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Scale to Assess the Sustainability of Rice-Wheat Cropping System

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ABSTRACT

Rice-Wheat Cropping System (RWCS) is a principle cropping system followed in Indo-Gangetic Plains (IGP). Though this monocropping system plays a key role in India's food sufficiency, it has led to various problems such as soil degradation, groundwater exploitation, environmental damage, yield plateau etc., posing challenge and risk to its sustainability. The scale was developed during 2021-22 to assess the perception level of farmers about the sustainability issues in RWCS. Summated rating scale method by Likert with standardized procedures was used to develop this scale. A total of 54 items were collected and sent to experts for relevancy analysis. Based on the results of relevancy analysis, a schedule consisting of 43 items was used to conduct personally interviewed pre-test. The items were further screened for their differentiating ability and thus, the final scale consisted of 31 items. The scale was found to be valid and reliable as ascertained by content validity and split half test reliability method, respectively. The reliability coefficient of 0.884 indicated the higher internal consistency.

INTRODUCTION

Rice and wheat are the staple foods in India, and the Rice-Wheat Cropping System (RWCS) is critical to the country's food security. RWCS is a monocropping system widely practised in South Asia, particularly in India's Indo-Gangetic Plains (IGP), including the states of Uttar Pradesh, Punjab, and Haryana. RWCS occupies 9.2 million hectares of area in India (Jat et al., 2020) and contributes to more than half of the food grain production of our nation thus, playing an important role in the nation's food sovereignty. The green revolution era ushered in a manyfold increase in food grain production, especially in rice and wheat with technological innovations such as high-yielding varieties, chemical fertilisers, pesticides, etc. However, these changes made the RWCS more resource intensive, resulting in soil degradation and ground water depletion, threatening the system's sustainability (Chauhan et al., 2012; Kumar et al., 2018). Other major threats to its sustainability include an exhausted nutrient pool of soil leading to its deterioration, groundwater depletion, rising production costs, labour scarcity, environmental pollution caused by improper crop residue management and increased greenhouse gas (GHGs) emissions, herbicide resistance in weeds, all contributing to climatic vulnerabilities (Dhanda et al., 2022). Farmers have been discouraged from pursuing other sustainable cropping methods due to insufficient procurement and assured minimum support price (MSP) regime, irrigation, and electricity facilities at subsidised rates. Farmers' lack of awareness and adoption of sustainable practises in RWCS has also exacerbated the problem.

Sustainability entails that it's not just enough to meet our own needs but we have to be conscious not to jeopardise future generations' ability to meet their own needs. Sustainability encompasses more than just being environmentally conscious. Most of the definitions of sustainability include concerns about social equity and economic development. According to the Food and Agricultural Organization (FAO), sustainable agriculture is the practise of food production that meets the needs of both current and future generations while ensuring profitability along with environmental health, social parity, and economic equity. In this

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context, the current study to develop a scale to assess the sustainability of the rice-wheat cropping system as perceived by farmers has become imperative. Perception is the process of selection, organization, and interpretation of sensory information about an object or construct (Fisher, 2021). Operationally, it was defined as the meaningful sensation and interpretation of the sustainability aspects of RWCS by the farmers. The ultimate goal of this scale was to probe the relationship between farmer perception and the effect it has on farmer adoption behaviour towards sustainable practises in RWCS. The farmers' perception and adoption behaviour are positively correlated as seen in the studies of Mottaleb (2018); Chatterjee et al., (2022); Choudhary et al., (2022) & Vecchio et al., (2022). During the exhaustive search for the appropriate research problem, it was found that little effort had been made in the study of farmers' perceptions of the sustainability of RWCS in particular. As a result, this scale aspires to bridge that chasm and contribute to the ocean of knowledge.

METHODOLOGY

This scale was developed using the standardized procedure of summated rating method as proposed by Likert (1932). For the construction of this scale, steps such as item collection and editing, relevancy analysis, item analysis, and scale standardisation were followed.

FAO (2014); Purvis et al., (2019); Gills et al., (2020) & Ahmed et al., (2021), delineate sustainability into three dimensions viz., environmental, social, and economic. A set of items on various issues of RWCS sustainability as perceived by farmers were gathered and grouped under their respective dimension from various available literature sources such as books, thesis, magazine, newspaper, and internet. Following consultation with researchers, extension experts, and farmers, a preliminary list consisting of 72 items was compiled. These were then screened using the 14 criteria proposed by Edward & Kilpatrick (1948) & Edwards (1969) for attitude scale construction. A set of 54 items meeting the informal scaling criteria were ultimately chosen from the pool of collected items.

For relevancy analysis, the items were sent via email to 90 judges with instructions to critically evaluate each item for its relevance (Kumar et al., 2016; Kumar et al., 2021; Gupta et al., 2022) on a five-point continuum of highly relevant (HR), relevant (R), neutral (N), irrelevant (IR), and highly irrelevant (HIR). Out of 90 judges, 39 responded within a time frame of two months, while five judges' responses being rejected due to incomplete and ambiguous responses. The Relevancy Percentage (RP), Mean Relevancy Weightage (MRW), and Mean Relevancy Score (MRS) for each of the 54 items were calculated for individual item following the criteria of relevancy percentage greater than 70 %, a mean relevancy weightage greater than 0.70, and a mean relevancy score greater or equal to the overall mean relevancy score of 3.83 (Raghuvanshi & Ansari, 2019) were conceded for final selection. This process resulted in selection of 43 items, which were then modified and rewritten in response to the comments of the judges.

Item analysis was conducted by personally interviewing 30 farmers from a non-sampled area using a schedule consisting of 43 items through responses on a five-point scale of strongly agree (SA), agree (A), undecided (UD), disagree (DA), and strongly disagree (SDA), with scores of 5, 4, 3, 2, and 1, respectively. The scoring pattern was transposed for negative items. The sum of the scores of all the items gave the perception score of a respondent. The respondents were then arranged in ascending order by their respective perception scores. 25 per cent of respondents each with the highest and lowest total scores which equals eight farmers each were chosen as two sets of criterion groups for evaluating the differentiating ability of individual items (Edwards, 1969). Each item may or may not distinguish the high group from the low group. This is known by calculating critical ratio i.e., the 't' value. The greater the 't' value, the greater its distinguishing ability. After computing that for each item, items with 't' value of 1.75 or greater were picked to be part of the final scale.

The method of content validity and split half method for reliability were utilized for standardization of the scale. The scale was divided into two sets based on odd and even number of items and administered to 30 farmers. As a result, two sets of scores were obtained. The Karl Pearson product moment correlation coefficient was calculated between the two sets of scores to determine the half test's reliability. This was corrected further by using the Spearman Brown formula to arrive at the reliability coefficient of the entire set, to determine whether the scale is reliable and valid for use in a variety of conditions.

RESULTS AND DISCUSSION

Validity and reliability analysis

Validity is defined as the accuracy with which a test measures what it is designed to measure (Thorndike, 1971). Content validity is the degree to which a test evaluates all aspects of the subject, behaviour, or construct that it is designed to measure. The current scale thoroughly covers the universe of sustainability issues in RWCS via literature review and expert opinion. All of the items had high differentiating values and met the procedural requirements of Likert's summated rating scaling technique. Accepting the scale as a valid measurement instrument, therefore, seems reasonable.

According to Anastasi (1968), the consistency of the scores produced by the same respondent to a test when administered on multiple occasions is called reliability. The split-half method was used to test the reliability of the scale. The scale was divided into two halves/sets based on the odd and even number of items and administered to 30 farmers of non-sample area. As a result, two sets of scores were obtained. The correlation coefficient between the set which gives the half test reliability was 0.792, which was corrected using Spearman's Brown formula to obtain the reliability coefficient (r) for the entire set. The 'r' value for scale was 0.884, which was significant at the one per cent level of significance, indicating the instrument's high reliability. Thus, the test is said to be valid and reliable for measuring farmers' perceptions about sustainability of RWCS. Table 2 shows the results of the reliability analysis.

The final scale consisted of 31 items, with 17 in environmental dimension and 7 each item in social and economic dimensions. It is a five-point scale with scores of 5, 4, 3, 2, and 1 for Strongly agree (SA), Agree (A), Undecided (UD), Disagree (D), and Strongly

Table 1. Relevancy and item analysis of selected items

S.No.	Items	RP	MRW	MRS	t-value
I	Environmental dimension				
1	One must aim at food production without depleting natural resources	94.12	0.94	4.71	4.10
2	Rice-Wheat Cropping System (RWCS) is not environmentally sustainable	72.94	0.78	3.88	3.13
3	RWCS is responsible for emission of greenhouse gases leading to global warming	76.47	0.81	4.06	2.65
4	RWCS practices such as puddling, excessive tillage, etc. results in soil health deterioration	84.71	0.85	4.24	3.24
5	Minimum tillage must be followed to conserve soil properties	87.06	0.88	4.41	2.97
6	Excessive use of chemical fertilizers is responsible for lowering soil fertility	85.29	0.85	4.26	3.46
7	RWCS has increased the multi micronutrient deficiency in soil	84.12	0.85	4.26	1.85
8	Practices such as mulching and green manuring should be followed for optimum soil health	85.29	0.86	4.32	2.96
9	Diversification with legumes in RWCS improves soil fertility	86.47	0.86	4.32	1.82
10	RWCS has created the problem of diverse weed flora	77.06	0.78	3.91	2.05
11	Excessive irrigation in RWCS results in soil erosion	84.71	0.86	4.29	2.05
12	The RWCS being irrigation intensive results in overexploitation of groundwater	83.53	0.85	4.24	1.99
13	Indiscriminate use of plant protection chemicals has led to pest and diseases resistance in RWCS	81.76	0.83	4.15	3.42
14	Monocropping of RWCS has given rise to outbreaks of new pests and diseases	82.35	0.84	4.18	2.55
15	In RWCS, an emphasis should be placed on integrated pest and disease management.	88.82	0.90	4.50	2.55
16	Stubble burning results in great loss of soil nutrients and beneficial soil microbes & creates pollution	88.24	0.88	4.41	2.26
17	Intensive practice of RWCS has led to yield stagnation	80.59	0.82	4.09	4.25
II	Social dimension				
18	Sustainable practices lead to the wellbeing of the farming community	82.94	0.84	4.21	2.04
19	Sustainable agricultural systems provide enough food to feed the world's burgeoning population	81.76	0.83	4.15	2.15
20	Farming community should be encouraged to adopt sustainable practices in RWCS	90.00	0.90	4.50	2.01
21	Everyone in community has a critical role to play in sustainable practice of RWCS	78.82	0.82	4.09	2.30
22	The relevant authorities must work together to raise awareness of the sustainability issues in RWCS	81.18	0.82	4.12	4.25
23	Formulation and proper implementation of policy measures for sustainability issues is essential	82.35	0.84	4.18	3.06
24	RWCS has led to increasing social divide among large and small farmers	72.94	0.77	3.85	2.77
III	Economic dimension				
25	Sustainable agriculture is economically viable for everyone	91.18	0.91	4.56	2.83
26	Even if it means sacrificing profits, one must protect the environment	84.12	0.85	4.26	4.86
27	One must aim at increasing the income through sustainable cropping practices	84.12	0.85	4.26	3.45
28	RWCS is economically sustainable	82.94	0.84	4.21	2.08
29	RWCS has become increasingly unprofitable due to rising cultivation costs	77.65	0.81	4.06	2.09
30	There is well established marketing and procurement system for rice & wheat in comparison other crops	75.88	0.79	3.94	6.35
31	In comparison to other crops, rice and wheat receive a lot of subsidies and crop insurance	84.12	0.84	4.21	2.49

Table 2. Reliability analysis of selected items

Cronbach's Alpha	Set 1 (Odd items)	Value	0.847
		N of items	22[a]
	Set 2 (Even items)	Value	0.778
		N of items	21[b]
Correlation Coefficient between sets		0.792	
Spearman-Brown Coefficient		Equal length	0.884
		Unequal length	0.884

Disagree (SDA), with the highest score of 155 and the lowest of 31.

CONCLUSION

The concept of sustainability of RWCS amidst the challenges of climate change and environmental safety is gaining a very high momentum to ensure food security of burgeoning population. The perception among farmers will highly influence the adoption of sustainabile practices. The measurement tool is created to assist researchers, policy makers and stake holders in determining pragmatic approaches for sustainability of RWCS. The scale is devised to assist them in conducting surveys to develop or design policies or programmes that will increase the productivity, profitability, and sustainability of the food production system. The created scale has a reliability coefficient of 0.884 which may be termed as highly consistent, hence usable under varied conditions.

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