The Pharma Innovation Journal 2023; SP-12(9): 1205-1209

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(9): 1205-1209

www.thepharmajournal.com
Received: 18-06-2023
Accepted: 30-07-2023

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Development of a comprehensive scale for evaluating technological dimensions in coastal homegardens of Kerala: A multidisciplinary approach

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Abstract
This research study aimed to develop a comprehensive scale for evaluating technology dimensions in coastal home gardens of Kerala, India. A total of 120 items were generated to delineate technology dimensions using Likert's summated rating method for scale construction. The relevancy of the items was established by judges' ratings, and the scores were summated over all the respondents to calculate the relevancy index. Single ANOVA was used as a statistical tool to select indicators, where the ones with a mean value less than 4.49 (Critical difference = 0.26) were chosen. The final scale consists of 26 variables under 8 selected dimensions, with split-half reliability assessed using the odd-even method, yielding a reliability of 0.917. The content validity criterion was met by including items covering the universe of content with respect to different dimensions of technology in the scale. The final items selected satisfied the construct validity criterion with Pearson's coefficient values greater than the tabulated value (0.25 at 0.05 level of significance), validating the scale for delineating the dimensions of technology in coastal home gardens. Overall, this study presents a multidisciplinary approach for developing a reliable and valid scale for evaluating technology dimensions in coastal home gardens of Kerala, India, which has important implications for sustainable agriculture practices.

Keywords: Coastal homegardens, technology, dimensions of technology, Kerala homegardens, Homegardens

Introduction

The home gardens found in Kerala represent a traditional agroforestry system meticulously designed to fulfill the needs for food, fodder, fuelwood, and timber within farming households. Additionally, they serve as a means to generate extra income by selling surplus produce. The remarkable structural and functional diversity of this agricultural system sets it apart, making it a distinctive and, in fact, the predominant method of agricultural production in the state of Kerala (Babu *et al*., 2023) [11]. This form of farming empowers farmers to utilize the land surrounding their homes for cultivating a wide range of crops, be they annuals, seasonals, or perennials (Jose and Shanmugaratnam, 1994) [6]. Furthermore, it offers the flexibility to incorporate specialized components such as sericulture, apiculture, and even fish farming based on the household's requirements and market preferences, provided there is surplus production and necessary land and resources (Thomas and Kumar, 2015) [14].

The Coastal Zone in Kerala extends over 560 km, and covers about 15% of the state's total area. Coastal population density is higher than state average (1500 persons/sq.km) whose livelihoods are mainly depended upon fishing and is most affected by climate vulnerabilities across seasons. In-depth explorations into the structure and composition of coastal home gardens can significantly benefit both the extension and research systems by informing their research priorities and delivery mechanisms. Collaborative efforts among various institutions have led to developing technologies encompassing a wide range of crops. However, the dissemination of these technologies through extension systems has often focused on individual crops, regardless of whether they are part of home gardens or not. It is essential to conduct thorough investigations into the technologies that have specifically integrated into home gardens, as these are essential for ensuring the gardens' long-term viability. This aspect warrants a comprehensive examination, as emphasized by Thomas *et al.* (2013) [13] in their research on home gardens. Hence, this study envisages delineating the dimensions of technology suited for coastal home gardens.

Materials and Methods
The methodology employed in this research paper for constructing the Coastal Home Garden Technology Dimension Scale is a rigorous and systematic process designed to ensure the reliability and validity of the instrument. The initial phase involves the collection of items, drawing upon a thorough literature review and expert consultations to compile a comprehensive list of dimensions and indicators relevant to technology within coastal home gardens. Following this, a preliminary screening of items was conducted through expert reviews, where experts rate each item's relevance. Items scoring below a predetermined threshold were eliminated. Item analysis, employing statistical techniques (Field, 2009) [4] such as one-way ANOVA, was then employed to ensure the retained items are internally consistent and accurately represent the research scope. Standardization of the scale includes split-half reliability testing and the Spearman-Brown Prophecy formula to establish the scale's reliability (Kumar, 2014) [7]. Additionally, both content and construct validity assessments (Lawshe, 1975) [9] were carried out, and indicators demonstrating strong validity were retained for the final scale (Raj and Thomas, 2022) [12]. This well-structured methodology ensured the precision and credibility of the Coastal Home Garden Technology Dimension Scale, making it a valuable tool for research and assessments in the context of coastal home gardens.

Results and Discussion
The results are detailed for the developed comprehensive scale to measure technology dimensions within coastal home gardens following rigorous methodology (Edward, 1957) [3] and are given below under the following subheads.

Collection of items
The initial phase of scale development involved gathering a set of statements or items designed to define the various aspects of technology within coastal home gardens. Drawing upon an extensive review of existing literature and in-depth consultations with experts, a comprehensive list of dimensions and indicators relevant to home garden technologies was compiled. This process resulted in the creation of a total of 120 indicators aimed at delineating the dimensions of technology in this context.

Preliminary Screening of the items by Relevancy Rating
The 120 indicators were then screened for ambiguity, vagueness, redundancy, and irrelevance, and the draft Likert-type scale (Likert, 1932) [10] with 8 dimensions and 105 indicators was subjected to expert review. Experts comprising of scientists, development officials and change agents involved in home garden activities were asked to rate the relevance of each item on a 5-point scale as given below in Table. 1.

Table 1: Scoring procedure

Options	Most relevant	More relevant	Relevant	less relevant	Least relevant
Indicators	5	4	3	2	1

Out of 90 experts, 64 were responded within the time period of one month. After collecting and tallying the scores, the relevancy index for each item was calculated as:

$$\text{Relevancy Index} = \frac{\text{Total Score obtained on each item}}{\text{Maximum possible Score}} \text{X100}$$

Based on the feedback of 64 experts, items that scored below 80 on a specific index were discarded. From this process, 57 items were retained and placed into eight categories, which include economic, financial, technical, environmental, psychological, human resources, political, and management dimensions. The relevancy index scores obtained for each item are presented in Table 2.

Table 2: Relevancy index of items N=64

Indicators	Relevancy score
1) Income generation potential	94.6
2) Commercialization	90.2
3) Regularity of returns	92.4
4) Profit	84.3
5) Initial cost	88.1
6) Benefit-cost ratio	91.9
7) Quality	95.6
8) Supply chain	90.8
9) Popularity/market share	85.9
10) Diversification	91.9
11) Viable market	86.5
12) Credit access	89.7
13) Credit support	83.8
14) Availability of credit	94.6
15) Price expectation	82.2
16) Sustainability	94.0
17) Availability of supplies and services	82.7
18) Seasonality of products	93.0
19) Delivery reliability	88.1
20) Post-harvest handling	91.9
21) Compatibility	92.4
22) Technical efficiency	82.2
23) Profitability	94.6
24) Availability	89.7
25) Flexibility	85.9

26) Simplicity	90.8
27) Observability	88.1
28) Viability	89.2
29) Energy saving potential	93.0
30) Resource recycling capacity	80.5
31) Local resource utilization	86.5
32) Sustainability	82.7
33) Social acceptability	91.9
34) Cultural compatibility	86.5
35) Social networking	89.8
36) Socio-economic status	94.1
37) Attitudes	93.0
38) Level of satisfaction	95.1
39) Scientific orientation	93.5
40) Perception of technology	90.2
41) Emotional stability	86.5
42) Change proneness	90.3
43) Decision making ability	88.6
44) Extension-officers' influence	83.2
45) Innovativeness	90.8
46) Family labour	88.6
47) Skilled labour requirement	84.3
48) Interpersonal relationship	82.7
49) Acquisition of information	87.0
50) Bureaucratic support	85.4
51) Government policies	94.6
52) Open-source technology	85.9
53) Managerial ability	91.4
54) Planning ability	94.0
55) Coordinating ability	86.5
56) Budgeting ability	84.3
57) Resource management	89.2

Item analysis and selection

Item analysis plays a crucial role in the construction of a scale that is valid and reliable. The selection of items for the scale greatly influences the acceptability of the test (Garrett and Woodworth, 1969) [5]. Therefore, it is essential to analyze each item to ensure that only internally consistent items are retained, while eliminating those that do not accurately represent the scope of the study.

In this study, the items for the scale were chosen using a single ANOVA test. The application of a one-way ANOVA allows for a direct comparison of the mean ratings of an item on one conceptual dimension with its ratings on another comparative dimension. Consequently, it becomes possible to determine whether an item's mean score is significantly higher on the proposed theoretical construct. ANOVA offers a robust assessment of item distinctiveness, as it is capable of accommodating moderate deviations from normality and unequal variances, particularly when sample sizes within cells are equal. (Agresti *et al.*, 1979) [1].

Based on the results obtained from the single ANOVA and using a critical difference of 0.26, it was found that all mean values greater than 4.49 are statistically equivalent, while the remaining values exhibit significance at a 5% level of significance. Consequently, the scale developed comprises a total of 32 variables across 8 selected dimensions, as presented in Table 3 without considering the construct validity.

Table 3: ANOVA – Construct validity (* - Significant at 5%, ** - Significant at 1%) N=64

Sl. No.	Dimensions	Indicators	Mean-ANOVA	Pearson correlation coefficient	Items selected
1.	Economic dimensions	1. Profit	4.22**	.385**	✓
		2. Initial cost	4.31**	.439**	✓
		3. Supply chain	4.44*	.285*	✓
		4. Popularity /market share	4.30**	0.180 #	
		5. Viable market	4.31**	0.117 #	
2.	Financial dimensions	6. Credit access	4.36**	.477**	✓
		7. Credit support	4.17**	0.221#	
		8. Price expectation	4.09**	.584**	✓
		9. Delivery reliability	4.38**	.507**	✓
3.	Technical dimensions	10. Technical efficiency	4.14**	.255*	✓
		11. Availability	4.45*	.695**	✓
		12. Flexibility	4.34**	.456**	✓
		13. Observability	4.41**	.459**	✓
		14. Viability	4.36**	.311*	✓
4.	Environmental dimensions	15. Resource recycling capacity	4.00**	.252*	✓
		16. Local resource utilization	4.23**	.532**	✓
		17. Availability of supplies and services	4.17**	0.148 #	

		18. Sustainability	4.02**	.548**	✓
5.	Psychological dimensions	19. Perception of technology	4.42*	.461**	✓
		20. Emotional stability	4.23**	0.044 #	
		21. Decision making ability	4.28**	.361**	✓
6.	Human resource dimensions	22. Family labour	4.39**	.487**	✓
		23. Skilled labour requirement	4.22**	.286*	✓
		24. Interpersonal relationship	4.05**	.780**	✓
		25. Extension-officers' influence	4.16**	0.229 #	
		26. Acquisition of information	4.42*	.309*	✓
7.	Political dimensions	27. Bureaucratic support	4.27**	.640**	✓
		28. Open-source technology	4.27**	.532**	✓
8.	Management dimensions	29. Co-ordinating	4.28**	.523**	✓
		30. Budgeting ability	4.16**	.250*	✓
		31. Resource management	4.44*	.520**	✓
		32. Social networking	4.38**	.563**	✓

#- Items removed from the final scale as they failed to fulfil construct validity criterion (Pearson's correlation coefficient < 0.25)

Standardization of scale

Standardization of a scale requires both validity and reliability. A well-constructed scale should provide accurate and consistent results. Reliability refers to the ability of a test to produce consistent scores across different measurements. Validity, on the other hand, pertains to the extent to which a test measures what it is intended to measure.

In assessing the reliability of the scale used in this study, Kerlinger (1986) [8] defines reliability as the accuracy or precision of measurement. Reliability can be determined by calculating the proportion of true variance to the total obtained variance of the data obtained from a measuring instrument. In this study, split-half reliability was employed using the odd-even method. The scores obtained from the odd items and even items were combined separately. These two sets of scores were then correlated using Pearson's product-moment correlation.

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

(r = split half reliability, X= score of odd items, Y= score of even items)

The split-half reliability coefficient (r = 0.846) was obtained from the correlation of the two half-tests. To estimate the reliability coefficient of the entire test, the Spearman-Brown Prophecy formula was used.

$$r_{full} = \frac{2(r\ half)}{1+r\ half}$$

The reliability of the full test was found to be 0.917, indicating a significant level of reliability for the scale.

Validity of the Scale

Scientifically, the validity of a scale is crucial for obtaining meaningful and accurate results in quantitative research. In order for the scale to be considered valid, it must possess both content validity and construct validity.

Content validity refers to the extent to which the scale adequately covers the behaviour domain it aims to measure (Anastasiadou, 2011) [2]. In this study, the contents of the scale were derived from a list of dimensions and indicators that were carefully selected through expert discussions and based on relevancy scores. This process ensured that the scale effectively measures what it is intended to measure.

Construct validity, on the other hand, examines how well a test measures the construct it was designed to assess. To evaluate the construct validity of the scale, a Pearson correlation test was conducted by calculating the cumulative value and comparing it with the tabulated value for the degrees of freedom (n-2). The Pearson's correlation coefficient values were found to be greater than the tabulated value (0.25 at a significance level of 0.05), indicating strong construct validity for the majority of the indicators. However, six indicators were found to have correlation coefficients lower than the tabulated value, leading to their removal from the final scale.

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \Sigma(yi - \bar{y})^2}}$$

Where, r = Pearson Correlation Coefficient, xi = x variable samples, yi = y variable sample, $\bar{x}$ = mean of values in x variable, $\bar{y}$ = mean of values in y variable

As a result, the scale attests to its validity in elucidating the multifaceted aspects of technology within coastal home gardens. By rigorously adhering to the principles of both content and construct validity, this scale furnishes a robust and precise instrument for quantifying the designated construct in the research study and our resulting scale comprises a total of 26 variables distributed across 8 carefully chosen dimensions.

Conclusion

In conclusion, this research endeavour was aimed at constructing a dependable and valid scale for the comprehensive assessment of technology-related dimensions within coastal home gardens of Kerala. The process of scale development encompassed various critical stages, such as item collection, refinement, item analysis, and rigorous item selection. To gauge the significance of each item, scores were amassed from all respondents, and a relevancy index was computed. The Single ANOVA statistical tool was utilized for item selection, guiding the final selection of indicators that had a mean value lower than 4.49 (with a critical difference of 0.26). For the assessment of reliability, the split-half method, utilizing the odd-even technique, was adopted. This approach yielded a commendable correlation coefficient of r=0.846 for the half-test, while the full test exhibited a high level of reliability with a coefficient of 0.917. Furthermore, special emphasis was placed on ensuring that the selected items comprehensively covered the entire content domain pertaining to the diverse dimensions of technology, thereby satisfying the criteria of content validity. Additionally, the Pearson's correlation coefficient values surpassed the tabulated value of 0.25 at a significance level of 0.05, affirming the scale's construct validity. Consequently, our resulting scale comprises a total of 26 variables distributed across 8 carefully chosen dimensions.

Overall, this study successfully developed a reliable and valid scale that can be utilized to accurately assess the dimensions of technology in coastal home gardens, providing a valuable tool for future research in this area.

Acknowledgements

Highly thankful to Kerala Agricultural University for the fellowship and to the subject experts from KAU, Central Institutes, Commodity Boards, Change Agents/Professionals and Agricultural Officers from State Department of Agriculture, for their sincere evaluation of scale items.

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