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Perceived importance and performance of System of Rice Intensification (SRI) Between adopters and Dis-adopters: Insights from Indonesia

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Abstract

System of Rice Intensification (SRI) is an innovative approach to increase rice production. This study examines the perceived importance and performance of six system of rice intensification (SRI) attributes by adopters and dis-adopters in Indonesia. The six attributes identified were 'profit', 'risk' 'effort', 'compatibility', 'assurance', and 'simplicity'. The importance-performance analysis revealed that 'profit' was the primary attribute. It was followed by 'risk' and 'effort'. However, their below average performance caused them to fall into the 'concentrate here' quadrant. These major weaknesses require immediate attention for an improvement in the uptake of SRI to occur. Given that local rice systems are competitive, SRI is more likely to be adopted and continued in use when it clearly demonstrates a degree of profitability that sufficiently outweighs its costs, associated risks and efforts, and opportunity costs. Market-based (i.e. access to high value market/returns) solutions are more sustainable (than government incentives) and therefore recommended. This study has made an important contribution to previous understanding of innovation diffusion by demonstrating the importance and performance of SRI attributes as perceived by Indonesian adopters and dis-adopters.

Keywords: System of rice intensification; Importance-performance analysis; Attributes; Adoption; Disadoption.

1. Introduction

Unlike most improved agricultu technologies (i.e. fertilizers, irrigation and seeds) and systems (i.e. Good Agricultural Practices), the invention of the System of Rice Intensificati (SRI) lies beyond the conventional circle of science-based experiment systems. The basic concepts of the SRI are (1) transplanting of young healthy rice seedlings (8-12 days old), handling their roots carefully and transplanting them only 1-2 cm deep, preferably just one seedling per point; (2) wide planting spacin (25 cm x 25 cm or wider); (3) applying irrigation water intermittently (Styger *et al.*, 2011). Fertilization utilises 100% organic or 100% inorganic fertilizer or a mixture of these. Given wide-scale availability of local resources, organic fertilizers are recommended highly. Organic matter is beneficial since it improves soil structure and quality, which has a direct impact on soil fertility and on its ability to retain soil moisture. In conseq ce, SRI works better with organic fertilizers. Sub-groups of the SRI users emerged who farmed organic rice (Stoop *et al.*, 2002; Styger *et al.*, 2011).

Controversy has centred on the claimed potential of the SRI's agronomic and economic performance. The SRI has been pitched as a pro-poor technology in t it can help improve yield albeit using lesser inputs of seed, er, and fertilizer. Support for that contention is widely documented on a range of sites (Berkhout and Glover, 2011; Styger *et al.*, 2011; Thakur and Amod, 2010; Yang *et al.*, 2017). Most studies demonstrate a net positive impact on farm profit. However, the application of SRI might come at a cost to household income. Because SRI requires intensive labour inputs, family members who were previously able to be involved in off-farm economic activities are reallocated to help address on-farm need (i.e. in manual weeding). Consequently, net household income gains have been found to be negligible (Noltze *et al.*, 2012; Takahashi *et al.*, 2013). Such focused reliance exposes farm households to greater risk and uncertainty.

Given competing empirical evidence and "without the clear stamp of scientific approval" (Glover, 2011), farmers' adoptive decisions are made according to their impressions regarding the attributes o e SRI (Dimara and Dimitris, 2003 If men perceive situations as real, they are real in their consequences" (Thomas and Thomas, 1928). It is the individuals' perceptions of the attributes (not the objective attributes suggested by experts) that matter

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Rogers (2003). More specifically, some attributes are more meaningful than others to farmers, and their functioning is crucial to convince farmers to either adopt or to retain farmers in using the SRI. Such a concept is similar to consumer satisfaction, which hinges upon both expectations toward important attributes and subsequently judgements of their performance.

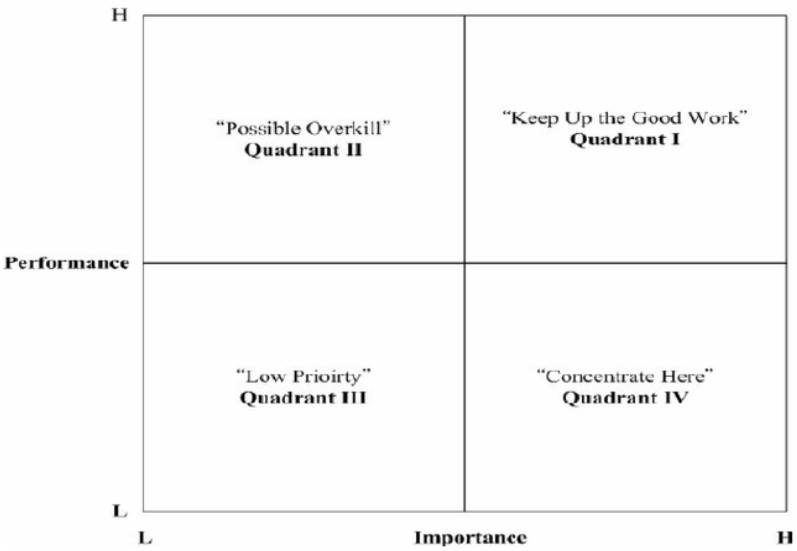
However, existing adoption research (Adesina and Moses, 1993) on agricultural innovations has largely been driven by Rogers (1962). It has explored the effects of the perceived performance of certain attributes on adoptive decisions. It is assumed that the investigated attributes are important and that the positive views toward them would lead to an inclination to use the innovation in question. As the adoption of an innovation is conceptualized as an investment, perceived profitability becomes a common attribute in the literature. This attribute is posited to demonstrate greater influence than technical feasibility in Cary and Roger (1997). Not only is the evidence such prioritisation claim scant, the number of attributes investigated in previous studies is also limited. Consequently, clear evidence to help practitioners understand how to improve an innovation and/or encourage more adoption, is lacking, particularly among adopters and dis-adopters. As there is lack of agreement among researchers with respect to the definition of "adopters" and "dis-adopters", a consideration given by Berkhout and Glover (2011); Takahashi *et al.* (2013) was applied. Farmers who apply at least one core component of SRI practices can be classified by adopters while dis-adopter can be referred to farmers that have tried the SRI method but discontinue the practice. Furthermore, adopters are farmers who adopt and retain the method (Moser *et al.*, 2003).

Importance-performance analysis (IPA) has been extensively used in the past to spot gaps that necessitate interventions in areas, such as service quality (Noltze *et al.*, 2012), travel and tourism (Dwyer *et al.*, 2016). This type of analysis facilitates structured assessment of the performance of important attributes with respect to a particular innovation. The output is particularly appealing because, through its systematic step-wise approach, it allows policymakers to comprehend what factors matter to farmers and how they value them. This generates better understanding of attribute importance-performance underpinning adoptive behaviour towards the SRI. The objectives of this study is to 1) group SRI attributes into a small number of interpretable factor using factor analysis, 2) identify, using Indonesian farmers' perspective, the importance and performance of SRI attributes between adopters and dis-adopters.

2. Conceptual Framework

Martilla and John (1977) IPA conceptually rests on multi-attribute models. Unlike Rogers (2003) multi-attribute model, which described the degree of perception of attributes, their IPA is commonly used for prioritizing attributes and measuring their performance to understand the likelihood of acceptance by potential customers. The underlying framework of IPA is presented as a matrix (Fig. 1). Attributes are classified according to their mean values of importance and performance in a two-dimensional grid. As such, the IPA is theorized that the target levels of performance of particular attributes should be proportional to their importance (Natawidjaja *et al.*, 2008). Highly important attributes should display higher performance standards than those of lower importance. In other words, importance reflects the relative significance with which farmers regard the various attributes. Attributes of higher (lower) importance are likely to play a bigger (smaller) role in affecting the adoption of an innovation. Figure 1 illustrates importance (the vertical axis) and performance (the horizontal axis) of attributes as two key criteria that farmers use in making a choice. Martilla and John (1977) demonstrated that the placement of attributes in this matrix suggests the suitability of individual strategies. Matrix of important-performance analysis consist four quadrants: 1)"keep up the good work", 2)"possible overkill", 3)"low priority" and 4) "concentrate here" (Fig. 1).

Figure-1. Matrix of importance-performance analysis



The framework of the IPA, as described above, is pragmatic. The IPA helps identify important areas where performance should be maintained at present levels or where improvement is likely to have significant effect on adoptive decision-making. It also generates insights into which areas are of little importance and in respect to which interventions will have little impact. As such, it is a useful management tool to understand the subjective wellbeing of an innovation from the farmer's point of view and, subsequently, provides a guide to translate the results into actions.

3. Methodology

3.1. Study Area

In Indonesia, SRI was introduced in 1987. The first site for SRI was managed by the Rice Research Centre in West Java. Between 2005 and 2010 it was actively promoted to some 134 regencies. In this study, the Tasikamalaya regency of West Java, the Purbalingga regency of Central Java and the Tabanan regency of Bali provinces were selected since they each had different exposure to the SRI. Tasikmalaya is one of the pioneer districts and has generated the pilot projects of SRI in Indonesia since 1990s (Natawidjaja *et al*., 2008). This regency is therefore notable both for SRI research and as being a key learning resource to other SRI enthusiasts. In contrast, the Purbalingga and Tabanan regencies were only introduced to the SRI in the mid-2000s.

3.2. Data Collection

The data collected for this study was gleaned through a questionnaire focussed on the attributes of SRI. To meet the objectives of this study, the questionnaire consisted of 31 statements that were designed to separately seek respondents' degree of perceived importance and performance using 5-point Likert scale. Portions of these statements were derived from variables listed in Rogers (2003) and other literature. Other statements were included on the basis of their significance to the SRI attributes elicited through a preliminary ground engagement and focus group discussion in which both adopters and dis-adopters of the SRI participated. The questionnaire was originally prepared in English. Given that most rice farmers are non-English speakers, it was then translated into the Indonesian language. When selected adopters and dis-adopters of SRI farmers in the field, we carefully used a list of farmers or farmers groups that followed SRI program given by local agricultural extension. After that, screening questions regarding SRI as well as past and present farmer practices were also asked. The survey was carried out between April and September 2015.

We aimed to collect primary information from approximately 360 respondents using a stratified sampling method. Some 60 respondents (a mix of adopters and dis-adopters) were identified for each stratum. Non-users were filtered. Assisted by six (6) trained enumerators (agricultural students), a total of 356 rice producers in West Java, Central Java and Bali were randomly interviewed.

Principal component analysis was employed to group the 31 Likert-scale items of perceived importance into a small number of interpretable factors. This type of factor analysis is commonly used in social science research for collating variables that measure the same factor and ascribing a meaning to the factor. Using the Kaiser eigenvalue criterion and the scree test, as suggested by Nunnally and Bernstein (1997).

Importance-performance analysis was used to evaluate the strengths and weaknesses of SRI attributes. As described in Fig. 1, quadrant 1, in which attributes are ranked high both in importance and performance, implies management to "keep up the good work". Quadrant 2 indicates that those attributes rated high in importance but low in performance need special attention. Those attributes in Quadrant 3, which are of low importance and rated standard in performance, demand low priority. Quadrant 4 suggests that "overkill" has occurred towards attributes that are low in importance but ranked high in performance (Dwyer *et al*., 2016).

3.3. Sociodemographic Respondents or Adopters and Dis-Adopters

Their socio-demographic information is presented in Table 1. Reflecting the domination of male farmers in rice farming activities, 86 percent of the 356 respondents is male. Nearly all of the interviewees are married and have an average family size of four (4). With the mean age of 53 years old, they have worked as rice farmers for approximately 31 years. In the sample, the use of SRI was reported as beginning in 2004. The first cases of abandonment occurred in 2007.

Table-1.Socio-demography of the 356 respondents

	Adopters (n=176)		Dis-adopters (n=180)		Total (n=356)	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Male	0.84	0.37	0.89	0.32	0.86	.343
Education*	1.57	0.17	1.77	0.20	1.68	0.19
Married	0.97	0.165	0.99	0.25	0.99	0.25
Family members	4.17	1.77	3.84	1.96	4.01	1.87
Age (years old)	52.19	14.64	54.70	11.45	53.45	13.18
Number of years as rice farmer	29.21	15.33	32.66	15.18	30.94	15.33

* University degree/diploma (4); Senior high school (3); Junior high school (2); Primary school (1)

4. Results

4.1. Descriptive Analysis Of Sri Attributes Between Adopters And Dis-Adopter

Table 2 shows the statements that were used in our survey to elicit from respondents' the perceived importance of SRI attributes with the respective distribution of Likert scale responses and descriptive statistics. The scale was defined as (1) extremely unimportant, (2) unimportant, (3) neutral, (4) important, and (5) extremely important. Based on the mean score, most of the attributes were regarded as important (M=≥4) by respondents. For example, the highest mean score of initial cost (M=4.56, SD=0.565) and profit (M=4.56, SD=0.560) of the SRI indicates that they were deemed important in the farmers' motivation to adopt the innovation. Specifically, for the same attributes, that degree of importance was indicated by approximately 40 percent of the respondents while greater emphasis was assigned by nearly 58 percent of the respondents. Exceptions are those with a mean score below 4 (but above 3). For such respondents the attributes were seen as relatively less important. For instance, in relation to the use of the SRI methods, more than 25 per cent of them shared a neutral view on the importance of opportunities to export (M=3.53, SD=0.854) and as a preparation for future business challenges (M=3.70, SD=0.749)

Table-2.Distribution and descriptive statistics of "importance" statements

How important are the following items to you when considering the System of Rice Intensification?	Descriptive statistics	
	Mean	Std. Deviation
Minimize chemical applications	4.35	0.624
Award of government incentives	4.24	0.856
Security of land right	4.22	0.604
Food safety	4.31	0.521
Product quality	4.35	0.558
Farm workers' health	4.36	0.550
Consumer confidence in my vegetables	3.96	0.683
Business reputation	3.80	0.684
Ability to export	3.53	0.854
Selling prices	4.38	0.643
Get ready for future business challenges (i.e. free trade)	3.70	0.749
Sales	4.33	0.588
Profit	4.56	0.565
Farming time	4.25	0.605
Farming effort	4.30	0.577
Initial costs	4.56	0.560
Risks	4.37	0.688
Immediate returns	4.59	0.622
Compatibility with your need to improve food safety	4.10	0.485
Compatibility with your need to improve product quality	4.08	0.495
Compatibility with your need to improve farm sustainability	4.18	0.480
Compatibility with your value on increasing farm production	4.20	0.571
Compatibility with your self-concept as a responsible farmer	4.05	0.528
Modification of your farming practices	4.05	0.602
Training for farm workers	4.17	0.623
Simplicity to understand	4.03	0.483
Simplicity to plan	4.02	0.460
Simplicity to implement	4.16	0.557
Simplicity to evaluate	4.01	0.451
Testability on a small plot	3.53	0.803
Visibility of the impacts on my produce	4.19	0.617

4.2. Factor Analysis

Suitability of our data for factor analysis was then assessed using the Kaiser-Mayer-Olkin's (KMO) measure of sampling adequacy. Our KMO measure value 0.867, which is greater than (Hair *et al*., 2010) suggested 0.6 benchmark, indicates that our data was likely to factor well based both on correlation and partial correlation. Support for the correlation was given by the significance in Bartlett's test of sphericity, which concludes that the items in the population correlation matrix are correlated.

In an unrotated matrix, factor loadings allow for the description of each factor and the structure in the set of items (Hair *et al*., 2010). In cases of 'testability on a small plot', 'ability to export', and 'get ready for future challenges', they presented unacceptable factor loadings (significantly lower than 0.4) and a communality value (significantly lower than 0.5).Consequently, they were eliminated.

The Varimax rotation method was used to rotate the remaining 28 items with a specification of six (6) retained factors. The rotated factor matrix is presented in Table 3. Items with a loading greater than 0.4 were considered significant and salient to the interpretation of their respective factor. They were grouped under their respective factor. The six (6) factors were labelled with a descriptive theme, largely correlating with the items with the higher

loading. The reliability of the scales of the items was achieved as Cronbach's coefficient alpha for each factor was higher than a generally acceptable benchmark of 0.7 (as suggested by Hair *et al.* (2010)).

Table-3. Rotated factor matrix, Cronbach's alpha and summated scale

	Factor					
Items	**1**	**2**	**3**	**4**	**5**	**6**
Simple to evaluate	0.833					
Simple to plan	0.829					
Simple to understand	0.802					
Simple to implement	0.740					
Little modification to my existing farming practices	0.717					
Little need for training farm workers	0.674					
Visible impacts on my produce	0.464					
Compatible with your value on increasing farm production		0.832				
Compatible with your need to improve food safety		0.810				
Compatible with your need to improve product quality		0.780				
Compatible with your need to improve farm sustainability		0.678				
Compatible with your self-concept as a responsible farmer		0.633				
Greater profit			0.790			
Higher selling prices			0.720			
Greater sales			0.691			
Lower initial costs			0.687			
Greater immediate returns			0.654			
Product quality				0.741		
Enhanced food safety				0.726		
Security of land right				0.711		
Greater consumer confidence in my product				0.615		
Better business reputation				0.556		
Enhanced farm workers' health				0.509		
Award of government incentives					0.768	
Reduced risks					0.696	
Better control on chemical applications					0.633	
Reduced farming time						0.790
Reduced farming effort						0.707
Cronbach's Alpha	0.873	0.863	0.837	0.807	0.715	0.861
Summated scale	4.09	4.12	4.49	4.16	4.32	4.28

Factors 1, 2, 3, 4, 5 and 6 are labelled as 'complexity', 'compatibility', 'profitability', 'assurance', 'risk', and 'effort' respectively. Taking 'simplicity' as an example, it is measured by seven (7) items and labelled according to 'simplicity to evaluation', 'simplicity to plan', 'simplicity to understand' and 'simplicity to implement' that load highly on the factor. Although the lowest summated scale (4.09) is recorded for 'easiness' among all factors, it was regarded important by the respondents. The highest summated scale (4.49) of the 'profitability' factor indicates that it is of primary concern for the respondents when considering the use of SRI.

4.3. Importance-Performance Analysis and Results

Using the derived factors (from factor analysis), IPA was employed to compare the perceived importance and performance of the SRI attributes between adopters and dis-adopters. Means of the perceived importance and performance of the six (6) factors and their underlying 28 attributes were computed and plotted into their respective graphical grids. Cross-hairs, using their median values, were drawn to separate the graphical grids into four (4) identifiable quadrants as proposed by Dwyer *et al.* (2016). The resultant importance-performance grids, as presented in Figure 2, display the importance of attributes on the vertical axis from high (Moser *et al.*) to low (bottom) and the performance of attributes on the horizontal axis from high (right) to low (left).

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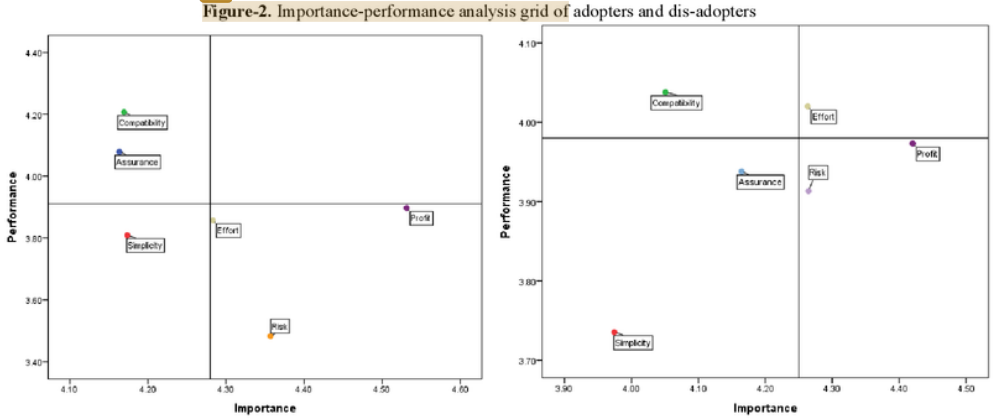
Figure-2. Importance-performance analysis grid of adopters and dis-adopters



(a) Adopters (b) Dis-adopters

5. Discussion

'Effort' found itself positioned in the 'concentrate here' and the 'keep up the good work' quadrants. Despite sharing similar importance, its performance was rated low by adopters and high by dis-adopters. At the time of writing, effort was still on-going to modify existing transplanter practises in order to transplant a single seedling per point. Seedlings were transplanted by hand into the node of a square marking, which are made on the puddled fields either by ropes or iron roller type marker, at 1-2 cm depth. Weeding is necessary to remove nutrient competitors due to the wide plant spacing. Because chemical inputs are discouraged and weeding machine are not readily available, weeding needed to be carried out both manually and more frequently. Similarly increased labour intensity also applied to organic fertilizer application. Since the slow and gradual release of nutrients from organic fertilizers necessitates repeated applications in order to build up soil fertility over time. In a similarly environmentally friendly manner, pests and diseases are controlled largely using biological methods. Considering the reliance on labour input as discussed, it becomes obvious that the SRI practices demand both greater effort and time. It is, however, unclear why dis-adopters expressed a different view given that there has been little progress in the mechanization of SRI methods.

In the 'concentrate here' quadrant, 'profit' was assigned the highest importance but moderate performance by both adopters and dis-adopters as well as among all attributes. Such prime importance is also found by Tey *et al.* (2014) relative to other attributes of good agricultural practices. Based on its principles, SRI methods incur very little investment cost. Production costs vary when farmers decide to use specific agricultural practices and synthetic and/or organic inputs (i.e., fertilizers). Costs are additionally affected by the type, quantity and frequency of use of the inputs. Because of good agricultural practices, the output is generally regarded as healthy rice. However, a significant price differentiation appears within the study areas. In the Purbalingga regency, organic SRI rice, which is distributed to Jakarta (the capital city) and directly to consumers through the Pamorbangga Farmer Association, commanded a price premium of about 50% above the wholesale price (IDR8,000/kg) of the local white rice. However, in the Tasikmalaya and Tabanan regencies, differentiation generated negligible added value to SRI farmers, who sold their rice outright to middlemen (including farmers' groups). As a result, in general, both adopters and dis-adopters in our sample reported average earnings

'Risk' was positioned in the 'concentrate here' quadrant and was viewed as a secondary important attribute. Like any business enterprise, farming involves taking risks to obtain a higher income than might be obtained otherwise (Harwood *et al.*, 1999). Most respondents associated risk with the likelihood of monetary loss resulting from crop failure or other misadventures. Transplanting young seedlings singly was deemed to make each seedling both less tolerant to winds and more susceptible to being washed away. Failure to replace a damaged or missing plant reduces rice production. Wide spacing between crops was deemed to make weeds more competitive and require greater time and effort for weeding in the absence of using chemical weedicides. Intermittent irrigation was often affected by inconsistent water supplies. Although the existence and degree of these challenges clearly depend on localities, the survey results indicated that adopters perceived SRI as having higher risk than did dis-adopter. However, this apparent anomaly might have a logical explanation: since dis-adopters have returned to using traditional methods, their negative impressions towards SRI might have diminished over time. Notwithstanding this result, both adopters and dis-adopters suggested that government incentives can help to minimize the risk.

'Compatibility' was positioned in the 'possible overkill' quadrant of low importance in the grid of adopters and of high performance in the grid of dis-adopters. High compatibility was achieved in terms of the farmers' need to improve production, food safety, product quality and farm sustainability in addition to being a responsible farmer. Such desirable states were seen as fundamental by respondents. Consequently the IPA indicates that these items were not their main concerns. Both adopters and dis-adopters shared the same opinion that they were aware of other comparable systems, and those systems can produce similar or even better results. A local rice system is *Jajar Legowo* in which planting distance between plants is systematically coordinated was frequently cited by respondents

to produce both comparable yield and crop quality. Importantly, a shift from the SRI to using such an alternative system incurs few switching costs and it can be implemented as immediately as the next crop.

'Assurance' had a position in the 'possible overkill' by adopters and the 'low priority' quadrants by dis-adopters. Despite of its low importance, adopters opined that the SRI methods enhanced the degree of food safety, consumer confidence in their rice, their business reputation, and workers' health and safety. It was also said that renewal of public or privately leased land was relatively easier for SRI users. These assurance impacts, however, were less applicable to dis-adopters. Such opinions were particularly emphasised by those who did not get to participate in high value markets. Food safety, consumer confidence and business reputation have little relevance in traditional rice markets. Probability of lease renewal was said to be most effective with rent increment. The health and safety of workers was claimed to be well protected by the use of personal protective equipment.

'Simplicity' was captured of low importance and performance and was categorized as 'low priority'. For both adopters and dis-adopters, farming itself is challenging. SRI methods present a new set of challenges without offering immediate solutions. Respondents are put on a steep learning curve which demands understanding, modification, planning, the training of workers, and the implementation of SRI farming practices. The learning process is not linear, but is rather carried out in a trial and error mode. Pest control serves as a good example. Initially, biological pest control was activated only after the presence of a pest became evident. Given that the consequent reaction is not instant, greater crop loss is inevitable when compared with the application of an effective pesticide. After learning both how pests developed and their patterns, specific preventive measures were rotated to control particular pests. The inability to address such complexity comes with a risk of crop loss or failure and was claimed to prompt the discontinuation of the SRI methods.

The unconventional diffusion of the SRI is notable and displayed many unique characteristics. SRI farmers (both current and past) make their adoptive and dis-adoptive decisions based on subjective perceptions rather than on objective truth. Viewed in this light, the SRI is constantly open to question and review. Such perceptions are constantly shaped through learning-by-doing. As the process continues, the quality of their decision making increases with their increasing knowledge of and experience of SRI.

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6. Conclusions and Policy Implications

In this study, the IPA reveals that 'compatibility', 'assurance', and 'simplicity' attributes were of insignificant importance. Subsequently, monitoring their performance becomes less meaningful. That is likely to hold true for currently engaged adopters and dis-adopters of the SRI (i.e. the group assessed for this study). However, for potential adopters and non-adopters, these attributes are likely to be considered as basic indicators. They should necessarily be spelt out in any initial promotion since they are felt critical in any decisions a farmer might take towards adding SRI to their shortlist of potential innovations. These three (3) attributes are more relevant to those who are in the early stage of the learning process with regard to the SRI. It is therefore axiomatic that a distinct policy should be assigned to recruit potential SRI users.

Attributes that are deemed important in this study, in ascending order, were 'profit', 'risk', and 'effort'. As these are business-like attributes, it is necessary to be aligned with the interest of farmers by seeing the SRI as an investment. However, their performance, in general, was below average. Such gaps are likely to imply that the expectations of present and former SRI users were not met. In order to make SRI more economically attractive for present and former SRI users, some efforts could focus on increasing profits through a competitive price and access to high value markets. This can be achieved if the consumers have enough knowledge of product benefits through promotion. Risks is also identified as the weakness of SRI. In addition, weeding mechanization can save farmers' time and effort as well as decreasing crop failure due to nutrient competition. As we have emphasised, it is paramount to make the SRI financially attractive. One clear implication of this is that the common strategy for promoting adoption and continuation through communication and education activities is unlikely to be fruitful unless farmers are convinced that returns sufficiently outweigh costs. Not only is such a business-as-usual model a waste of public money, the professional standing of extension agents might also suffer. Consequently, change agents (i.e., government agencies and NGOs) should invest time and resources in attempting to identify high value markets for SRI rice before proceeding with strategies promoting its uptake.

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