [18.8%]	33 (31.6%) [36.7%]	77		

Note. The value within ( ) refers to Row Percentage; The value within [ ] refers to Column Percentage; ** denotes significance at 1% level; *denotes significance at 5% level.

From the data from the Table 20, it could be noted that 53.0% of the respondents with marginal land holding have low level of knowledge on CA whereas 29.9% and 17.1% of the marginal farmers category have medium and high level of knowledge on CA. among the small farmers category, 46.8% have low level of knowledge, 26.6% have medium and high level of knowledge on CA respectively. Among big farmers, 44.3% have low knowledge on CA whereas 24.1% of respondents have medium knowledge and 31.6% have high knowledge on CA. Since P value is insignificant, it could be inferred that there is no significant relationship between knowledge on CA and various categories of farmers based on their land holding pattern. The reason for the above trend might be due to the fact that acquisition of knowledge and information is primarily a farmer characteristic and not a farm characteristic.

Though the size of the land holding may influence the acquisition of in depth knowledge and the adoption of acquired knowledge, the overall awareness and knowledge on new technologies like CA may not dependent on the size of the land holding as irrespective of land holding farmers tend to increase their profitability and long term sustainability of farming. This is in line with the findings of McRobert and Rickards (2010).

5) Innovativeness

The following table presents the distribution of respondents among various categories of their innovativeness with respect to level of knowledge on CA.

Table 21. Distribution of respondents based on their innovativeness and level of knowledge on CA

S No	Category of farmers	Level of Knowledge on CA			Total	Chi square value	P value
		Low	Medium	High			
1	Low	37 (75.5%) [22.6%]	8 (16.3%) [8.3%]	4 (8.2%) [4.4%]	49		
2	Medium	64 (36.2%) [39.0%]	49 (27.6%) [51.0%]	64 (36.2%) [71.1%]	177	32.703	0.001**
3	High	63 (50.8%) [38.4%]	39 (31.5) [40.6%]	22 (17.7%) [24.4%]	124		

Note. The value within ( ) refers to Row Percentage; The value within [ ] refers to Column Percentage; ** denotes significance at 1% level; *denotes significance at 5% level.

It could be noted from the data from the Table 21 that 75.5% of the respondents with low innovativeness have low level of knowledge on CA. 16.3% of respondents had medium level of knowledge on CA among the respondents with low innovativeness whereas a meager proportion of 8.2% of the respondents had higher level of knowledge on CA. Among the respondents with medium level of innovativeness, the proportion of low and high level of knowledge on CA was equal at 36.2% whereas only 27.6% of respondents had medium level of knowledge on CA.

It was surprising to note that among the farmers with high innovativeness, a majority of 50.8% of the respondents with low level of knowledge on CA whereas only a meager proportion of 17.7% of the respondents had high knowledge level on CA. Similar views were expressed by Hussain et al. (2010).

3.4 Extent of Adoption of Conservation Agriculture Practices

3.4.1 Minimum Tillage

The table below shows the distribution of respondents based on the adoption of minimum tillage practices.

Table 22. Distribution of respondents according to their level of adoption of minimum tillage (n = 350)

S No	Category	Frequency	Percentage
1	Adopters	11	3.1
2	Non adopters	339	96.9
	Total	350	100.0

Table 23. Distribution of respondents according to their level of adoption of minimum tillage among the knowledgeable about minimum tillage (n = 96)

S No	Category	Frequency	Percentage
1	Adopters	11	11.5
2	Non adopters	85	88.5
	Total	96	100.0

The results in the table above show very low adoption of minimum tillage by the respondents (3.1%). A whopping majority of the respondents were non adopters of minimum tillage to the tune of 96.9%. The main reason for very low adoption of minimum tillage was the ignorance of respondents about minimum tillage as they had never heard about existence of such technology. Even among the total respondents who were knowledgeable about minimum tillage, only 11.5% adopt it. This may be due to the fact that most of the respondents had strong belief in conventional farming practices including intensive plouging of land using heavy implements like rotary tiller.

3.4.2 Permanent Soil Cover

The following table presents the distribution of respondents based on the adoption of permanent soil cover practices.

Table 24. Distribution of respondents according to their level of adoption of permanent soil cover (n = 350)

S No	Category	Frequency	Percentage
1	Adopters	24	6.9
2	Non adopters	326	93.1
	Total	350	100.0

Table 25. Distribution of respondents according to their level of adoption of permanent soil cover who are knowledgeable about permanent soil cover

S No	Category	Frequency	Percentage
1	Adopters	24	27.6
2	Non adopters	63	72.4
	Total	87	100.0

The data from Table 25 clearly show that only 6.9% of the respondents adopted permanent soil cover whereas the vast majority of the respondents did not adopt permanent soil cover by stubble mulching. The meager percentage of adopters was predominantly sugarcane growers who covered the interspaces of the crop using sugarcane trashes. It could also be noted that among the respondents who were knowledgeable about permanent soil cover, 1/4th of them adopted the same whereas about 3/4th of them did not adopt it.

It was given to understand from the respondents that they did practice trash mulching as per the advice of extension officials of sugar mills of their respective area. It was also expressed that not many followed this as it required lot of labour and with heavy demand for labour and their increasing wages; it was not profitable for them. However, those respondents who practiced trash mulching expressed that they could control the incidence of weeds and could observe an improvement in soil fertility though the process of improvement was slow.

3.4.3 Crop Rotation

The classification of respondents based on their adoption levels of crop rotation practices are presented below

Table 26. Distribution of respondents according to their level of adoption of crop rotation (n = 350)

S No	Category	Frequency	Percentage
1	Adopters	273	78.0
2	Non adopters	77	22.0
	Total	350	100.0

The results from the above table indicate that more than three fourths (78%) of the respondents practiced crop rotation with at least two crops in rotation. The crops in rotation varied from place to place. However, paddy remained one of the crops in all the locations.

However, majority of the respondents expressed that they adopted crop rotation primarily due to non availability of sufficient irrigation water for cultivation of second crop of paddy. Some of the non adopters also revealed that though they wished to cultivate different crops in rotation, they resorted to mono-cropping of paddy predominantly due to the reason that their lands are low lying and were bound to be under water stagnation.

Adopting CA principles involves shift from (1) excessive tillage with associated runoff to drastically reduced tillage combined with in situ soil and moisture conservation (2) residue burning or incorporation to surface retention of residues and (3) crop based management to cropping system based management (Bhaduri, 2012). Conservation Agriculture is seen as effective technology to increase farmers' resilience to climate variability and address soil degradation. However adoption of conservation agriculture is limited since promotion of CA lacks involvement of farmers (Giller et al., 2009). Most of the farmers are not aware of minimum/zero tillage practices. Farmers are not retaining crop residues in their fields; they are using it for other uses undermining the benefits of retaining crop residues in the field. Different patterns of crop rotations are followed by farmers making full use of land throughout the year (Usharani & Neelu, 2011).

4. Conclusion

Strategies to promote CA will call for moving away from conventional approach and to involve all stakeholders for end-end solutions. The study revealed that among the CA technologies, only Crop Rotation is popular among farmers and is being followed though to a limited extent. Other CA technologies like Minimum tillage and Permanent soil cover is not known to majority of the farmers and is also not being adopted by them. It implies the need for popularizing CA technologies and educating the farmers on the usefulness of CA technologies. Establishing frontline demonstrations, organizing training programs, promotion of community owned CA programs through institutional and governmental support would enhance the adoption of CA which has potential for long term profitability and sustainability of agriculture production systems.

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