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Development of a scale to measure the adaptive capacity of mango growers with respect to climate change

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Abstract

The scale development procedure is widely accepted and used as a qualitative tool to measure constructs in the behavioural research. The research paper describe the entire methodology adopted for the developing a scale to measure the adaptive capacity of mango growers with respect to climate change. Based on extensive literature research reports; eight sub components of adaptive capacity namely, economic resources, information resources, technology resources, social capital, knowledge, human resources, institutional resources and management approach were identified and selected on the basis of review of literature and consultation with extension scientists. 96 sub items under the 8 sub components were subjected to relevancy test by sending if for expert content evaluation. Based on Relevancy Percentage (RP), Relevancy Weightage (RW) and Mean Relevancy Score (MRS), 50 items were selected. The scale administered to 40 non-respondent farmers for item analysis. The reliability of the scale was tested using test retest method and a coefficient value of 0.9367 was obtained indicating higher reliability. The final scale consisting of 8 sub-components and 46 sub items had practical applicability in measuring adaptive capacity of mango growers with respect to climate change.

Keywords: Adaptive capacity, mango growers, scale development, t value

Introduction

Mango (*Mangifera indica* L.), belonging to the family *Anacardiaceae*, is one of the most important and commercially grown fruit crops in India. In the *Konkan* region of Maharashtra, mango cultivation spans over 1,26,241 hectares, yielding an annual production of 2,19,589 metric tonnes. However, the region's productivity is relatively low at 1.74 tonnes per hectare, which is about three to four times lower than the national average of 9.60 tonnes per hectare. The *Konkan* region, particularly the southern districts of Ratnagiri and parts of Sindhudurg, Raigad, and Palghar, are renowned for producing high-quality Alphonso mangoes. Despite the favorable climate, the region's mango production faces challenges, including declining productivity due to climate change and other factors (Source: Anonymous, 2022). The *Konkan* region accounts for approximately 10% of India's total mango cultivation area, with Alphonso mango (locally called 'Hapus') dominating almost 90 per cent of this area. Alphonso mangoes hold a significant share of India's mango exports, contributing over 35 per cent to the total mango export market (Holkar, 2021) ^[4]. The region's warm, humid climate and rain-free period from November to May provide

an ideal environment for Alphonso cultivation, which is highly prized both domestically and internationally for its unique sugar-acid blend, pleasant aroma, and exceptional flavor. However, the productivity of Alphonso mangoes faces several challenges. These include pest as well as diseases infestations, inadequate moisture retention, and serious physiological issues like spongy tissue, alternate bearing, and excessive fruit drop due to recurrent flowering. These long-standing constraints hinder efforts to increase productivity. To address these challenges, climate-resilient farming practices are essential. Such farming methods help prevent environmental degradation and make plants more resistant to pests and diseases, while also providing nutritionally superior food, by integrating climate-resilient agriculture (CRA), the region can improve soil fertility, manage water resources better, and enhance mango yields, all while ensuring sustainability and reducing the negative impacts of climate change on Alphonso mango production. Adaptive capacity means that ability of the mango grower to adjust climate change with special focus on climatic indices, to take advantage of opportunities, or to cope with the consequences or that enhances their adaptive capacity to climate resilient management practices'. Considering the

importance of adaptive capacity among mango growers in climate changing situation, the present study aims to develop and validate this scale.

Materials and methods

In the present paper, Adaptive capacity has been operationally defined 'as the ability of the mango grower to adjust climate change with special focus on climatic indices, to take advantage of opportunities, or to cope with the consequences or that enhances their adaptive capacity to climate resilient management practices'. The major objective is developing a scale to measure the adaptive capacity of mango growers with respect to climate change. A standard and reliable scale was developed to measure this variable. The steps followed in construction and standardization of scale to measure the adaptive capacity of the mango growers with respect to climate change. The method consists of following steps:

Identification of sub components

The possible sub components of adaptive capacity were gathered through exhaustive review of literature. After through in-depth investigation and detailed comprehension, these sub components were consulted with the experts of agricultural extension, agricultural economics and

horticultural scientists. Finally, 8 possible sub components of adaptive capacity were found and included in the process of scale development.

Selection of judges and their valuable opinion

Near about 110 judges were selected from State agricultural Universities, Krishi Vigyan Kendras, various ICAR research institutes, Ph.D. pass out concern scholars, to develop the adaptive capacity scale. These selected sub components with concerns statements were send to the judges through formal letter, personal contact, Whatsapp number and Google forms. They were requested to provide valuable opinion on the applicability and significance of the selected sub components with concerns statements and to mark their relevancy in a three point continuum viz., Most Relevant (MR), Relevant (R) and Not Relevant (NR) with score of 3, 2 and 1 for positive statements and 1, 2 and 3 for negative statements, respectively.

Relevance of the sub components

The responses of the judges were tabulated and analyzed to calculate Relevancy Percentage (RP), Relevancy Weightage (RW) and Mean Relevancy Score (MRS) were worked out for all the 96 sub items individually, using the formulae given by Edward (1969) [2].

Relevancy Percentage (%)

$$\text{Relevancy Percentage} = \frac{(MR \times 3) + (R \times 2) + (NR \times 1)}{\text{Maximum Possible Score}} \times 100$$

Relevancy Weightage

$$\text{Relevancy Weightage} = \frac{(MR \times 3) + (R \times 2) + (NR \times 1)}{\text{Maximum Possible Score}}$$

Mean Relevancy Score (MRS)

$$\text{Mean Relevancy Score} = \frac{(MR \times 3) + (R \times 2) + (NR \times 1)}{\text{Number of Judges (110)}}$$

Item analysis for final selection of statements

It is important step for final selection of the items made on the basis of items analysis. For computation of t value, the 50 items selected through judge's opinion were administered to a random sample of 40 respondents from non-sample area. For analysis, upper and lower 25 per cent of the respondents score i.e., 10 respondents with the highest total score and 10 respondents with the lowest total score were selected. These two groups were used as criterion groups to evaluate the individual statements. The critical ratio that is the "t" value (a measure of the extent to which a given statement differentiates between the high and low groups of respondents for each statement) was calculated by using the formula given by Edwards (1957) [1].

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\sum(X_H - \bar{X}_H)^2 + \sum(X_L - \bar{X}_L)^2}{n_H + n_L - 2} \left(\frac{1}{n_H} + \frac{1}{n_L} \right)}}$$

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\sum(X_H - \bar{X}_H)^2 + \sum(X_L - \bar{X}_L)^2}{2n - 2} \left(\frac{2}{n} \right)}}$$

Where;

$$\sum(X_H - \bar{X}_H)^2 = \sum X_H^2 - \frac{(\sum X_H)^2}{n}$$

and

$$\sum(X_L - \bar{X}_L)^2 = \sum X_L^2 - \frac{(\sum X_L)^2}{n}$$

$\sum X_H^2$ = sum of the squares of the individual scores in the high group.

$\sum X_L^2$ = sum of the squares of the individual scores in the low group.

$\bar{X}_H$ = mean score on a given statement for the high group.

$\bar{X}_L$ = mean score on a given statement for the low group.

n = number of respondents in each group.

Reliability of the adaptive capacity scale:

It is degree to which the measure of a construct is consistent or dependable. A scale is said to be reliable when it consistently produces the same results when applied to measure the same phenomenon from time to time. For this study, test-retest method of reliability was used. The coefficient of reliability was calculated by using following the Rulon's formula (Guliford, 1954) ^[3].

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Where;

- r = reliability coefficient
- n = number of respondents
- x = scores of test
- y = scores of retest
- $\sum x$ = summation of x (scores of test)
- $\sum y$ = summation of y (scores of retest)
- $\sum x^2$ = summation of squares of x (scores of test)
- $\sum y^2$ = summation of squares of y (scores of test)

Validity of the adaptive capacity scale:

It is extent of which a measure adequately represents the underlying construct that is supposed to measure. The validity of the adaptive capacity scale is the accuracy which an instrument what is intended to measure. The validity of

this developed scale was measure by content validity method.

Administering the developed scale

The respondents were asked to express their responses with regard to each of the 46 items included in the scale. The responses were collected on three continuum namely "agree", "undecided" and "disagree" with a score of assigned 3, 2 and 1 respectively for positive statements and 1, 2 and 3 for negative statements, respectively. The scale would measure the adaptive capacity of mango growers with respect to climate change. Based on the scores obtained, the respondents will be categorized into, low, medium and high adaptive capacity using mean and standard deviation.

Results and discussion**Identification and selection of various sub components of adaptive capacity**

Based on extensive literature research reports; following eight sub components of adaptive capacity like, economic resources, information resources, technology resources, social capital, knowledge, human resources, institutional resources and management approach were identified and selected on the basis of review of literature and consultation with extension scientists. These sub components are operationalized define given in Table 1.

Table 1. Operational definition of all eight sub components of adaptive capacity

Sl. No.	Sub components	Operational definition
1	Economic resources	It is defined as the level, variability and diversity of income sources and access to other economic resources that contribute to the wealth.
2	Information resources	It is defined as the availability, access to, effective use of knowledge, data, climate information, early warning systems, and skills that enable individuals, communities & societies to understand risks & implement informed adaptation strategies.
3	Technology resources	It is defined as the innovative techniques and practices contributing to climate change adaptation process.
4	Social capital	It is defined as the features of social life, with interpersonal networks, norms and trust enabling mango growers to act together more effectively to pursue shared objectives.
5	Knowledge	It is defined as the acquaintance with the truths, principles or facts as from study or the level to which the mango grower correctly answered the questions about the climate change.
6	Human resources	It is defined as the availability of knowledge, skills, education, health, and labor that enable individuals and communities to anticipate, respond to, and recover from climate impacts.
7	Institutional resources	It is defined as the presence and effectiveness of governance structures, policies, organizations & institutional arrangements that enable planning, coordination, equitable resource distribution & implementation of adaptation measures.
8	Management approach	It is defined as the respondents' ability for ensuring execution of farm operations and surveillance against possible damage to crops due to climate variability.

Development of a scale to measure adaptive capacity of the mango growers

Item collection: The first step in the scale construction was to collect and select a set of statements covering the entire universe of content. That is specifying adaptive capacity of the mango growers with respect to climate change. As such large numbers of statements covering the entire universe of content were collected from available literature and through discussion with the experts in the field of agricultural extension education, agricultural economics and fruit science horticulturalist. As such battery of 120 statements the adaptive capacity of mango growers was drafted under the eight components.

Editing of statements

The statements collected were carefully examined in the light of the fourteen criterion suggested by Edwards (1957) ^[1] for screening the items. Out of 120 statements 96 statements were which satisfied the criteria were selected.

Item selection

These statements were then subjected to scrutiny by an expert panel of judges to determine the relevancy. For this purpose, the statements were given to a panel of 110 judges. They were requested to indicate appropriateness (relevancy) of each statement for inclusion in the scale. The responses were obtained on three point continuum viz., Most Relevant

(MR), Relevant (R) and Not Relevant (NR) with score of 3, 2 and 1 for positive statements and 1, 2 and 3 for negative statements, respectively.

Relevancy test

From the data so gathered, Relevancy Percentage (RP), Relevancy Weightage (RW) and Mean Relevancy Score (MRS) were worked out for all the 96 sub items individually, using the formulae given by Edward (1969) [2].

Using these three criteria, the items were screened for their relevancy. Accordingly, items having relevancy percentage of more than 66, relevancy weightage of more than 0.66 and mean relevancy score of more than 2 were considered for final selection. Thus, finally 50 statements were selected in the first stage. The details regarding sub components, number of items identified and retained for measuring adaptive capacity of the mango growers are given in Table 2 and Table 3.

Table 2: Retained statements of scale in first stage

Sl. No.	Sub components	Statements	
		Identified	Retained
1	Economic resources	12	6
2	Information resources	14	7
3	Technology resources	14	8
4	Social capital	12	6
5	Knowledge	14	8
6	Human resources	10	5
7	Institutional resources	10	5
8	Management approach	10	5
Total		96	50

Table 3: Statements with relevancy percentage, relevancy weightage and mean relevancy scores given by extension specialists.

Sl. No.	Statements	Rating			Interpretation
		RP	RW	MRS	
1)	Economic resources				
1.1	I have enough financial backup options to face any difficulties.	79.39	0.79	2.38	Accepted
1.2	I earn a satisfactory income throughout the year through farming.	90.00	0.90	2.70	Accepted
1.3	I benefit from crop insurance policies.	56.06	0.56	1.68	Rejected
1.4	I am aware that there is a possibility of fluctuations in the market price.	81.52	0.82	2.45	Accepted
1.5	I also have an alternative source of income from other industries available to me.	59.70	0.60	1.79	Rejected
1.6*	In old orchards, harvesting costs are relatively low.	69.39	0.69	2.08	Accepted
1.7	I can receive financial assistance from relatives and friends.	53.64	0.54	1.61	Rejected
1.8	I can sell my farm produce without any problem.	84.24	0.84	2.53	Accepted
1.9	I follow sure ways to get tools related to agricultural inputs.	87.88	0.88	2.64	Accepted
1.10	I know that the government has the necessary incentive policies for obtaining insurance for mango crops.	59.39	0.59	1.78	Rejected
1.11	I have information about formal sources of funds from banks regarding loans.	66.06	0.66	1.98	Rejected
1.12*	Due to the perishable nature of mango produce, no financial loss occurs.	65.15	0.65	1.95	Rejected
2)	Information resources				
2.1	I receive regular updates on weather forecast from the scientists of Krishi Vigyan Kendra.	80.91	0.81	2.43	Accepted
2.2	I get all the essential information from the Agricultural University, State Department of Agriculture and other related department.	80.61	0.81	2.42	Accepted
2.3	Social media helps me to get timely information related to climate change.	83.03	0.83	2.49	Accepted
2.4	It's essential to adopt solar/wind energy to reduce greenhouse gas emissions.	55.45	0.55	1.66	Rejected
2.5*	I think the rejuvenation technology of mango orchards had no effect.	73.33	0.73	2.20	Accepted
2.6	I feel it is necessary to participate in the agricultural study tour.	83.33	0.83	2.50	Accepted
2.7*	I don't think reliable information about climate change and its impact on mango cultivation is essential.	62.73	0.63	1.88	Rejected
2.8	I think the guidance of agricultural assistant working at primary level is useful.	74.24	0.74	2.23	Accepted
2.9	I can access climate change information using my mobile phone.	63.64	0.64	1.91	Rejected
2.10	A record of agricultural technical information must be maintained continuously.	66.67	0.67	2.00	Accepted
2.11	I believe that mango rejuvenation technology is essential for growers.	61.52	0.62	1.85	Rejected
2.12*	I don't believe technology is necessary for accessing information and guidance.	59.70	0.60	1.79	Rejected
2.13	Training on improved agricultural technology is necessary.	60.91	0.61	1.83	Rejected

2.14	I agree that adopting mango processing methods is necessary.	57.58	0.58	1.73	Rejected
3)	Technology resources				
3.1	I prioritize to use improved technology as per climate change.	68.48	0.68	2.05	Accepted
3.2	I think 'Rakshak' pheromone traps should be used for fruit fly control.	70.61	0.71	2.12	Accepted
3.3*	The integrated nutrient management technology in mangoes does not guarantee higher production.	54.24	0.54	1.63	Rejected
3.4	I think it's essential to use plant growth regulators as recommended.	57.27	0.57	1.72	Rejected
3.5	I use spraying technology schedule for pest management recommended by the university.	80.30	0.80	2.41	Accepted
3.6	Mechanization technology is necessary for farming.	84.85	0.85	2.55	Accepted
3.7*	After rejuvenating an old orchard, the yield is lower.	62.73	0.63	1.88	Rejected
3.8	Proper care should be taken for the marketing of fruits.	79.39	0.79	2.38	Accepted
3.9	It's crucial to adopt proper methods for grading.	55.45	0.55	1.66	Rejected
3.10	I use local technology related to climate change adaptation.	76.36	0.76	2.29	Accepted
3.11*	I think that climate change does not affect agricultural production.	80.91	0.81	2.43	Accepted
3.12	It is essential for mango growers to have a rejuvenation plan for their orchards.	56.06	0.56	1.68	Rejected
3.13*	The knowledge of geographic location characteristics is not necessary for commercial mango cultivation.	67.88	0.68	2.04	Accepted
3.14	Technological information helps in indiscriminate and improper use of Paclobutrazol	54.24	0.54	1.63	Rejected
4)	Social capital				
4.1	I think that the growers should not only talk about the problem of mango cultivation, but also think about how to manage it and start practicing it.	81.52	0.82	2.45	Accepted
4.2	Mango growers find it challenging to use new climate-resilient technology without adequate training and support.	62.73	0.63	1.88	Rejected
4.3	Adoption of climate resilient technology helps in raising the social status of mango growers.	80.61	0.81	2.42	Accepted
4.4	I meet and discuss with farmers who are facing problems caused by climate change.	73.33	0.73	2.20	Accepted
4.5	I am aware of the adverse effects of non-organic mangoes on human health and society.	59.70	0.60	1.79	Rejected
4.6	I receive updated information through mango growers associations.	60.30	0.60	1.81	Rejected
4.7	Agricultural extension services play an important role in getting maximum yield.	66.67	0.67	2.00	Accepted
4.8*	Mango growers should sell their produce through the middlemen only.	70.61	0.71	2.12	Accepted
4.9	Any social program related to mango farming should be organized.	63.64	0.64	1.91	Rejected
4.10	Farmers' field school helps in knowing about the climate change.	76.36	0.76	2.29	Accepted
4.11*	Mango growers do not face difficulties in accessing reliable pesticides at the village level.	57.27	0.57	1.72	Rejected
4.12	I can access information on soil/water testing services through my mobile phone.	54.24	0.54	1.63	Rejected
5)	Knowledge				
5.1	I know about value addition and the importance of this process.	87.88	0.88	2.64	Accepted
5.2*	It is not necessary to have information about the various uses of mango fruits.	62.73	0.63	1.88	Rejected
5.3	I try to minimize the pollution while carrying cultivation practices.	90.00	0.90	2.70	Accepted
5.4	Effective reuse of available resources is essential.	77.58	0.78	2.33	Accepted
5.5*	Knowledge of updated technical aspects is not necessary for handling mango fruits.	56.06	0.56	1.68	Rejected
5.6	I follow recommended spray schedules to control fruit drop.	54.24	0.54	1.63	Rejected
5.7	I use 50 ppm Gibberellic Acid during the full blossoming stage of mangoes.	63.64	0.64	1.91	Rejected
5.8	If chemical pesticides are used properly, they are not harmful.	84.85	0.85	2.55	Accepted
5.9	Using 20 ppm Naphthalene Acetic Acid (NAA) for spraying is necessary to prevent fruit drop.	60.30	0.60	1.81	Rejected
5.10	I believe that using 'Amrashakti' during flower and fruit development improves mango quality and yield.	56.06	0.56	1.68	Rejected
5.11*	The use of chemical pesticides is the only reason I get complete satisfaction.	85.76	0.86	2.57	Accepted
5.12	I have capacity to manage the effect of the climate change on mango cultivation at the local level.	69.39	0.69	2.08	Accepted
5.13	Proper use of pesticides helps increase productivity. #	80.61	0.81	2.42	Accepted
5.14*	The impact of climate change on agriculture is the only reason for migration from rural areas to cities.	90.00	0.90	2.70	Accepted

6)	Human resources				
6.1	I get family support to bear the agricultural losses due to climate change.	86.97	0.87	2.61	Accepted
6.2	Age old mango growers are wise to use new technologies instead of just relying on their own experience.	82.12	0.82	2.46	Accepted
6.3	I receive timely help from neighbors and friends during periods of crop damage due to climate change.	54.24	0.54	1.63	Rejected
6.4	Mango farmers must stay updated on climate-resilient practices.	57.27	0.57	1.72	Rejected
6.5	I take guidance from extension workers at the right time.	84.24	0.84	2.53	Accepted
6.6	I think crop rotation should be done according to climate change.	87.88	0.88	2.64	Accepted
6.77	I use pesticides, fertilizers, etc., as per the recommendations of concerned authorities.	56.06	0.56	1.68	Rejected
6.8*	I think only mango farming is the best business for me than any other business.	85.76	0.86	2.57	Accepted
6.9	Proper use of certified pesticides can easily lead to increased mango productivity.	54.24	0.54	1.63	Rejected
6.10*	I believe it is right to use pesticides excessively.	59.70	0.60	1.79	Rejected
7)	Institutional resources				
7.1	It is essential for the concerned department to play a crucial role in mitigating the adverse effects of climate change on agriculture.	63.64	0.64	1.91	Rejected
7.2	It is necessary to solve the problems caused by climate change through an organization /association formed by mango growers.	69.39	0.69	2.08	Accepted
7.3	To minimize the adverse effect of climate change on mangoes, it is necessary to receive reliable information from relevant institutions.	56.06	0.56	1.68	Rejected
7.4	It is essential to receive guidance from subject matter specialist institutions on post-harvest technology.	62.73	0.63	1.88	Rejected
7.5	It is important to accept and follow the advice given by Grameen Krishi Mausam Seva.	67.88	0.68	2.04	Accepted
7.6	Information on cold storage and transportation of mangoes can be highly beneficial.	56.06	0.56	1.68	Rejected
7.7	Taking information from relevant centers is essential for successful marketing of mangoes.	79.39	0.79	2.38	Accepted
7.8*	It is essential to adopt only the technologies recommended by Agricultural University scientists regarding the problems caused by climate change.	90.00	0.90	2.70	Accepted
7.9*	I do not believe it is necessary to adopt integrated pest management technology schedules related to climate change.	54.24	0.54	1.63	Rejected
7.10	It would be advisable to get information from experienced mango growers rather than weather observatory unit.	73.33	0.73	2.20	Accepted
8)	Management approach				
8.1	I make the right decisions regarding climate change at the right time.	60.30	0.60	1.81	Rejected
8.2	Mango growers must adopt intercropping to increase their income.	75.76	0.76	2.27	Accepted
8.3	Mango growers should have the necessary knowledge about irrigation.	59.70	0.60	1.79	Rejected
8.4	I personally supervise all the work in my mango orchard.	81.52	0.82	2.45	Accepted
8.5*	As flower and fruit drop are natural, no chemical methods need to be followed.	68.48	0.68	2.05	Accepted
8.6	I believe mango farmers should use their own suitable systems since climate change is a natural process.	62.73	0.63	1.88	Rejected
8.7	Mechanization should be adopted as needed.	63.64	0.64	1.91	Rejected
8.8	Adoption of improved technology is necessary for reduction of soil erosion, evaporation etc.	76.36	0.76	2.29	Accepted
8.9	Orchards with undulating topography are difficult to manage.	80.30	0.80	2.41	Accepted
8.10*	I don't think it's necessary to have information on post-harvest management practices for mango crops.	60.91	0.61	1.83	Rejected
[*Negative Statements, RP - Relevancy Percentage, RW – Relevancy Weightage, MRS – Mean Relevancy Scores]					

Item analysis

Final selection of the items made on the basis of items analysis. For computation of t value, the 50 items selected through judge's opinion were administered to a random sample of 40 respondents from non-sample area. For analysis, upper and lower 25 per cent of the respondents score i.e., 10 respondents with the highest total score and 10 respondents with the lowest total score were selected. These two groups were used as criterion groups to evaluate the

individual statements. The critical ratio that is the "t" value was calculated by using the formula given by Edwards (1957)^[1].

Selection of adaptive capacity statements for final scale

Critical ratio ("t"- value) of each item was calculated for the final selection of items. Items were selected on the basis of 't' value equal to or, greater than 1.75 as this 't' value significantly differentiates between high and low groups of items. Accordingly, 46 statements were retained in the final

scale for measuring the adaptive capacity of mango growers. The details regarding sub components, numbers of items

identified and retained for measuring adaptive capacity of mango growers are given in Table 4 and Table 5.

Table 4: Retained statements of scale in final stage

Sl. No.	Sub components	Statements	
		Identified	Retained
1	Economic resources	6	6
2	Information resources	7	7
3	Technology resources	8	6
4	Social capital	6	6
5	Knowledge	8	6
6	Human resources	5	5
7	Institutional resources	5	5
8	Management approach	5	5
Total		50	46

Table 5: Statements with 't' value

Sl. No.	Statements	't' value	Interpretation
1)	Economic resources		
1.1	I have enough financial backup options to face any difficulties.	1.7649	Accepted
1.2	I earn a satisfactory income throughout the year through farming.	1.8079	Accepted
1.3	I am aware that there is a possibility of fluctuations in the market price.	1.7797	Accepted
1.4*	In old orchards, harvesting costs are relatively low.	1.8283	Accepted
1.5	I can sell my farm produce without any problem.	1.7649	Accepted
1.6	I follow sure ways to get tools related to agricultural inputs.	1.7797	Accepted
2)	Information resources		
2.1	I receive regular updates on weather forecast from the scientists of Krishi Vigyan Kendra.	1.8079	Accepted
2.2	I get all the essential information from the Agricultural University, State Department of Agriculture and other related department.	1.7797	Accepted
2.3	Social media helps me to get timely information related to climate change.	1.8754	Accepted
2.4	I feel it is necessary to participate in the agricultural study tour.	1.7854	Accepted
2.5*	I think the rejuvenation technology of mango orchards had no effect.	1.8283	Accepted
2.6	A record of agricultural technical information must be maintained continuously.	1.7649	Accepted
2.7	I think the guidance of agricultural assistant working at primary level is useful.	1.8283	Accepted
3)	Technology resources		
3.1	I prioritize to use improved technology as per climate change.	1.8300	Accepted
3.2	I think 'Rakshak' pheromone traps should be used for fruit fly control.	1.7797	Accepted
3.3	I use spraying technology schedule for pest management recommended by the university.	1.7649	Accepted
3.4	Mechanization technology is necessary for farming.	1.8754	Accepted
3.5	Proper care should be taken for the marketing of fruits.	1.7649	Accepted
3.6	I use local technology related to climate change adaptation.	1.4657	Rejected
3.7*	I think that climate change does not affect agricultural production.	1.8283	Accepted
3.8*	The knowledge of geographic location characteristics is not necessary for commercial mango cultivation.	1.6243	Rejected
4)	Social capital		
4.1	I think that the growers should not only talk about the problem of mango cultivation, but also think about how to manage it and start practicing it.	1.7649	Accepted
4.2	Adoption of climate resilient technology helps in raising the social status of mango growers.	1.8079	Accepted
4.3	I meet and discuss with farmers who are facing problems caused by climate change.	1.8754	Accepted
4.4	Agricultural extension services play an important role in getting maximum yield.	1.8283	Accepted
4.5*	Mango growers should sell their produce through the middlemen only.	1.7797	Accepted
4.6	Farmers' field school helps in knowing about the climate change.	1.8300	Accepted
5)	Knowledge		
5.1	I know about value addition and the importance of this process.	2.2520	Accepted
5.2	I try to minimize the pollution while carrying cultivation practices.	1.8754	Accepted
5.3	Effective reuse of available resources is essential.	1.7649	Accepted
5.4	If chemical pesticides are used properly, they are not harmful.	1.8079	Accepted
5.5*	The use of chemical pesticides is the only reason I get complete satisfaction.	1.3920	Rejected
5.6	I have capacity to manage the effect of the climate change on mango cultivation at the local level.	1.7797	Accepted
5.7	Proper use of pesticides helps increase productivity.	1.3080	Rejected
5.8*	The impact of climate change on agriculture is the only reason for migration from rural	2.2561	Accepted

	areas to cities.		
6)	Human resources		
6.1	I get family support to bear the agricultural losses due to climate change.	1.7797	Accepted
6.2	Age old mango growers are wise to use new technologies instead of just relying on their own experience.	1.8754	Accepted
6.3	I take guidance from extension workers at the right time.	1.7649	Accepted
6.4	I think crop rotation should be done according to climate change.	1.8079	Accepted
6.5*	I think only mango farming is the best business for me than any other business.	1.8754	Accepted
7)	Institutional resources		
7.1	It is necessary to solve the problems caused by climate change through an organization/association formed by mango growers.	1.8079	Accepted
7.2	It is important to accept and follow the advice given by Grameen Krishi Mausam Seva.	1.8754	Accepted
7.3	Taking information from relevant centers is essential for successful marketing of mangoes.	1.7649	Accepted
7.4*	It is essential to adopt only the technologies recommended by Agricultural University scientists regarding the problems caused by climate change.	1.7797	Accepted
7.5	It would be advisable to get information from experienced mango growers rather than weather observatory unit.	1.8079	Accepted
8)	Management approach		
8.1	Mango growers must adopt intercropping to increase their income.	1.7649	Accepted
8.2	I personally supervise all the work in my mango orchard.	1.8754	Accepted
8.3*	As flower and fruit drop are natural, no chemical methods need to be followed.	1.7797	Accepted
8.4	Adoption of improved technology is necessary for reduction of soil erosion, evaporation etc.	1.7649	Accepted
8.5	Orchards with undulating topography are difficult to manage.	1.8283	Accepted

Reliability of scale

Reliability is the degree to which the measure of a construct is consistent or dependable. A scale is said to be reliable when it consistently produces the same results when applied to measure the same phenomenon from time to time. For this study, test-retest method of reliability was used.

Test retest method

In this method, a single form of the test was administered twice on the same populations with a reasonable time gap and the results were compared. The adaptive capacity scale

with 46 items administered to the 40 mango growers who were neither previously contacted nor had chance to come in the final sample. After period of 15 days, the same 40 mango growers were given the test. Two sets of scale score were thus obtained. Each of the two sets of statements was treated as a separate scale and these two sub-scales were correlated. The coefficient of reliability was calculated by using the Rulon's formula (Guliford, 1954), which came to 0.9367. Thus the scale developed was found highly reliable. (Table 6)

Table 6: Reliability of adaptive capacity scale (n = 40)

Sr. No.	X (First set)	After 15 Days	X2	Y2	XY
1	74	80	5476	6400	5920
2	75	81	5625	6561	6075
3	80	75	6400	5625	6000
4	78	80	6084	6400	6240
5	70	79	4900	6241	5530
6	82	80	6724	6400	6560
7	75	75	5625	5625	5625
8	71	79	5041	6241	5609
9	79	74	6241	5476	5846
10	82	82	6724	6724	6724
11	81	75	6561	5625	6075
12	83	75	6889	5625	6225
13	82	82	6724	6724	6724
14	80	77	6400	5929	6160
15	79	82	6241	6724	6478
16	82	81	6724	6561	6642
17	70	80	4900	6400	5600
18	83	81	6889	6561	6723
19	79	82	6241	6724	6478
20	82	77	6724	5929	6314
21	77	78	5929	6084	6006
22	85	80	7225	6400	6800
23	73	75	5329	5625	5475
24	78	79	6084	6241	6162

25	79	80	6241	6400	6320
26	79	77	6241	5929	6083
27	89	80	7921	6400	7120
28	85	79	7225	6241	6715
29	79	81	6241	6561	6399
30	83	83	6889	6889	6889
31	83	81	6889	6561	6723
32	77	77	5929	5929	5929
33	86	76	7396	5776	6536
34	85	77	7225	5929	6545
35	80	68	6400	4624	5440
36	84	77	7056	5929	6468
37	79	80	6241	6400	6320
38	82	77	6724	5929	6314
39	81	79	6561	6241	6399
40	76	83	5776	6889	6308
Total	$\sum x = 3187$	$\sum y = 3144$	$\sum x^2 = 254401$	$\sum y^2 = 247646$	$\sum xy = 250968$

The coefficient of reliability was calculated by,

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Where,

- $n = 40$
- $\sum x = 3187$
- $\sum y = 3144$
- $\sum x^2 = 254401$
- $\sum y^2 = 247646$
- $\sum xy = 250968$

$$n\sum xy - (\sum x)(\sum y) = 18792 = 20061.76$$

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad r = 0.93670$$

Validity of scale

It is referred to the extent of which a measure adequately represents the underlying construct that is supposed to measure. The validity of the developed scale was measure by content validity method.

Content validity

According to Kerlinger (1976) [5], the content validity is

representativeness of sampling adequacy, of the content, the substance, the matter and the topics of measuring instrument.

It means the extent to which the items included in the test represent the total universe of the content. It was ensured while framing the items, which were collected from the available books, journals, referenced research papers, related research articles, relevant literature and through interviews with experts. The content validity of the scale was ensured by selecting the contents after discussion with specialists of extension and academicians of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. While selecting adaptive capacity of mango grower statements, due care was taken for obtaining a fair degree of content validity. The calculated “t” value being significant for all the finalized statements of the score indicated that the present scale satisfied the content validity.

2.7 Administering the developed scale

The respondents were asked to express their responses with regard to each of the 46 items included in the scale. The responses were collected on three continuum namely “agree”, “undecided” and “disagree” with a score of assigned 3, 2 and 1 respectively for positive statements and 1, 2 and 3 for negative statements, respectively. (Table 7)

Table 7: Final statements for adaptive capacity of mango growers with respect to climate change

Sl. No.	Statements	Responses		
		MR (✓)	R (✓)	NR (✓)
1)	Economic resources			
1.1.	I have enough financial backup options to face any difficulties.			
1.2.	I earn a satisfactory income throughout the year through farming.			
1.3.	I am aware that there is a possibility of fluctuations in the market price.			
1.4.*	In old orchards, harvesting costs are relatively low.			
1.5.	I can sell my farm produce without any problem.			
1.6.	I follow sure ways to get tools related to agricultural inputs.			
2)	Information resources			
2.1.	I receive regular updates on weather forecast from the scientists of Krishi Vigyan Kendra.			
2.2.	I get all the essential information from the Agricultural University, State Department of Agriculture and other related department.			
2.3.	Social media helps me to get timely information related to climate change.			
2.4.	I feel it is necessary to participate in the agricultural study tour.			

2.5.*	I think the rejuvenation technology of mango orchards had no effect.			
2.6.	I think the guidance of agricultural assistant working at primary level is useful.			
2.7.	A record of agricultural technical information must be maintained continuously.			
3)	Technology resources			
3.1.	I prioritize to use improved technology as per climate change.			
3.2.	I think 'Rakshak' pheromone traps should be used for fruit fly control.			
3.3.	I use spraying technology schedule for pest management recommended by the university.			
3.4.	Mechanization technology is necessary for farming.			
3.5.	Proper care should be taken for the marketing of fruits.			
3.6.*	I think that climate change does not affect agricultural production.			
4)	Social capital			
4.1.	I think that the growers should not only talk about the problem of mango cultivation, but also think about how to manage it and start practicing it.			
4.2.	Adoption of climate resilient technology helps in raising the social status of mango growers.			
4.3.	I meet and discuss with farmers who are facing problems caused by climate change.			
4.4.	Agricultural extension services play an important role in getting maximum yield.			
4.5.*	Mango growers should sell their produce through the middlemen only.			
4.6.	Farmers' field school helps in knowing about the climate change.			
5)	Knowledge			
5.1.	I know about value addition and the importance of this process.			
5.2.	I try to minimize the pollution while carrying cultivation practices.			
5.3.	Effective reuse of available resources is essential.			
5.4.	If chemical pesticides are used properly, they are not harmful.			
5.5.	I have capacity to manage the effect of the climate change on mango cultivation at the local level.			
5.6.*	The impact of climate change on agriculture is the only reason for migration from rural areas to cities.			
6)	Human resources			
6.1.	I get family support to bear the agricultural losses due to climate change.			
6.2.	Age old mango growers are wise to use new technologies instead of just relying on their own experience.			
6.3.	I take guidance from extension workers at the right time.			
6.4.	I think crop rotation should be done according to climate change.			
6.5.*	I think only mango farming is the best business for me than any other business.			
7)	Institutional resources			
7.1.	It is necessary to solve the problems caused by climate change through an organization/association formed by mango growers.			
7.2.	It is important to accept and follow the advice given by Grameen Krishi Mausam Seva.			
7.3.	Taking information from relevant centers is essential for successful marketing of mangoes.			
7.4.*	It is essential to adopt only the technologies recommended by Agricultural University scientists regarding the problems caused by climate change.			
7.5.	It would be advisable to get information from experienced mango growers rather than weather observatory unit.			
8)	Management approach			
8.1.	Mango growers must adopt intercropping to increase their income.			
8.2.	I personally supervise all the work in my mango orchard.			
8.3.*	As flower and fruit drop are natural, no chemical methods need to be followed.			
8.4.	Adoption of improved technology is necessary for reduction of soil erosion, evaporation etc.			
8.5.	Orchards with undulating topography are difficult to manage.			
[*Negative Statements, MR = Most Relevant, R = Relevant and NR = Not Relevant]				

[* Negative Statements]

Conclusion

The scale to measure the adaptive capacity was found to be highly reliable and valid. The scale consist of eight sub components namely, economic resources, information resources, technology resources, social capital, knowledge, human resources, institutional resources and management approach. The adaptive capacity scale consists of total 46 sub items. The developed scale administered on a three-point continuum ranging from 'agree', 'undecided' and 'disagree' to measure the adaptive capacity of the mango growers with respect to climate change. To modified and improve this scale usability and applicability, it is suggested to validate it in different demographics.

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