

Feasibility of introducing integrated rice-fish farming in Hambantota District, Sri Lanka

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Abstract

This study examined the feasibility of introducing integrated rice fish farming (IRFF) system among rice farmers in the Hambantota District, Sri Lanka, by assessing their knowledge, perceptions, misconceptions, constraints and perceived potentials. A cross-sectional study design with a two-stage sampling procedure was employed. Data were collected from 100 randomly selected farmers under major irrigation schemes using structured questionnaires and individual interviews. Statistical analyses included chi-square tests, Pearson correlation and binary logistic regression to identify factors influencing willingness to adopt. Results showed that younger, better-educated and land-owning farmers with smaller landholdings were more willing to adopt IRFF system, while older and more experienced farmers were less receptive. Knowledge and perception were positively associated with feasibility to adopt, whereas constraints had a significant negative effect. Logistic regression confirmed knowledge, perception and constraints as the most decisive predictors of adoption feasibility, with higher knowledge and favourable perceptions substantially increasing feasibility and constraints reducing it. Although myths did not directly affect feasibility, they were negatively correlated with knowledge and perceptions, suggesting an indirect influence. The findings suggest that the feasibility of introducing IRFF system may be enhanced by improving farmer knowledge and perceptions through targeted extension and demonstration programs, while addressing institutional and resource-related constraints.



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Introduction

Rice (*Oryza sativa* L.) is one of the most important staple foods globally serving as the primary food source for over half the world's population (Jiang *et al.*, 2020). Asia accounts for about 86% of the global rice area and contributes about 90% to global rice production (Samal *et al.*, 2022). Sri Lanka, like many other Asian nations, has a deep-rooted history in rice cultivation, with paddy fields dominating large portions of the rural landscape (Huraira and Seinulabdeen, 2021). Rice is the primary staple food crop that covers nearly 40% of the cultivated land in the country, while the majority (66%) of these paddy lands are less than one hectare (Ratnayake *et al.*,

2023). Rice farming has long been tied to both the cultural and economic life of the island's agrarian communities (Moreen *et al.*, 2022). According to Lebbe (2014), 95% of the domestic staple food requirement is fulfilled by rice and curry, underscoring the significance of paddy production in the Sri Lankan context. However, with growing concerns over food security, environmental sustainability and the socioeconomic challenges faced by small-scale farmers, innovative and sustainable agricultural practices are necessary to maintain and enhance productivity (Dissanayake *et al.*, 2021). In this context, several approaches have been widely adopted in many nations such as genetic improvements in seeds, soil amendments, agrochemical developments,

diversification of farming practices and integrated agriculture (Halwart and Gupta, 2004; Lal, 2011; FAO, 2017).

Among these approaches, the integration of rice farming with aquaculture dates back centuries in various parts of Asia (Kumara *et al.*, 2024). Integrated rice fish farming (IRFF) system is a traditional, nature-based practice in China, India, Bangladesh, Malaysia, Indonesia, the Philippines, Thailand, Vietnam and many others. It contributes significantly to both economic and environmental sustainability (Halwart and Gupta, 2004; Gangaiah *et al.*, 2019; Bashir *et al.*, 2020; Ahmed and Turchini, 2021). The system offers mutual benefits: while fish contribute to the ecosystem by controlling pests and fertilising rice crops, while rice fields provide shelter and nutrition for the fish (Kumara *et al.*, 2024). In addition to boosting overall land productivity, IRFF system enhances biodiversity, reduces reliance on chemical inputs and offers farmers an additional source of income (Ahmed and Turchini, 2021).

China is one of the pioneers of IRFF system, where the system has been successfully practiced for over a thousand years (Tang *et al.*, 2020). The Chinese experience demonstrates how traditional agricultural systems can provide sustainable solutions to food security challenges while contributing to economic resilience in rural areas (Weimin, 2010). This success has attracted global attention, leading the United Nations Food and Agriculture Organisation (FAO) to recognise China's IRFF system as a Globally Important Agricultural Heritage System (GIAHS) in 2005 (Ahmed and Garnett, 2011; Jian *et al.*, 2011; Xie *et al.*, 2011; Jiao and Min, 2017; Sathoria and Roy, 2022). In Bangladesh, IRFF system has been an integral part of rural livelihoods for centuries (Ahmed and Garnett, 2011). Their experience demonstrates that IRFF system can play a key role in addressing not only hunger and malnutrition but also poverty, by offering rural communities an additional source of income (Ahmed and Garnett, 2011). The Government of India has implemented natural farming-based agricultural methods through strategic planning under the National Mission on Natural Farming (GOI, 2024). For instance, the Andhra Pradesh government has recognised IRFF system as a potential tool to accelerate agroecological transition under the Andhra Pradesh Community Managed Natural Farming (APCNF) program (Samaddar *et al.*, 2025). In areas such as the Mekong Delta in Vietnam, IRFF system has contributed to enhanced food security and rural development by improving both fish and rice productivity (Bosma *et al.*, 2012). Some studies in Vietnam have shown that IRFF system can provide a competitive alternative to intensive rice monocropping if farmers reduce pesticide use and leverage the ecosystem services provided by rice-field systems (Berg *et al.*, 2012). These success stories illustrate the adaptability of IRFF system to various climatic conditions, soil types and economic contexts, making it an attractive option for other rice-producing nations, including Sri Lanka (Weimin, 2010).

A key factor influencing the feasibility of introducing IRFF system is the reliability and governance of irrigation systems. Globally, IRFF system has been widely practiced in irrigated paddy fields, particularly on small holder farms that rely on canal irrigation with rotational water releases (Sathoria and Roy, 2022). Research demonstrates that the successful adoption of IRFF system in Sub-Saharan Africa requires adapting system design to existing farm conditions and ensuring sustainable water governance through collective action and accountability (Koide *et al.*, 2015). However, irrigation schemes are increasingly vulnerable to

climate variability, competing demands and institutional limitations in water management. Cambodia illustrates these challenges, where irregular water releases, poor infrastructure, sectoral competition and weak coordination among agencies undermine rice intensification, despite a significant government investment (Sithirith *et al.*, 2024). In Vietnam's Mekong Delta, farmers with better access to irrigated fields, capital and knowledge of IRFF system were more likely to adopt the system, confirming that reliable infrastructure and resource access available are key drivers of adoption (Bosma *et al.*, 2012).

Despite such challenges, IRFF has proven workable under similar conditions in Asia. In China and Vietnam, farmers synchronised fish stocking with irrigation schedules and constructed small refuge ponds or trenches to safeguard fish (Halwart and Gupta, 2004; Frei and Becker, 2005). In Bangladesh, water user associations helped reduce conflicts and ensured equitable water allocation (Ahmed and Garnett, 2011). Integrating backup water systems that utilise rainwater, groundwater and surface water can reduce dependency on canal irrigation (Ahmed *et al.*, 2022). These solutions demonstrate that, with appropriate field modifications, institutional support and farmer participation, IRFF can be sustained even in water-limited regions.

Experiences from India show that IRFF is successfully practiced under diverse irrigation conditions, including rainfed lowlands, medium lowlands and irrigated plains, often managed by smallholder farmers with fragmented plots of less than one hectare (Sathoria and Roy, 2022). Traditional systems such as Zabo in Nagaland and Apatani in Arunachal Pradesh rely on harvested rainwater or small stream irrigation, while modern models in Odisha and Bihar integrate canal irrigation with refuge ponds and nurseries. In the Golinga irrigation scheme, smallholder rice farmers practicing IRFF achieved higher rice yields (from 3.5 to 4.6 - 5.8 t ha⁻¹) and greater incomes through improved IPM skills and integrated farming practices (Ibrahim *et al.*, 2013). Ahmed *et al.* (2022) found that IRFF can remain viable in such environments when canal irrigation is supplemented with groundwater, harvested rainwater, or collectively managed distribution systems. These examples demonstrate that IRFF is adaptable to dry and semi-arid areas with small plots, provided it is supported by efficient water harvesting and supplementary irrigation measures (Sathoria and Roy, 2022).

In Sri Lanka, the feasibility of introducing IRFF system depends on its alignment with existing irrigation schedules, rather than requiring additional water. Farmers can raise bunds, create refuge ponds and adopt water-saving techniques such as lining bunds and refuges with impermeable materials (Jian *et al.*, 2011; Lokuhetti *et al.*, 2025). Agro-wells and tube wells like supplementary water sources are prioritised as the first-ranked adaptation strategy by farmers in dry zone farming systems in Sri Lanka, indicating a reliance on these alternative water sources for coping with climate-related vulnerabilities (Dilini *et al.*, 2020). Bosma *et al.* (2012) noted that prioritising irrigated paddy lands near ponds or water sources and involving farmers with greater financial resources and knowledge of IRFF system, would enhance feasibility. Such measures can enable IRFF system to effectively complement existing irrigation systems in districts like Hambantota.

It is equally important to recognise that not all paddy lands and farms are suitable for the implementation of IRFF system. Evidence from

China, Vietnam, Bangladesh and Cambodia indicates that IRFF system was typically limited to zones with reliable irrigation, sufficient flooding duration and appropriate plot sizes, while other areas were excluded (Jian *et al.*, 2011; Dey *et al.*, 2013; Freed *et al.*, 2020). Systematic land suitability assessments, as conducted in other countries prior to IRFF system implementation, are necessary in Sri Lanka to identify feasible locations for this approach. For example, in India, although an estimated 20 million ha of land is suitable for IRFF system, only 0.23 million ha are currently under cultivation using this system (Mansharamani *et al.*, 2020). To promote its adoption, the ICAR-Central Rice Research Institute (ICAR-CRRI), Cuttack, Odisha, has developed several IRFF system models tailored to the Indian context (Poonam *et al.*, 2019; Nayak *et al.*, 2020). However, identifying suitable land with adequate infrastructure alone does not guarantee successful implementation. Even under favourable conditions, feasibility depends on farmer acceptance, institutional support, and community cooperation (Dey *et al.*, 2013).

Despite the country's long history of rice cultivation and the availability of irrigation infrastructure, no systematic study has yet been conducted to assess farmer's readiness or feasibility of adopting IRFF system under local conditions. In particular, there is a lack of experiential evidence on how farmer knowledge, perceptions, misconceptions, constraints and perceived potentials influence the feasibility of introducing IRFF system. Currently, agricultural planning and extension efforts in Sri Lanka rely on generalised assumptions or experiences from other countries, which may not fully capture the socio-demographic, cultural and institutional realities of rural rice farmers. This absence of locally grounded insights represents a clear research gap, as the feasibility of introducing IRFF system cannot be assessed effectively without understanding the attitudes, barriers, and enabling factors among potential farmer beneficiaries.

The present study is the first systematic pilot feasibility investigation in Sri Lanka to explore the possibility of introducing IRFF system through a farmer-centered lens. Specifically, it aimed to assess farmer's knowledge, perceptions, myths, constraints and perceived potentials toward IRFF system and to identify socio-demographic factors influencing willingness to adopt IRFF system. These

findings provide an initial foundation for guiding the socially acceptable and technically feasible introduction of IRFF system for feasible rice farmers in potential areas of the Hambantota District, Sri Lanka.

Materials and methods

Study area

The present study was conducted in the Hambantota District, located in Southern Sri Lanka. The district comprises 12 Divisional Secretariats (DS) and 17 Agrarian Service Divisions (ASDs). Hambantota covers approximately 2,609 km², representing about 4% of Sri Lanka's total land area of 65,610 km². The total population of the district is 654,668, comprising individuals from multi-cultural and multi-ethnic backgrounds.

Hambantota is a dry, semi-arid region characterised by hot, dry weather and high solar radiation. The mean temperature ranges from 26°C in January, the coolest month, to over 30°C in April, the hottest month. The north-east monsoon, occurring from October to January, serves as the primary rainy season. Annual rainfall in the dry, intermediate, and wet zones ranges from 1,000–1,250 mm, 1,000–1,500 mm and 1,500–2,000 mm, respectively. Wind speeds vary between 15 km h⁻¹ during the north-east monsoon and 23 km h⁻¹ during the south-west monsoon. According to the Department of Agrarian Service, rice farmers in the Hambantota District conduct their paddy cultivations using three distinct water sources; Major irrigation, minor irrigation and rain-fed systems. Farmers under major irrigation schemes generally have more reliable access to water compared to those operating under minor or rain-fed systems. However, even major irrigation systems are not free from seasonal shortages, as water distribution follows rotational schedules and is affected by climate variability. Of the 17 Agrarian Service Divisions (ASDs) in the Hambantota District, only 10 falls under major irrigation schemes. From these 10 ASDs, five were randomly selected for this study (Fig. 1).

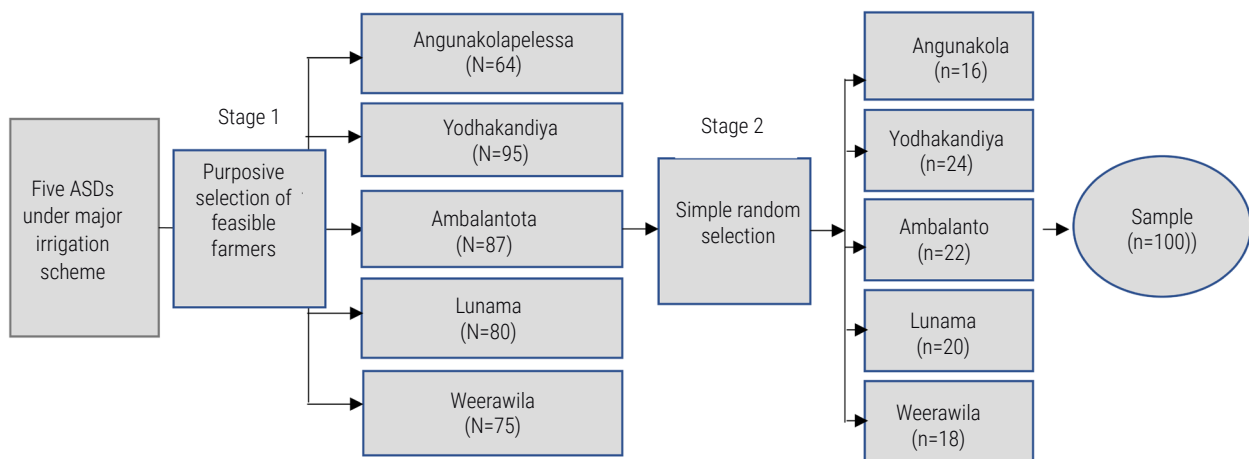


Fig. 1. Schematic presentation of selection of potential rice farmers for the study

Selection of rice farmers

Prior to identifying eligible farmers, discussions were held with local Agriculture Instructors (AIs) and irrigation officials to assess the feasibility of practicing IRFF system in the study area. Their insights regarding water availability, land suitability and local management practices were incorporated into the development of farmer selection criteria.

A two-stage sampling process was employed. In the first stage, eligible farmers were purposively identified with the assistance of AIs, based on predefined criteria. The selection criteria included: (1) relatively reliable irrigation water availability throughout the cultivation season within tank and canal command areas (considered both season); (2) proximity to a water source (*i.e.*, within ≤ 1 km of an irrigation tank or main canal); (3) access to or feasibility to get one or few backup water facilities (*e.g.*, ground water, tube well water, drainage canals); (4) absence of seasonal flooding; (5) current active engagement in rice cultivation and (6) regular participation in farmer meetings. Farmers who did not meet these conditions were excluded from the target population. Lists of eligible farmers were prepared with help of local agriculture officials. In the second stage, simple random sampling was applied to the compiled list of eligible farmers to select the final study participants.

The minimum required sample size for this study was determined using the following formula, considering the known population size of the study area (Israel, 1992):

$$n_0 = \frac{N}{1 + N e^2}$$

where; N = Size of population; n = Sample size; and e = Margin of error (10% for a 95% confidence level)

Data collection

Since IRFF system is not commonly practiced in Sri Lanka, a brief preliminary session was conducted before the survey to introduce

the concept and ensure that farmers had a basic understanding of the practice. The session was carefully designed to provide only neutral, factual information about what IRFF system involves, without encouraging or discouraging future adoption, in order to eliminate any potential bias. Following this session, primary data were collected through structured individual interviews using a pre-tested questionnaire. Limited focus group discussions were also conducted with selected farmer representatives and agricultural officers to triangulate and validate the findings; however, all statistical analyses were based solely on data from individual interviews. A pilot test involving 15 rice farmers was conducted prior to the main survey to identify potential challenges in the survey process. Insights from the pilot study were used to refine and improve the design of the structured questionnaire, thereby enhancing its clarity and reliability.

Analytical framework

The study assessed the influence of farmer knowledge, perceptions, personal and institutional constraints, myths and perceived potentials on their willingness to adopt IRFF system (Fig. 2). Farmer-related factors were assessed under five categories: knowledge, perception, myths, constraints and perceived potentials. Each factor was measured using multiple Likert-scale statements rated on a 5-point scale (1 = strongly disagree to 5 = strongly agree). Mean scores were calculated for each factor and interpreted using defined thresholds:

Knowledge, myths, constraints, potentials: High (MS>3.5), Moderate (2.6-3.5), Low (≤ 2.5)

Perception: Positive (MS ≥ 2.5), Negative (MS<2.5)

Ethical clearance

Ethical clearance for this study was obtained from the Ethics Review Committee of the Institute of Biology, Sri Lanka (ERC-IOBSL). Informed consent was obtained from all participating farmers and the confidentiality of personal data was maintained in accordance

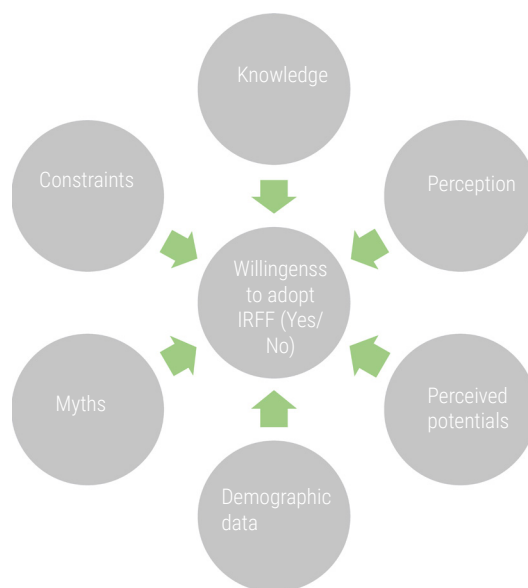


Fig. 2. Analytical framework of factors influencing feasibility of introducing IRFF system

Table 1. Socio-demographic characteristics of rice farmers in Hambantota District (n = 100)

Variable	Category	Frequency	Percentage
Age (years)	≤ 40	23	23.0
	41 -60	43	43.0
	≥ 61	34	34.0
	Total	100	100.0
Gender	Male	79	79.0
	Female	21	21.0
	Total	100	100.0
Religion	Buddhism	79	79.0
	Other	21	21.0
	Total	100	100
Civil status	Married	85	85.0
	Single	15	15.0
	Total	100	100.0
Education	No proper education	10	10.0
	Primary	41	41.0
	Secondary	34	34.0
	Tertiary	15	15.0
	Total	100	100.0
Family size (members)	≥ 3	25	25.0
	4 – 6	51	51.0
	> 6	24	24.0
	Total	100	100.0
Experience (years)	≥ 5	11	11.0
	6 – 10	15	15.0
	11 – 15	14	14.0
	> 15	60	60.0
	Total	100	100.0
Land ownership	Owned land	81	81.0
	Hired land	19	19.0
	Total	100	100.0
Land size (acre)	< 2.5	54	54.0
	2.5 – 5.0	27	27.0
	> 5.0	19	19.0
	Total	100	100.0

with accepted ethical standards for research involving human participants.

Statistical analysis

To investigate the factors influencing the feasibility of introducing IRFF system among feasible rice farmers, the study employed a combination of univariate, bivariate and multivariate analyses. All statistical analyses were conducted using SPSS (Version 25). Pearson's correlation coefficients were used to examine the relationships between continuous variables and farmer's willingness to adopt IRFF system. A Chi-square test was employed to assess the association between categorical variables and willingness to adopt IRFF system.

A binary logistic regression model was used to identify the factors influencing the likelihood of adopting IRFF system. The dependent variable was willingness to adopt IRFF system, coded as 1 for "willing to adopt" and 0 for "not willing to adopt." Independent variables included key constructs such as knowledge, perception,

myths, constraints and perceived potentials. The logistic regression model was specified as follows:

$$\text{Log} \frac{p}{(1-p)} = \beta_0 + \beta_1 (\text{knowledge}) + \beta_2 (\text{Perception}) + \beta_3 (\text{Myths}) + \beta_4 (\text{Constraints}) + \beta_5 (\text{Perceived potentials})$$

where: $\text{Log} (P/(1-p))$ represents the probability that a farmer adopts IRFF system.

β_0 is the intercept (constant) of the model

$\beta_1, \beta_2, \dots, \beta_5$ represent the coefficients for the predictor variables.

To ensure the stability of the regression model, Variance Inflation Factor (VIF) and tolerance values were calculated for each independent variable to assess multicollinearity.

Results and discussion

Demographic characteristics of rice farmers in Hambantota District

Table 1 presents the distribution of socio-demographic variables among the selected rice farmers in the study. The sample was predominantly composed of middle-aged to older farmers, with 43% aged between 41-60 years and 34% over 60 years, while only 23% were younger than 40. This indicates that rice farming in Hambantota is primarily practiced by an aging population, consistent with findings by Chamara and De Silva (2021), who reported that most farmers in the district were between 51-70 years of age. Rice farming was found to be male-dominated with 79% of respondents being male and only 21% female. Similar trends have been observed in previous studies from Hambantota, where over three-quarters of rice farmers were men (Chamara and De Silva, 2021). Such gender imbalances may limit women's participation in decision-making and access to IRFF system, although targeted technical support and financial incentives could encourage greater involvement of both men and women (Hasan *et al.*, 2020).

Religious affiliation largely mirrored the district's demographic composition, with Buddhists comprising 79% of respondents. Willingness to adopt IRFF system was expressed by 58.2% of Buddhists and 47.6% of farmers from other religious backgrounds, suggesting that religion is not a significant determinant of adoption feasibility.

Most farmers (85%) were married, consistent with findings from Nigeria, where married individuals made up the majority of rice growers, motivated by household livelihood needs (Onemolease *et al.*, 2023). Family size was typically medium (4-6 members; 51%), followed by small (≤3 members; 25%) and large (≥6 members; 24%). These findings are similar to those of Vidanapathirana (2003), who reported an average household size of four in Hambantota. Larger families may contribute positively to labour availability for IRFF system, as family members often serve as the primary source of labour in smallholder systems. In terms of education, 41% of farmers had completed only primary education, 34% had completed secondary education, 10% had no formal schooling and 15% had tertiary qualifications. This indicates that most farmers possess

at least some level of formal education, which can influence their ability to understand and adopt new practices such as IRFF system (Sunding and Zilberman, 2001).

Farming experience was generally high with 60% of respondents reported more than 15 years of experience in rice cultivation, while only 11% had less than five years. Although this suggests a strong knowledge base, it may also contribute to reluctance to adopt new practices due to a reliance on traditional methods. Patterns of land tenure and landholding size reflect the dominance of smallholders. A majority (81%) of farmers owned their land, providing the tenure security necessary for long-term investments such as IRFF system. Land tenure security has been widely recognised as a key driver of sustainable land management and agricultural technology adoption (Gebremedhin and Swinton, 2003; Bewket, 2007; Teklewold and Kohlin, 2011; Belay and Bewket, 2013). More than half (54%) of farmers cultivated less than 2.5 acres, while only 19% managed holdings larger than five acres. This is consistent with earlier findings that rice farming in Hambantota is predominantly small-scale (Mendis and Edirisinghe, 2013).

Association between adoption willingness and socio-demographic variables

The chi-square analysis revealed that several socio-demographic factors were significantly associated with farmer's willingness to adopt IRFF, whereas others showed no significant association (Table 2). Age emerged as an important determinant, with younger farmers showing greater willingness to adopt IRFF system compared to older farmers. This pattern supports earlier findings that younger farmers are generally more receptive to innovation and less risk-averse than their older counterparts (Sunding and Zilberman, 2001; Sharma, 2016). Targeting younger farmers may therefore be a practical entry point for introducing IRFF system, while awareness campaigns and demonstration programs could gradually increase acceptance among older farmers (Manyise *et al.*, 2024).

Gender was not significantly related to willingness to adopt, reflecting the male-dominated structure of rice farming in Hambantota (Chamara and De Silva, 2021). However, evidence from Asia shows that empowering women in agricultural decision-making can positively influence household adoption of integrated practices (Nandeesh, 2007; Iannotti *et al.*, 2009). Extension programs that highlight the successful participation of both men and women could therefore strengthen the feasibility of introducing efforts of IRFF system.

Religion also showed no significant association, suggesting that future adoption decisions are shaped more by economic and educational factors than by cultural identity. Similarly, family size did not have a significant effect, although larger households may still contribute labour for IRFF system, as observed in other smallholder systems (Posadas-Domínguez *et al.*, 2014). Civil status was significantly associated with future adoption decision, with married farmers more willing to adopt than unmarried farmers. This likely reflects the responsibility of supporting households and ensuring food and income stability (Onemolease *et al.*, 2023). Education showed a strong positive relationship with willingness to adopt IRFF system. Farmers with secondary and tertiary education were more likely to adopt IRFF system, consistent with the role of

education in improving the capacity to evaluate and implement new practices (Strauss *et al.*, 1991; Warriner and Moul, 1992). Given that Als are a trusted source of information in Hambantota (Silva, 2022), training them in IRFF system could be a key strategy for reaching less-educated farmers. Farming experience was significantly associated with willingness to adopt, but the relationship was non-linear. Farmers with less experience were more open to IRFF system, while those with over 15 years of experience were less willing, likely due to reliance on established practices and greater risk aversion (Silva, 2022). Younger, less experienced farmers often seek information through digital platforms, which may explain their higher receptivity to innovation (Uy *et al.*, 2024).

Land ownership significantly influenced willingness to adopt, with landowners more willing than tenants. Secure land tenure provides farmers with the confidence to make long-term investments, a factor consistently shown to encourage sustainable land management practices (Gebremedhin and Swinton, 2003; Teklewold and Kohlin, 2011). Finally, land size was also found significant. Farmers with small to medium holdings expressed greater willingness to adopt IRFF system than large landholders. This may be due to the relative ease of managing smaller plots and the stronger incentive to diversify income sources. Conversely, large landholders may perceive higher risks in altering established practices. However, some studies have found that larger farms to be more likely to adopt due to greater resource availability (Diederer *et al.*, 2003), suggesting that adoption patterns are context-specific.

Descriptive statistics of key variables

Farmer's knowledge, perceptions, myths, constraints and perceived potentials regarding IRFF system were assessed and the results are summarised in Table 3. Overall, farmers demonstrated a moderate level of knowledge, suggesting that while they are familiar with the basic principles of IRFF system, their technical understanding remains limited. Similar gaps in technical knowledge have been reported among rice farmers in Bangladesh, where the lack of training and institutional support discouraged participation in IRFF system (Ahmed *et al.*, 2011). This finding highlights the importance of targeted extension and capacity building programs to strengthen farmer's technical skills and confidence.

Perceptions of IRFF system were moderately positive but cautious, indicating that many farmers recognise its potential yet remain hesitant to adopt without clearer evidence of benefits. Field demonstrations and farmer-led trials may therefore be essential to build confidence and reduce skepticism. Previous studies have shown that positive perceptions of net benefits play a decisive role in shaping feasibility of adoption behaviour (Adrian *et al.*, 2005). Although farmers generally displayed a sound understanding of IRFF system, misconceptions were still present. While myths did not dominate overall responses, they continue to pose a barrier for some groups, particularly older or less-educated farmers, as noted by Muruganandam *et al.* (2014). Addressing these misconceptions through training, participatory learning and visible success stories could help to reduce resistance. By contrast, constraints received the highest scores among all dimensions, underscoring the persistence of significant barriers to adoption feasibility of IRFF system. Farmers identified gaps in technical knowledge, shortages of inputs such as quality seed and feed, high input costs, limited

Table 2. Association between farmer socio-demographic characteristics and willingness to adopt IRFF system (n = 100)

Variable	Category	Willingness to adopt IRFF system		X ²	p value
		Yes	No		
Age (years)	≤ 40	17	6	9.716	0.008
	41 -60	27	16		
	≥ 61	12	22		
	Total	56	44		
Gender	Male	43	36	0.376	0.540
	Female	13	8		
	Total	56	44		
Religion	Buddhism	46	33	0.758	0.384
	Other	10	11		
	Total	56	44		
Civil status	Married	52	33	6.162	0.013
	Single	4	11		
	Total	56	44		
Education	No proper education	3	7	7.925	0.048
	Primary	19	22		
	Secondary	24	10		
	Tertiary	10	5		
	Total	56	44		
Family size (members)	≥ 3	11	14	2.435	0.296
	4 – 6	32	19		
	> 6	13	11		
	Total	56	44		
Experience (years)	≥ 5	9	2	8.141	0.043
	6 – 10	11	4		
	11 – 15	9	5		
	> 15	27	33		
	Total	56	44		
Land ownership	Owned land	50	31	5.677	0.017
	Hired land	6	13		
	Total	56	44		
Land size (acres)	< 2.5	35	19	11.652	0.003
	2.5 – 5.0	17	10		
	> 5.0	4	15		
	Total	56	44		

Table 3. Mean scores (±SE), minimum and maximum values of rice farmer's knowledge, perception, myths, constraints and perceived potentials toward IRFF system (n = 100)

Variable	Mean±SE	Min	Max
Knowledge	3.19±0.04	1.75	4.05
Perception	2.79±0.06	1.78	3.78
Myths	2.67±0.08	1.30	4.70
Constraints	3.74±0.05	2.44	5.00
Potentials	3.11±0.06	1.90	4.50

SE = Standard Error.

access to capital and climate-related risks. Similar challenges have been reported in IRFF system and pond culture in Cambodia and other Asian contexts (Joffre *et al.*, 2021; Anyango *et al.*, 2024). Policy support, infrastructure development and financial assistance are therefore critical for overcoming these obstacles.

Despite these constraints, farmers acknowledged the potential of IRFF, particularly its capacity to diversify livelihoods and enhance food security. However, the moderate potential score suggests that enthusiasm is tempered by practical challenges. Strengthening knowledge-sharing mechanisms and communication strategies

such as farmer field schools, public service campaigns and community demonstrations could enhance positive attitudes and accelerate adoption feasibility (Hudson, 2018; Jin *et al.*, 2022).

Association between willingness to adopt and key variables

Pearson's correlation analysis revealed that both knowledge and perceptions were positively and significantly associated with farmer's willingness to adopt IRFF system (Table 4). These results indicate that farmers with greater knowledge and more favourable perceptions are more inclined to adopt IRFF system. This finding is consistent with previous research showing that knowledge and perceptions of technological characteristics strongly influence future adoption behaviour (Adesina and Baidu-Forson, 1995). In Hambantota, where farmers often rely on AIs for technical advice (Silva, 2022), strengthening extension services could play a vital role in enhancing farmer knowledge and shaping positive perceptions of IRFF (Pandey *et al.*, 2024). Myths showed a weak, non-significant negative correlation with willingness to adopt IRFF system, suggesting that misconceptions alone are not decisive barriers. However, myths were negatively correlated with both knowledge

and perceptions, implying that misinformation may indirectly discourage feasibility of introducing IRFF system. As Rogers (2014) emphasised, accurate information is key to reducing resistance to innovation. Addressing misconceptions through training and field demonstrations could therefore complement efforts to improve knowledge and perceptions.

Constraints exhibited a significant negative association with both farmer's willingness to adopt and perceived potential. This highlights that barriers such as technical knowledge gaps, input shortages and financial limitations can dampen the feasibility to introduce as well as optimism about the benefits of IRFF system. Similar findings by Nabi (2008) and Akpoffo *et al.* (2023) suggest that feasibility may increase when policymakers recognise these constraints and tailor extension support accordingly. Perceived potential showed no significant relationship with willingness to adopt, suggesting that while farmers acknowledge possible benefits, their decisions are more strongly shaped by practical knowledge, perceptions, and the constraints they face.

Predicting the feasible factors of IRFF system through logistic regression

Of the five independent variables initially tested (knowledge, perceptions, myths, constraints and perceived potentials), the final logistic regression model retained knowledge, perceptions and constraints as significant predictors (Table 5). Knowledge emerged as the strongest predictor, with the odds of adoption increasing more than fivefold for each unit increase in knowledge. This finding aligns with studies in Iran and Bangladesh, which demonstrated that access to training, technical information and extension services is central to IRFF system introduction

(Ahmed and Garnett, 2011; Noorhosseini-Niyaki and Allahyari, 2012). Strengthening farmer knowledge through targeted extension-particularly on technical aspects such as field modification, fish stocking, water management and integration methods, is therefore essential to reduce uncertainty and increase feasibility to introduce IRFF system.

Perceptions also emerged as a significant positive predictor, with more favourable attitudes toward IRFF system associated with a fourfold increase in adoption likelihood. Evidence from Indonesia similarly shows that positive perceptions of farming innovations strongly influence adoption intentions (Sharifuddin *et al.*, 2019). This highlights the value of demonstration plots and participatory approaches that visibly showcase the ecological and economic benefits of IRFF system. In contrast, constraints had a significant negative effect, with higher levels of perceived barriers substantially reducing adoption likelihood. These findings are consistent with broader evidence showing that overcoming resource and institutional barriers is essential for enabling innovation in smallholder systems (Bai *et al.*, 2024).

The final regression model can be expressed as:

$$\text{Log} \frac{P}{(1-P)} = -4.006 + 1.680 (\text{Knowledge}) + 1.522 (\text{Perception}) - 1.410 (\text{Constraints})$$

where: P represents the probability of a farmer adopting IRFF system. $\text{Log}(P/1-P)$ represents the log-odds of adoption.

Collinearity diagnostics indicated no serious multicollinearity, as all VIF values were below 1.6 and tolerance values were above acceptable thresholds.

Table 4. Pearson's correlation coefficients between willingness to adopt IRFF system and farmer's knowledge, perceptions, myths, constraints and perceived potentials (n = 100)

		Willingness to adopt IRFF system	Knowledge	Perception	Myths	Constraints	Perceived potentials
Willingness to adopt IRFF system	Pearson Correlation	1					
	Sig. (2-tailed)						
Knowledge	Pearson Correlation	0.382**	1				
	Sig. (2-tailed)	0.000					
Perception	Pearson Correlation	0.400**	0.429**	1			
	Sig. (2-tailed)	0.000	0.000				
Myths	Pearson Correlation	-0.169	-0.460**	-0.281**	1		
	Sig. (2-tailed)	0.092	0.000	0.005			
Constraints	Pearson Correlation	-0.243*	-0.108	0.086	0.066	1	
	Sig. (2-tailed)	0.015	0.285	0.397	0.512		
Potentials	Pearson Correlation	0.120	0.091	-0.069	0.103	-0.205*	1
	Sig. (2-tailed)	0.234	0.369	0.497	0.307	0.041	

** and * indicate the significant level of 0.01 and 0.05 respectively at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Table 5. Logistic regression analysis of key factors influencing the feasibility of introducing IRFF system (n = 100)

		B	S.E.	Sig.	Exp(B) Tolerance	Collinearity statistics	
						Tolerance	VIF
Step 3 ^a	Knowledge	1.680	0.830	0.043	5.367	0.662	1.511
	Perception	1.522	0.516	0.003	4.581	0.786	1.273
	Constraints	-1.410	0.532	0.008	0.244	0.931	1.074
	Constant	-4.006	3.038	0.187	0.018		

Variable(s) entered on step 1: Knowledge, Perception, Myths, Constraints, Potentials

This study provides evidence that willingness to adopt IRFF system in Hambantota is influenced by both socio-demographic and attitudinal factors. Younger, better-educated, land-owning farmers with small to medium plots were more feasible factors to introduce IRFF system, while constraints such as technical gaps, resource limitations, and weak institutional support limited uptake. Logistic regression highlighted knowledge, perceptions and constraints as the most decisive predictors. Enhancing farmer knowledge and perceptions through extension support, alongside addressing institutional and resource challenges, could improve the feasibility of introducing IRFF system in Hambantota District. These findings offer preliminary insights that may inform pilot initiatives and provide a basis for exploring feasibility of introducing IRFF system in other contexts. However, as this study was limited to 100 farmers in Hambantota District under major irrigation schemes, results should be interpreted as context-specific and preliminary. Broader, multi-zone surveys and longitudinal research are needed to validate and extend these findings.

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