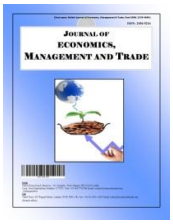

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Consumers' Perceptions Regarding Adoption of Leaf Color Chart for Resource Management

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: This study attempts to understand the consumers' perceptions regarding adoption of leaf color chart for resource management in agriculture and how the adoption level varies among various age groups, landholding sizes and income groups.
Study Design: An exploratory research study was undertaken and consumer responses were recorded using a well-structured, disguised questionnaire.
Methodology: From eight villages of two major districts of Punjab state, a total of 150 farmers were selected as respondents. These respondents selected belonged to different age groups, landholding sizes and income groups in order to represent the whole population effectively. The data collected through questionnaires were analyzed using appropriate statistical tools.
Major Findings: It was found that most of the respondents were aware of ill-effects of excessive usage of fertilizers, but were still practicing fertilizer inputs based on their personal experiences instead of using any technical advice or techniques established. Young farmers, farmers belonging to small and semi-medium landholding sizes and medium income groups were observed to have higher adoption level as compared to others.

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Conclusion: Approximately 70 percent of the respondents were not using leaf color chart, even though 73 percent of the total respondents were aware about the technology. Age, landholding sizes and income groups had significant effect on the perception of respondents towards adoption of leaf color chart for resource management.

Keywords: Perception; resource management; adoption; etc.

1. INTRODUCTION

The Green Revolution was a set of development of technology transfer initiatives that increased agricultural production worldwide, particularly in the developing world, beginning most markedly in India in the late 1960s. In India, the Green Revolution was initiated with the motive of making India self-sufficient in terms of food production. This included new high-yielding varieties (HYVs) of cereals, especially dwarf wheat and paddy, in association with chemical fertilizers and agro-chemicals, and with controlled water-supply (usually involving irrigation) and new methods of cultivation, including mechanization; the creation of large dams and irrigation projects. All of these together were seen as a 'package of practices' to supersede 'traditional' technology and to be adopted as a whole.

The Indian state of Punjab pioneered green revolution along with the other states, transforming India into a food-surplus country. The state then witnessed serious consequences of intensive farming using chemicals and pesticides. A comprehensive study conducted in Punjab [1] underlined the direct relationship between indiscriminate use of these chemicals and increased incidence of cancer in this region. An increase in the number of cancer cases was reported in several villages of Malwa region in Punjab. Various environmental activists claimed that the Green Revolution's reliance on heavy use of chemical inputs and monocultures resulted in water scarcity, vulnerability to pests, and incidents of violent conflict and social marginalization.

Tirado R [2] conducted a study in 50 villages in Muktsar, Bathinda and Ludhiana districts and found chemical, radiation and biological toxicity rampant in Punjab. Twenty percent of the sampled wells showed nitrate levels above the safety limit established by the World Health Organization. The study connected this high nitrate level with high use of synthetic nitrogen fertilizers.

The emphasis needs to be laid on increasing soil productivity, in order to achieve the objective of doubling farmers' income by the year 2020, along with sustainable agricultural practices. The focus demands to be shifted from resource intensive traditional agriculture towards Conservation Agriculture (CA). The strategy to promote CA calls for moving away from conventional compartmentalization and hierarchical arrangements of research that generate and perfect technologies, extension that delivers it and farmers who passively adopt it. There is a need to bring all the involved stakeholders on a common platform to conceive end-to-end strategies [3].

Factors that trigger adoption of new technologies are progressive, young and educated male farmers. Although farmers have positive perception of effects of the newer technology, problems are faced in application of the technology due to deficiency of capital, lesser direction from the government and extension services and insufficient compensation policy in terms of insure of yield [4]. Farouque and Takeya [5] conducted a study of awareness among farmers regarding conservation techniques and concluded that farmers have very low awareness of integrated soil fertility (ISF) and nutrient management (NM) for sustainable crop production. Medium and high levels of awareness were observed only for those who were belonged to medium and large farm holders. Farmer's education, farming experience and communication exposure was observed to have significant positive influence on farmers' perception. The overall perception of farmers in the study areas revealed that a significant proportion (78%) had either a low or a very low level of perception while 22% had a medium to high level of perception of preparation of farm yard manure and the role of organic matter as well as the beneficial aspect of ISF and NM for sustainable crop production. Family size and fertilizer use negatively influenced farmers' perception of ISF and NM for sustainable crop production. Fakoya et al. [6] observed that the knowledge of the fungibility and renewability potential of natural resources are critical determinants of the attitude and management of conservation measures adopted to achieve sustainability. The study investigated knowledge

and attitude of farmers of South West Nigeria towards sustainable land management practices in arable food crop production. The study revealed that there is a strong positive ($r = 0.63$; $p < 0.05$) correlation between the attitude score and land management practices adopted by the women farmers. The study recommended increase in awareness campaigns on land use, fertility and management practices.

Mohapatra and Kameswari [7] conducted study on Bringing Green Revolution in Eastern India (BGREI) in two villages in Odisha to find out the extent of adoption of acidic soil management practices by the farmers and constraints faced by them. Aggregate adoption scores indicated medium level of adoption. Use of compost (42.22%), application of soil amendment (38.88%) and soil testing and application of micronutrients (37.78%) were adopted by maximum number of farmers. On the other hand use of super phosphate in compost pit (80%), application of sulphur (67.78%) and use of bio-fertilizers (66.66%) were rejected by farmers. Major constraints in adoption include difficulty in understanding soil test recommendations, lack of awareness and non-availability of inputs. Zerssa et al. [8] determined the factors affecting farmer's perception to make decision on soil and water conservation practices on their farm land in West Ethiopia. The study found that majority of the farmers had optimum awareness about the introduced soil and water conservation (SWC) and few of them implements it. The study also concluded that many of the problems in the implementation were related to lack of real participation of farmers in planning of conservation effort.

Most of the farmers are using large quantities of chemical fertilizers to increase production without knowing the fertility status of the soils of their fields. It is essential to create maximum awareness among farmers about careful use of chemical fertilizer. The Leaf color Chart was developed by International Rice Research Institute (IRRI) in collaboration with Philippines Rice Research Institute (PhilRice) in late 1980s in Japan and was released in 2003. Leaf Color Chart is a tool for Site-specific nutrient management (SSNM) which enables farmers to dynamically adjust fertilizer use, by supplying optimum amounts of nutrients at critical time points in the crop's growth to produce high yields. In SSNM, farmers tailor their nutrient management strategy to the specific conditions of their field. Since Nitrogen fertilizer is important in crop production, it is applied several times during the growing season to ensure that the required nutrient is supplied to the crop, particularly at critical growth stages. The LCC is used to determine the N fertilizer needs of various crops. LCC is simple, inexpensive and portable diagnostic tool that can be used to measure in situ N fertilizer requirement for various crops [9,10].

The LCC has six green strips, with color ranging from yellow green to dark green. It determines the greenness of the plant leaf which indicates its N content. It should be used every 7 – 10 days starting from the beginning of tillering and be continued up to 5 – 10 days after panicle initiation. To use LCC, 10 disease-free plants must be selected randomly from the field where the plant population is uniform. The topmost, youngest, fully expanded leaves from the plants best reflect the N status of the plants. The middle part of the leaf should be placed on the LCC and its color be compared with the color panels. The leaf color should be measured under the shade of your body. Direct sunlight affects color reading. If the color of the leaf is in between two shades, take the average of the two values as the reading. The reading of all the 10 leaves should be taken and average is determined. Using this average reading, the amount of fertilizer needed by the crop can be determined.

Islam et al. [11] conducted a farmer-participatory research to validate real-time N management in rice by the use of LCC in West Bengal state of India. LCC was adopted, on average 57–63% of the adopters' rice lands. First time adopters experimented with LCC on about half of their rice lands which rapidly increased with experience reaching 97% in 3rd year. Adoption of LCC saved N by 25 kg per hectare (19.4%), with the highest saving of 31.4 kg per hectare (21.0%) in the boro season. Adoption of LCC resulted in 50, 60 and 90 kg additional paddy per ha in the pre-kharif, kharif and boro seasons, respectively. LCC adoption also reduced insecticide applications by 50%. Economic benefit of LCC adoption estimated at Rs. 1107 (US$ 27.0) per hectare in boro, followed by Rs. 808 (US$ 19.7) per hectare in kharif and Rs. 778(US$ 19.0) per hectare in pre-kharif season. Huan et al. [12] applied a participatory planning process to develop a media campaign to motivate rice farmers in the Mekong Delta to change their pest management practices and seed and fertilizer inputs. It was observed that the insecticide inputs reduced by approximately 13–33%, while the

input seed rates dropped by approximately 10% and N fertilizer inputs by almost 7%. These practices lead to changes in attitudes that advocated the idea high inputs and yield loss with lower inputs.

Singh et al. [13] explained that large field to field variability restricts efficient fertilizer N management when broad based blanket recommendations are used in maize (*Zea mays L.*). To achieve higher yields and to avoid nitrogen (N) deficiency risks, many farmers apply fertilizer N in excess of crop requirement in maize. The study concluded that matching fertilizer N supply with crop demand using threshold LCC shade 5 saved 25–50% fertilizer N. This study provides evidence for the usefulness of LCC guided need based fertilizer N management technology in assuring high yields and improvement in fertilizer N recovery efficiency. Mohamed et al. [14] conducted a study of the need to maintain high rice yields and improve fertilizer nitrogen (N)-use efficiency by using leaf color chart (LCC) and chlorophyll meter (SPAD meter) in managing fertilizer N based on color of the leaf. Monitoring N uptake rate during the growing season of DDSR resulted in optimal rice yield along with higher N-use efficiency as compared to the blanket recommendation. This study revealed that in DDSR, fertilizer N could be managed more efficiently using the tools of LCC and SPAD meter than the current blanket recommendation. Kumar et al. [15] also claimed that N fertilizer inputs in maize crop can be managed more efficiently and effectively by applying N dose based on LCC readings.

Even with the development of numerous conservation technologies, there are challenges in acceptance of these technologies. This study attempts to understand consumers' preferences regarding adoption of leaf color chart for resource management. The study also makes an attempt to understand the effects of age of the respondents, landholding size and income of the respondents on their level of adoption and their perception towards the use of leaf color chart.

2. RESEARCH METHODOLOGY

2.1 Research Design

Exploratory research was carried out for meeting the objectives of the study. The study explored farmers' awareness and adoption of conservation agriculture technologies in Punjab. Secondary data was collected to develop the items in the questionnaire. Primary data was collected through a structured, non-disguised questionaire.

2.2 Sampling Design and Sample Selection

From eight villages of Ludhiana and Patiala districts of Punjab, 150 farmers were selected on stratified sampling basis. Out of 150 farmers surveyed 46 farmers were marginal-small, 54 were semi-medium and 50 were medium-large farmers.

2.3 Data collection

The data was collected from the farmers by personally interviewing them. Questions were specifically designed to get in depth information about the profile of the respondents, frequency of usage of LCC, source of information, perception about LCC, benefits and constraints they face in using this technology. The farmers who were not using the conservation agriculture technologies were interviewed to understand the reasons for them not using these technologies. This was done specifically using open ended question.

Respondents were asked close-ended as well as open-ended questions, multiple choice and scale based questions. They were asked to provide response on five-point Likert scale. The questionnaire was pre-tested and suitable modifications were made before the selection of the text of the questionnaire. Before administrating the questionnaire, main objectives of the study were explained to respondents.

3. RESULTS AND DISCUSSION

Profile of respondents (Farmers): From Table 1, it can be seen than out of 150 farmers, 46 (30.7%) farmers aged between 18-35 years, 70 (46.7%) farmers aged between 36-50 years and 34 (22.7%) farmers aged above 50 years. Amongst these 150 farmers, 5 (3.3%) were illiterate, 13 (8.7%) have studied primary education, 23 (21.3%) have studied secondary education, 66 (44.0%) have studied till higher secondary, 22 (14.7%) were graduates and 12 (8.0%) were postgraduates.

Based upon the size of the landholding of these 150 farmers, 18 (12.0%) were marginal farmers (with landholding size less than 1 hectare), 28 (18.7%) were small farmers (with landholding size 1-2 hectare), 54 (36.0%) were semi medium

farmers (with landholding size 2-4 hectares), 36 (24.0%) were medium farmers (with landholding size 4-10 hectares) and 14 (9.3%) were large scale farmers (with landholding size more than 10 hectares). Also, out of these 150 farmers, 131 (87.3%) farmers owned their lands, 10 (6.7%) farmers rented and 9 (6.0%) leased the lands for cultivation.

From Table 2, it can be observed that 53 (35.3%) of the farmers had low farming experience (1-10 years), 24 (16.0%) farmers had medium farming experience (11-20 years) and 73 (48.7%) farmers had high farming experience (more than 20 years). 28 (18.7%) farmers out of 150 had only agriculture as their occupation, 93 (62.0%) undertook agriculture along with livestock farming and 29 (19.3%) had a business/ service in addition to agriculture and livestock farming. The annual income from agriculture was observed to be less than 2 lacs for 35 (23.3%) farmers, between 2-4 lacs for 53 (35.3%) of the farmers, between 4-6 lacs for 50 (33.3%) farmers, between 6-8 lacs for 1 (0.7%) farmers and above 8 lacs for 11 (7.3%) out of the 150 farmers.

Out of these 150 farmers, 47 (31.3%) farmers undertook commercial agriculture, i.e. they cultivate for commercial purposes whereas the rest 103 farmers did subsistence agriculture. All the 150 farmers observed during this study carried out conventional cultivation practices and none practiced organic agriculture. For crop fertility management, 37 (24.7%) farmers practiced crop rotation, 1 (0.7%) farmer practiced intercropping, 13 (8.7%) practiced manure addition to the soil, while 99 (66.0%) farmers do not practice any method for crop fertility management.

Perception and awareness of farmers towards selected conservation technologies: This section describes the perception of the farmers towards application of fertilizers and irrigation, and awareness regarding leaf color chart. Various observations under this section are discussed further.

Table 3 depicts the basis on which the farmers put fertilizers into their crops. The research shows that maximum of the farmers, i.e. 69 (46.0%) apply fertilizers based on their own experiences and 43 (28.7%) farmers apply fertilizers according to the blanket recommendations by the state university. Only 24 (16.0%) farmers apply fertilizers according to

Table 1. Profile of the respondents

Particulars	No. of Respondents	Percentage
Age		
18-35(Young)	46	30.7
36-50(Middle aged)	70	46.7
Above 50(Old)	34	22.7
Total	**150**	**100**
Education		
Illiterate	5	3.3
Primary (1st to 7th)	13	8.7
Secondary (8th to 10th)	32	21.3
Higher Secondary (11th to 12th)	66	44.0
Graduate	22	14.7
Post Graduate and above	12	8.0
Total	**150**	**100**
Land Holding		
Marginal (<1 hectare)	18	12.0
Small (1 to 2 hectare)	28	18.7
Semi medium farmers(2 to 4 hectares)	54	36.0
Medium farmers (4 to 10 hectares)	36	24.0
Large (Above 10 hectare)	14	9.3
Total	**150**	**100**
Source of land		
Owned/inherited	131	87.3
Rented	10	6.7
Leased	9	6.0
Total	**150**	**100**

Table 2. Profile of farmers regarding farming

Particulars	No. of Respondents	Percentage
Farming Experience		
Low (1 to 10 years)	53	35.3
Medium (11 to 20 years)	24	16.0
High (> 20 years)	73	48.7
Total	**150**	**100**
Occupation		
Only Agriculture	28	18.7
Agriculture with Livestock Farming	93	62.0
Agriculture with Livestock farming and Business/Service	29	19.3
Total	**150**	**100**
Annual income		
<2 lakhs	35	23.3
2-4 lakhs	53	35.3
4-6 lakhs	50	33.3
6-8 lakhs	1	0.7
>8 lakhs	11	7.3
Total	**150**	**100**
Farming purpose		
Commercial	47	31.3
Subsistence	103	68.7
Total	**150**	**100**
Cultivation practices		
Organic	0	0
Conventional	150	100.0
Total	**150**	**100**
Crop management fertility practices		
Crop rotation	37	24.7
Intercropping	1	0.7
Any other	13	8.7
None	99	66.0
Total	**150**	**100**

Table 3. Information regarding chemical and fertilizer application

Information of fertilizer and chemical application	No. of respondents	Percentage
According to blanket recommendations by the state university	43	28.7
On dealers' advice	7	4.7
Based on your own experiences	69	46.0
Based on other farmers' experience	7	4.7
According to actual requirements of the soil	24	16.0
Total	**150**	**100**

actual requirements of the soil. The over-usage and/or under-usage of fertilizers is justified, since only a few farmers actually get their soils and crops checked for actual fertilizer requirements. These actual requirements can be checked using various tools, among which soil nutrient testing and leaf color chart are covered under this study.

Table 4 shows the perception of farmers towards excessive usage of fertilizers. From this table, it can be observed that the farmers tend to disagree with the statement that application of more fertilizers lead to increased yield (mean score – 3.63, p value - .000). Farmers tend to agree with the statements that excessive fertilizers may impact farmers' health by direct contamination (mean score – 1.07, p value - .000), that excessive fertilizers may damage the quality of underground water (mean score – 1.32, p value - .000),that excessive use of fertilizers

may have severe effect on the crop produce to be consumed (mean score – 1.42, p value - .000), that excessive fertilizers harm soil fertility in long term (mean score – 1.45, p value - .000) and slightly agree with the statement that excessive fertilizers invite insects pests and diseases (mean score – 1.51, p value - .000).

From Table 5, it is observed that 119 (79.3%) people know about Leaf color chart but only 43 people have used it. Out of these 43 (28.7%), only 27 (18.0%) people used it more than once.

Among all the sources of information regarding leaf color chart, Department of Agriculture and Farmers' welfare is the most effective source of information (mean score – 0.35, p value - .000), followed by Kisan melas (mean score – 0.34, p value - .000), Agricultural input supply sector (mean score – 0.17, p value - .000), followed by Agricultural magazines and extension literature (mean score – 0.11, p value - .000). Television and Progressive farmers are the least effective sources of information for this technology.

Table 7 depicts the overall perception of respondents towards leaf color chart. The respondents tend to remain neutral towards statements that the leaf color chart doesn't have a prominent use (mean score – 3.01) and that they are not interested in using leaf color chart because fellow farmers are not interested (mean score – 3.05). The respondents tend to disagree with the statements that handling leaf color chart in not easy (mean score – 3.44), that they might lose some share of crop if they use leaf color chart (mean score – 3.92) and that the technique for using leaf color chart is difficult to get (mean score – 4.08).

It can be drawn from table 8 that the perception of respondents towards leaf color chart varies significantly among different age group with regard to leaf color chart not having a prominent use, handling of leaf color chart not being easy and that their interest in leaf color chart is not influenced by fellow farmers. The respondents of all the different age groups tend to disagree with the statements that technique for using leaf color chart is difficult to get and that they might lose some share of crop if they used leaf color chart.

Table 4. Perception towards excessive usage of fertilizers

Sr. No.	Statements	Mean	SD	t-value	p- value
1	Application of more fertilizers leads to increased yield	3.63	1.046	42.455*	.000
2	Excessive use of fertilizers harm soil fertility in long term	1.45	0.756	23.542*	.000
3	Excess fertilizers may be absorbed by the soil and may damage the quality of underground water	1.32	0.509	31.746*	.000
4	Excess fertilizers may impact my health by direct contamination through hands	1.07	0.321	40.724*	.000
5	Excessive use of fertilizers may have severe effect on the crop produce to be consumed	1.42	0.627	27.746*	.000
6	Excess fertilizers invite insects, pests and diseases	1.51	0.766	24.081*	.000

**Significant at 5% level of significance.* $t_{(table)}$*=1.96, df=149, μ=3*

Table 5. Knowledge and frequency of usage of Leaf Color Chart

Particulars	No. of Respondents	Percentage
Knowledge about LCC		
Yes	119	79.3
No	31	20.7
Total	**150**	**100**
Frequency of usage		
Never	107	71.3
Only once	16	10.7
More than once	27	18.0
Total	**150**	**100**

Table 6. Source of information regarding Leaf Color Chart

Sr. No.	Source of information	Mean	SD	t value	p value
1	Agricultural magazines and extension literature	0.11	0.318	4.364*	.000
2	Progressive Farmers	0.00	0.000	-	-
3	KVK subject matter specialists/ scientists	0.06	0.238	3.084*	.002
4	Department of Agriculture and Farmers' Welfare	0.35	0.480	9.023*	.000
5	Agricultural input supply sector	0.17	0.374	5.459*	.000
6	Television	0.00	0.000	-	-
7	Radio	0.01	0.115	1.419	.158
8	Kisan melas	0.34	0.475	8.761*	.000
9	Relatives/ fellow farmers	0.01	0.082	1.000	.319
10	No information	0.00	0.000	-	-

**Significant at 5% level of significance. $t_{(table)}$=1.96, df=149, μ=0.5*

Table 7. Perception of respondents towards Leaf Color Chart

Sr. No.	Statements	Mean	SD	t-value	p- value
1	Leaf color chart doesn't have a prominent use	3.01	1.344	25.517*	.000
2	Handling of LCC is not easy, thus it gets lost	3.44	1.403	27.939*	.000
3	Technique for using LCC is difficult to get	4.08	0.872	53.414*	.000
4	I'm not interested because fellow farmers don't use it	3.05	1.360	25.601*	.000
5	I may lose some share of crop yield if I take the risk of using LCC	3.92	0.973	45.892*	.000

**Significant at 5% level of significance. $t_{(table)}$=1.96, df=149, μ=3*

Table 8. Perception of respondents towards Leaf Color Chart with respect to Age

Sr. No.	Statements	Age groups			F	Sig.
		18-35 (Young)	36-50 (Middle aged)	Above 50 (Old)		
1	Leaf color chart doesn't have a prominent use	2.17	3.56	2.96	16.683*	.000
2	Handling of LCC is not easy, thus it gets lost	2.83	3.67	3.84	6.242*	.003
3	Technique for using LCC is difficult to get	4.34	3.94	4.04	2.799	.065
4	I'm not interested because fellow farmers don't use it	3.59	2.78	2.88	4.900*	.009
5	I may lose some share of crop yield if I take the risk of using LCC	3.90	3.89	4.00	0.117	.889

Table 9. Age and frequency usage of leaf color chart

Age groups	No knowledge	Never used	Only once	More than once	Total
18-35 (young)	19 (12.67)	12 (8.00)	0 (0.00)	15 (10.00)	46 (30.67)
36-50 (middle aged)	10 (6.67)	42 (28.00)	6 (4.00)	12 (8.00)	70 (46.67)
Above 50 (old)	11 (7.33)	13 (8.66)	10 (6.67)	0 (0.00)	34 (22.66)
Total	40 (26.67)	67 (44.66)	16 (10.67)	27 (18.00)	**150 (100)**

(Figures given in brackets are percentages)

Table 9 depicts the frequency of usage of leaf color chart with respect to age groups. Out of the 27 respondents using leaf color chart for more than once, 12 belong to middle age group and 15

belong to young age. There is no respondent in young age group who stopped using leaf color chart after one use, while 10 respondents from old age group stopped using leaf color chart after one use. In middle age group, 60 out of 70 people had knowledge about leaf color chart, but only 18 respondents used it.

From this information, it can be concluded that there is a need to develop interest among the farmers of middle aged group towards using leaf color chart.

From Table 10, it can be concluded that the mean perceptions of respondents belonging to various groups of size of their landholding towards leaf color chart vary significantly. The statements mainly test the factors that may disinterest farmers from using leaf color chart and the perception of different farmer groups of different landholding sizes towards these factors vary significantly.

From Table 11, it can be observed that the respondents belonging to semi medium landholding size group use leaf color chart the most (15), while the respondents belonging to small landholding size group stopped using leaf color chart after one time (13).

Table 12 shows that there is a significant difference between mean perceptions of the respondents towards leaf color chart with respect to various income groups. The perceptions of the income groups seem to differ significantly except for the statement that their interest is not influenced by the interest of fellow farmers.

Table 13 shows that most of the respondents from income group 2-4 lakhs are not aware about leaf color chart, while mostly respondents from income group 4-6 lakhs used the leaf color chart more than once.

Table 10. Perception of respondents towards Leaf Color Chart with respect to landholding

Sr. No.	Statements	Mean perception with respect to landholding					F	Sig.
		Marginal	Small	Semi medium	Medium	Large		
1	Leaf color chart doesn't have a prominent use	3.00	2.95	2.94	3.90	1.31	11.270*	.000
2	Handling of LCC is not easy, thus it gets lost	3.47	4.24	2.53	3.77	4.77	14.389*	.000
3	Technique for using LCC is difficult to get	3.82	4.33	4.02	3.90	4.69	2.959*	.022
4	I'm not interested because fellow farmers don't use it	2.35	4.33	4.02	3.90	4.69	7.807*	.000
5	I may lose some share of crop yield if I take the risk of using LCC	3.82	4.24	3.65	3.80	4.77	4.572*	.002

Table 11. Land holding and frequency of usage of Leaf Color Chart

Land holding	No knowledge	Never used	Once only	More than once	Total
Marginal	1 (0.67)	16 (10.67)	1 (0.67)	0 (0.00)	18 (12.01)
Small	14 (9.33)	0 (0.00)	13 (8.67)	1 (0.67)	28 (18.67)
Semi medium	12 (8.00)	25 (16.67)	2 (1.33)	15 (10.00)	54 (36.00)
Medium	6 (4.00)	20 (13.33)	0 (0.00)	10 (6.66)	36 (23.99)
Large	7 (4.66)	6 (4.00)	0 (0.00)	1 (0.67)	14 (9.33)
Total	40 (26.66)	67 (44.67)	16 (10.67)	27 (18.00)	**150 (100)**

(Figures given in brackets are percentages)

Table 12. Perception of respondents towards Leaf Color Chart with respect to income

Sr. No.	Statements	Mean perception of income groups					F	Sig.
		<2 lakhs	2-4 lakhs	4-6 lakhs	6-8 lakhs	>8 lakhs		
1	Leaf color chart doesn't have a prominent use	3.06	3.61	2.53	2.00	3.00	3.897*	.005
2	Handling of LCC is not easy, thus it gets lost	4.19	3.11	2.98	2.00	4.70	7.750*	.000
3	Technique for using LCC is difficult to get	4.38	4.00	4.18	4.00	3.00	5.742*	.000
4	I'm not interested because fellow farmers don't use it	2.59	3.29	3.16	4.00	3.00	1.423	.230
5	I may lose some share of crop yield if I take the risk of using LCC	4.38	3.45	3.84	3.00	4.70	7.016*	.000

Table 13. Income and frequency of usage of Leaf Color Chart

Income	No knowledge	Never used	Once only	More than once	Total
<2 lakhs	10 (6.67)	24 (16.00)	1 (0.67)	0 (0.00)	35 (23.34)
2-4 lakhs	20 (13.33)	16 (10.66)	7 (4.66)	10 (6.67)	53 (35.32)
4-6 lakhs	10 (6.67)	17 (11.33)	8 (5.33)	15 (10.00)	50 (33.33)
6-8 lakhs	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.67)	1 (0.67)
>8 lakhs	0 (0.00)	10 (6.67)	0 (0.00)	1 (0.67)	11 (7.34)
Total	40 (26.67)	67 (44.66)	16 (10.66)	27 (18.01)	**150 (100)**

(Figures given in brackets are percentages)

4. CONCLUSIONS

The awareness among respondents regarding leaf color chart was mostly the result of extension activities by Department of Agriculture and Farmers' Welfare, Kisan melas, Agricultural input supply sector and Agricultural magazines and extension literate. Efforts need to be taken to reach the segment of farmers that are still unaware of the technology.

The respondents were found to be familiar with the ill-effects of excessive usage of fertilizers, but majority were still not using any resource management technology for resource management in agriculture. There is enough awareness, moderate level of interest of the farmers as well, but the desire to buy and use LCC still needs to be created. Among those who adopted LCC for resource management, young farmers, farmers with semi-medium and medium landholding sizes and those belonging to medium income groups adopted LCC most actively.

When asked about the reason for not adopting this technology in an open-ended question, most common answer was the unavailability of the technology at convenient agri-input dealerships and outlets. Thus, the agricultural supply chain for this technology needs to be revised and closely examined.

This study concludes that the farmers as a group are aware of ill-effects the higher fertilizer inputs are causing to the environment and are willing to take steps towards the better cultivation practices, provided that alternatives are made easily and readily available to them. Thus, once the supply chain is maintained for conservation technologies and the farmers get the technologies conveniently, the situation of agriculture in Punjab can be turned away from resource intensive agriculture more towards sustainable agriculture.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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