



Evaluating the Effectiveness of the Digital Farmer Field School Extension Approach for Technology Dissemination for Tea Smallholdings in Kandy District in Sri Lanka

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Abstract. The tea smallholding sector occupies a pivotal position within the tea industry in Sri Lanka; however, it faces numerous challenges, viz technological deficiencies, a shortage of skilled labour, limited access to inputs, low productivity, and high production costs. To address these issues, the Farmer Field School (FFS) approach was piloted by the Tea Small Holding Development Authority, evolving into the Digital Farmer Field School (DFFS) platform during the COVID-19 pandemic. This study evaluates the effectiveness of the DFFS in increasing farmers' adoption of agricultural practices, productivity, and income. Using a stratified sampling technique, 50 smallholders who participated in DFFS and 50 non-participants were selected from five Grama Niladhari Divisions in Kandy district. A cross-sectional survey was conducted with a pretested instrument, ensuring reliability (Cronbach's alpha of 0.8224). Descriptive analysis, hypothesis testing, correlation and multiple regression were employed to explore relationships. Results indicated significant differences between DFFS and non-participants (NDFFS) at $P < 0.05$ in ICT literacy, knowledge and practice adoption, land productivity, and average income. The multiple regression model was fitted successfully ($P < 0.05$), showing that 92% of the variance in DFFS effectiveness was explained by ten independent variables such as organizational assistance, facilitation conditions, effort expectancy, income, age, and gender. However, family workforce, education, and ICT affordability did not demonstrate significant relationships. The study concludes that DFFS effectively enhances agricultural knowledge and practices among smallholders, highlighting the need for policymakers to implement DFFS approaches for technology transfer and engage various farmer groups and stakeholders in Sri Lanka.

Keywords: Adoption; Effectiveness; Digital Farmer Field School; ICT literacy; Tea smallholders

1 Introduction

The *Camellia sinensis* plant leaves are the foundation of the world's most consumed beverage after water. The global demand for tea has remained stable for over a century, significantly contributing to Sri Lanka's economy through foreign exchange, national output, and employment. In 2021, Sri Lanka exported 285,867 metric tons of tea, generating USD 1.32 billion in revenue. The Tea Control Act classifies tea smallholdings as areas less than 10 acres, with smallholders cultivating approximately 60% of total acreage and accounting for over 75% of annual production (Tea Board, 2021). The smallholder sector exhibits greater productivity than corporate plantations, emphasizing its vital role in Sri Lanka's tea industry. Although tea smallholders in the Doluwa sector of the Kandy district earn higher incomes from tea cultivation than from other crops, they encounter several challenges. Although tea smallholders in the Doluwa sector of the Kandy district earn higher incomes from tea cultivation compared to other crops, they face several challenges. These include a lack of essential inputs such as fertilizers, chemicals, and equipment; land degradation; low productivity levels of land and labour; high production costs; inadequate outreach from extension services; less effective conventional extension methods; and limited knowledge and adoption of appropriate cultural practices for tea cultivation [Amarathunga, 2019; Perera, 2014]. Several extension approaches were used in the tea smallholding sector in the past to help smallholders improve their living standards. Farm and home visits, office visits, telephone calls, and group discussions/meetings were all undertaken from time to time, but due to many restrictions, all of these approaches only partially succeeded in obtaining the required objectives. For example, when considering the farm and home visits approach, the field officers/ Tea Inspector (TI) to tea smallholders' ratio in the tea smallholdings sector is 1:2784, and the number of extension officers to tea smallholders needed for effective extension services is approximately 1: 1000 [Annual report of TSHDA, 2019]. Amarathunga (2019) noted that increasing the number of officers is necessary to reduce the number of tea smallholders served and enhance extension service productivity. However, limitations in provisions and expenditure make this challenging. Traditional extension programs for tea smallholders have proven to be less effective, emphasizing the necessity for participatory approaches that enhance farmers' self-confidence, promote hands-on learning, and address their ongoing challenges.

In light of this, a pilot program called Farmer Field School (FFS) was launched in 2018 with financial support from the Rehabilitation of Degraded Agricultural Land Project of the FAO (RDALP-FAO). This program selected tea smallholders from the Grama Niladhari Divisions (GN) within the Doluwa Secretariat Division of the Kandy district. Under this project, tea Inspectors (TIs) and Agricultural Research and Production Assistants (Kupanisa) within their respective areas were trained in the Farmer Field School (FFS) concept. They were assigned the task of changing the attitudes of tea smallholders and improving their adoption of appropriate cultural practices through the FFS approach. The FFS approach enhances critical thinking and decision-making skills, allowing farmers to analyze their production systems and adopt Integrated Crop Management practices [Porkodi & Kannan, 2020]. Since the late 1980s, agricultural

support has shifted from top-down extension to more participatory methods for smallholders, like the farmer field school (FFS). Research shows that FFS graduates have significantly gathered knowledge of agricultural technologies than non-graduates [Bunyatta et al., 2006]. Rola et al. (1998) found that FFS helps tea smallholders understand their agrochemical use with guidance from trained facilitators, significantly impacting their decision-making. Tea smallholders were educated on raising a healthy crop while maintaining a healthy environment by reducing their reliance on external chemical inputs and implementing other pest management strategies that sustain yield at a lower cash cost. However, in response to the COVID-19 pandemic, traditional FFS transitioned to Digital Farmer Field Schools (DFFS), creating an innovative Information and Communication Technology (ICT)-driven learning environment tailored for farmers and stakeholders within the rural knowledge system [Lairing et al., 2021]. This digital platform facilitates real-time communication and provides essential rural services and up-to-date information, serving as an alternative and supplementary resource to conventional rural technology dissemination methods. The pandemic worsened existing issues by imposing travel restrictions, which hindered timely communication between technology dissemination officers and rural farmers. In this context, Digital Farmer Field Schools (DFFS) present a viable solution to bridge the technology dissemination gap. By exploring this innovative approach, we can better understand how digital solutions can enhance agricultural practices and support the livelihoods of smallholder tea farmers in an increasingly challenging environment.

1.1 Research Objective

This study aims to evaluate the effectiveness of DFFS as a tool for technology dissemination, with a specific focus on its impact on the productivity and profitability of tea smallholders in the Kandy District.

1.2 Theoretical Model

The UTAUT model, proposed by Venkatesh et al. (2003), was applied to this study with some modifications. This model has been widely utilized to predict behavioral intentions regarding technology adoption. In this research, the UTAUT model will be used to assess the effectiveness of Direct Farm to Fork Services (DFFS) among tea smallholders. Venkatesh et al. (2003) and other researchers, including Venkatesh et al. (2012) and Chhachhar et al. (2016), established that usage intention is likely influenced by effort expectancy (EE), social influence (SI), and facilitating conditions (FC). Additionally, this study will also examine the role of organizational assistance (OA) and affordability in predicting the usage intention (see Figure 1).

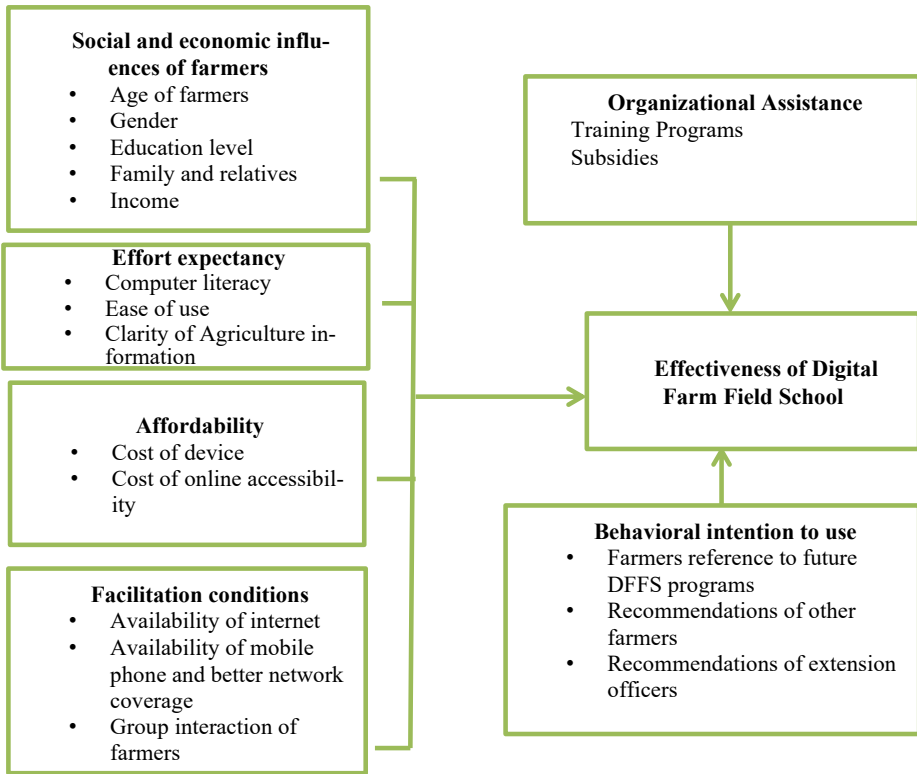


Fig. 1. Theoretical Model (UTAUT model was proposed by Venkatesh et al. (2003)

2 Methodology

2.1 Study Location

Table 1. : The Studied Grama Niladhari (GN) divisions

GN divisions	DFFS participants	NDFFS participants
Panvilathanna	15	15
Pambadeniya	10	10
Lagumdeniya	10	10
Masgolla	8	8
Wariyagala	7	7
Total Participants	50	50

A cross-sectional survey was conducted using a stratified purposive sampling technique to select 50 farmers from a total of 182 participants in the Digital Farm Field School (DFFS). This program was part of the Rehabilitation of Degraded Agricultural Land Project (RDALP) by the FAO. The survey took place in five Grama Niladhari (GN) divisions: Panvilathanna, Pambadeniya, Lagumdeniya, Masgolla, and Wariyagala within the Doluwa Divisional Secretariat area in the Kandy district (Table 1). Additionally, another group of 50 farmers in the same GN division to account for differences in social, economic, behavioral, and environmental factors that vary by location and who were not participating in the DFFS programme conducted by RDALP and was included as a control group (NDFFS).

2.2 Data Collection

A pretested structured questionnaire which was validated through a pilot survey and applying a reliability test, was used for primary data collection. Additionally, focus group discussions and field observations were also conducted to collect primary data from tea smallholders belonging to both the Farmer Field School (FFS) group and the Non-Farmer Field School (NFFS) group. Data regarding socio-economic status, knowledge, attitudes, and levels of adoption were collected. Yield and cost of production from both groups, and data on further improvement, evaluation criteria, and pros and cons of the FFS approach were collected only from FFS smallholders.

Table 2. Operationalization of variables

Independent Variable	Measurement
Affordability index	Likert scale (1 highly not satisfy, 2 Not satisfy 3 neither not satisfy or satisfy, 4 satisfy, 5 highly satisfy)
Effort expectancy index	Likert scale (1 highly not satisfy, 2 Not satisfy 3 neither not satisfy or satisfy, 4 satisfy, 5 highly satisfy)
Facilitation conditions index	Likert scale (1 highly not satisfy, 2 Not satisfy 3 neither not satisfy or satisfy, 4 satisfy, 5 highly satisfy)
Organizational assistance index	Likert scale (1 highly not satisfy, 2 Not satisfy 3 neither not satisfy or satisfy, 4 satisfy, 5 highly satisfy)
Behavioural intention to use index	Likert scale (1 highly not satisfy, 2 Not satisfy 3 neither not satisfy or satisfy, 4 satisfy, 5 highly satisfy)
ICT Literacy index	Likert scale (1 highly not satisfy, 2 Not satisfy 3 neither not satisfy or satisfy, 4 satisfy, 5 highly satisfy)
Gender	Dami Male (0), Female (1)

Education level	Categorical (1-primary (1-5 year) 2- (6-8 year), 3 up to O/L 4 AL or more)
Age	Years
Household, size	Number of members
Average Monthly yield Yield	Kg/ha (Green Leaf)
Household income	Amount Rs/month
Dependent Variable	Measurement
Effectiveness index	Likert scale (1 highly not satisfy, 2 Not satisfy 3 nether not satisfy or satisfy, 4 satisfy, 5 highly satisfy)

To identify the effectiveness of FFS by comparing the information collected from FFS and NFFS groups. Accordingly, farmers' attitude, knowledge, and the adoption of the following sections of FFS Guidelines were measured. Familiarization with agroecosystem analysis involves understanding the key field operations that directly and indirectly affect overall land productivity. These operations include:- Soil conservation, Pre- and post-pruning of tea plants, Infilling in tea land, Harvesting techniques and minimizing post-harvest damage, Shade tree management, Plant nutrient management, Organic manure and compost production, Weed management Pest and disease management and Farm record keeping and financing. By focusing on these areas, farmers can improve the land productivity and sustainability of their agroecosystems. Secondary data was obtained from the Tea Small Holdings Development Authority's Kandy regional office. The effectiveness of the DFFS program will be evaluated based on the extent to which farmers apply the knowledge gained during the DFFS sessions. Independent variables such as affordability, effort expectancy, facilitation conditions, behavioural intention, ICT literacy and the dependent variable of effectiveness were measured by developing the index [Amarathunga, 2019] as follows.

$$\text{Variable index} = \frac{\text{Marks achieved by farmer}}{\text{Total Potential marks allocated for variable}} \times 100$$

2.3 Data Analysis

Data analysis was performed using the Statistical Package for Social Sciences (SPSS), STATA, and Microsoft Excel 2019. Inferential analysis was conducted using STATA, while descriptive analysis was carried out with Microsoft Excel 2019 and SPSS software. The analysis included descriptive statistical methods, independent t-tests, and a multiple linear regression model to examine the relationship between the independent and dependent variables.

Reliability Analysis

The questionnaire instrument was considered reliable as it underwent a pre-test with 20 respondents. The reliability was confirmed by the Cronbach Alpha values for each item, which ranged from 0.7 to 0.9, indicating good reliability (Table 3). Based on these

results, we can conclude that the internal consistency was acceptable and the research tool was reliable, providing credible results.

Table 3. : Variables and their Cronbach’s alpha value

Variable	Cronbach’s Alpha value	Item
Effectiveness	0.874	12
Effort expectancy	0.702	07
Behavioural intention to use	0.756	06
Facilitation conditions	0.948	07
Affordability index	0.786	08
Organizational Assistance	0.832	06
ICT Literacy	0.764	06
Overall value	0.816	08

2.4 Empirical Model

An empirical model for the research was also developed to identify the relationship between dependent and independent variables using a multiple linear regression model. The study used a multiple linear regression model to analyse and estimate the influence of independent variables (factors that influence the Usage of DFFS) on the dependent variable (Effectiveness of DFFS).

$$\text{Effectiveness of DFFS} = \beta_0 + \beta_1 (AF) + \beta_2 (EE) + \beta_3 (FC) + \beta_4 (OA) + \beta_5 (BI) + \beta_6 (GE) + \beta_7 (EL) + \beta_8 (AG) + \beta_9 (HH) + \beta_{10} (IN) + \epsilon$$

Where,

- AF-Affordability
- EE-Effort Expectancy
- FC-Facilitation Conditions
- OA-Organizational Assistance
- BI-Behavioural Intention to Use
- GE-Gender
- EL-Education Level
- AG-Age
- HH-Household size
- IN-Income
- ϵ – Error term

3 Result and discussion

3.1 Descriptive Analysis

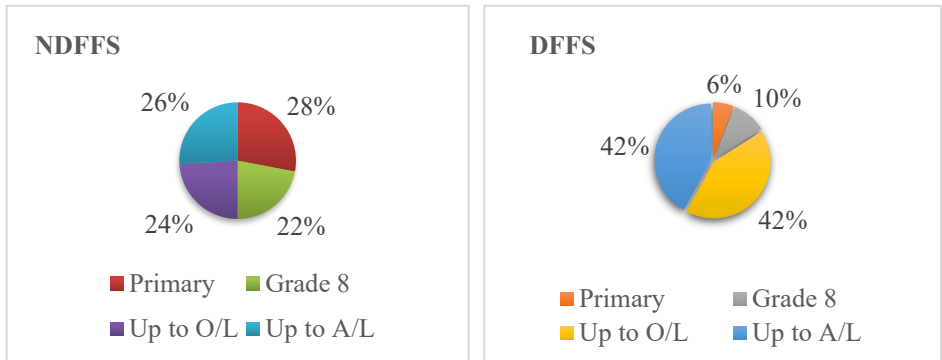
To identify farmers' characteristics and activities in the Doluwa DS division, a comparison was made between the DFFS farmer group and the NDFFS farmer group.

Gender: According to the results of the descriptive analysis, over 70% of the farmers in both the DFFS and NDFFS groups are female.

Age: Most of the DFFS participants in the selected sample are between the ages of 40 and 50, whereas most of the farmers of the NDFFS group are above 50.

Educational Level: The educational levels of DFFS participants vary significantly. Among them, 42% have completed their O-Level and A-Level education, while 10% attended school only up to grade 8. In comparison, 28% of NDFFS farmers have completed primary education, 26% have reached A-Level, 24% have completed O-Level, and 22% attended school up to grade 8. DFFS farmers generally have slightly higher education levels than NDFFS farmers (see Figure 2).

Fig. 2. Educational profile of DFFS and NDFFS groups



Preferences for the method of agricultural technology dissemination:

In the DFFS group, 90% of participants prefer the dissemination of digital agriculture technology, while 56% of NDFFS farmers favour conventional methods (Figure 3). Additionally, 38% of DFFS farmers also prefer conventional dissemination, with some expressing mixed preferences. Among DFFS participants, 9% are indifferent to digital technology, and 16% are indifferent to conventional technology dissemination.

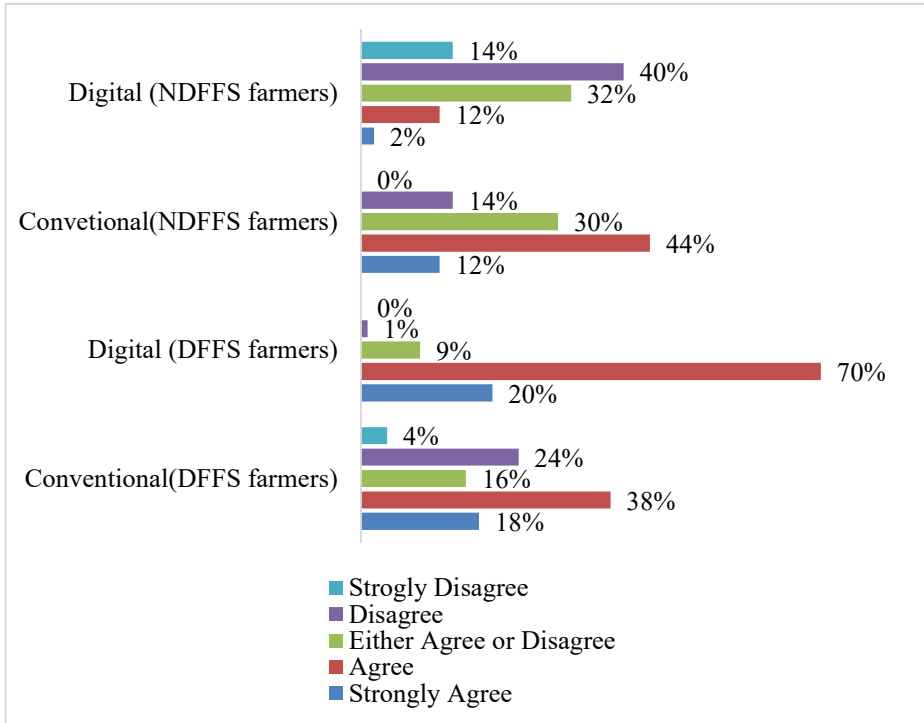


Fig. 3. Preferences for the method of agricultural technology dissemination among DFFS and NDFFS Groups.

ICT Literacy of DFFS Farmers:

The ICT and digital technology usage among DFFS participants shows that most farmers rely on mobile phone calls for timely market information (Figure 4). WhatsApp was the primary digital tool, with 42% using it very frequently, and training has been provided to farmers by agricultural assistants. YouTube was used frequently by 60% of farmers, while 34% receive phone calls frequently for market and cultivation information. Facebook usage was reported by 60% of participants, and 54% use Google to access agricultural information. However, there was a notable reluctance to use CDs and DVDs, with 40% of farmers not using them at all. Overall, many farmers are hesitant to adopt new digital devices and applications. During the study, it was found that most of the NDDFS group farmers were very reluctant to use Digital devices and novel Digital Apps.

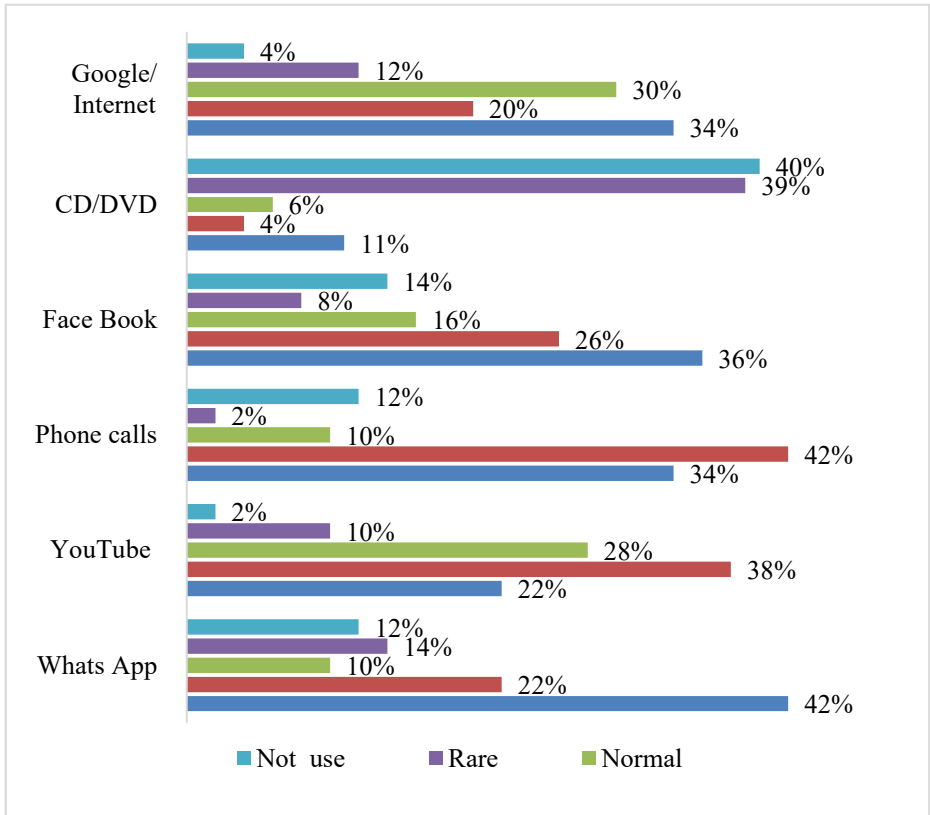


Fig. 4. ICT Literacy of DFFS Farmers

Group interaction among DFFS farmers:

The study findings indicate that 76% of DFFS farmers participated with neighbours, while 24% engaged individually. This high group participation is largely due to poor signal facilities and limited access to smartphones. Despite these challenges, many farmers are using digital apps, influenced by group interactions and help from their children. However, the data show that mobile phone usage for obtaining crop-related information among smallholder farmers remains very low, with some individuals lacking any mobile phone access (Figure 5).

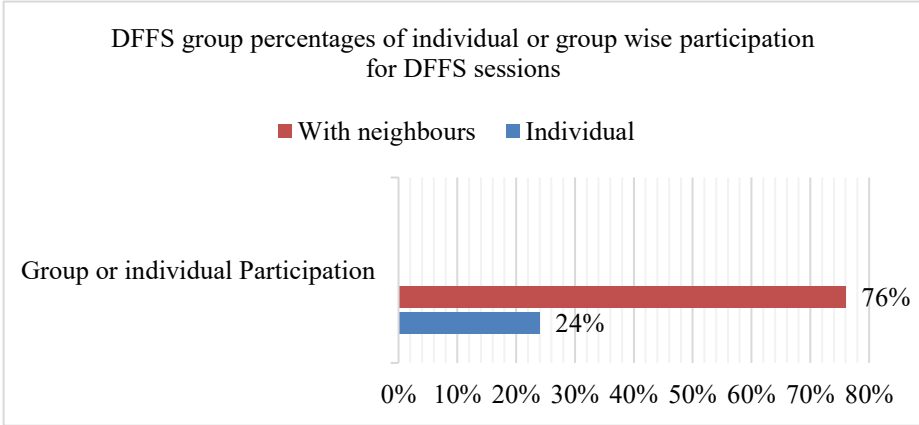


Fig. 5. DFFS group percentages of individual or group-wise participation for DFFS sessions

Assistance from children for DFFS farmers to use digital devices:

The Figure 6 shows the responses of DFFS farmers regarding help from their children in using digital services. In the Doluwa area, 72% of farmers reported receiving assistance from their children. The younger generation in developing countries like Sri Lanka is generally more familiar with technology. This trend is encouraging for the adoption of ICT among farmers, as they can learn from their children to use these devices effectively.

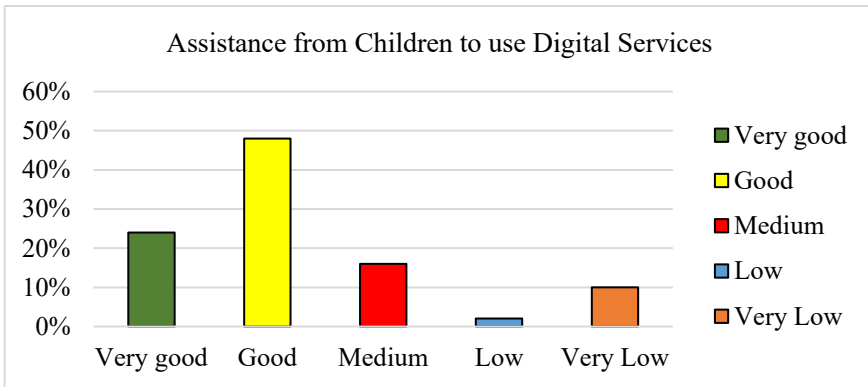


Fig. 6. Farmers getting assistance from Children to use Digital services

3.2 Comparison of the ICT literacy Index between DFFS and NDFFS farmers

Table 4. Mean comparison of the ICT literacy Index

Parameter	Group	N	Mean	Std. Dev.	Std. Error mean	DF	P	T
Index of ICT literacy	DFFS	50	77.96	10.47	74.98	49	0.000	12
	NDFFS	50	53.26	13.17	49.51			

H0 = The difference in ICT literacy is equal to zero.

H1 = The difference in ICT literacy is not equal to zero.

The average ICT literacy index stands at 77.96 for the DFFS group compared to just 53.26 for the NDFFS group (Table 4). With a p-value below 0.05, we can confidently reject the null hypothesis at the 5% significance level, demonstrating a significant disparity between the ICT literacy indexes of the two groups. It is imperative to promote continuous education programs that evolve alongside the digital landscape, addressing the needs of both DFFS and NDFFS groups [Junaedi et al., 2024]. Additionally, a crucial need is to foster partnerships among governments, educational institutions, and technology companies to establish sustainable digital literacy programs [Dayanand et al., 2024; Nigam, 2024].

3.3 Comparison of the index of knowledge and adoption related to the agricultural practices between DFFS and NDFFS farmers

The average knowledge and adoption index related to agricultural practices is 46.64 for the DFFS group and 31.2 for the NDFFS group. Since the p-value for the comparison of means between these two groups is less than 0.05, we can reject the null hypothesis (H0) at the 5% significance level (Table 5).

Table 5. Mean comparison of the index of knowledge and adoption related to the agricultural practices

Parameter	Group	N	Mean	Std. Dev.	Std. Error mean	DF	P	t
Index of Knowledge and Adoption	DFFS	50	46.64	3.75	0.53	98	0.000	10.69
	NDFFS	50	31.2	9.49	1.34			

H_0 = The difference of knowledge and adoption index between the DFFS and NDFFS groups equals zero.

H_1 = The difference of knowledge and adoption index between the DFFS group and NDFFS group is not equal to zero

Therefore, there is a significant difference in the knowledge and adoption index related to agricultural practices between the DFFS and NDFFS groups. Previous research has consistently shown a relationship between knowledge and the adoption of agricultural practices. This emphasizes the importance of educational interventions and community support in enhancing farmers' methods. As noted by Bonabana-Wabbi (2002) and Hamza Ahmed and Mousab Ahmed (2023), technology leads to increased efficiency and productivity, enabling individuals to complete tasks more quickly and easily than they could without it. In a cross-country study in Eastern Africa, farmer field schools proved beneficial for women, farmers with lower literacy levels, and those with medium-sized farmlands [Davis et al., 2012].

3.4 Comparison of the average monthly tea yield of DFFS farmer group before and after introducing the digital farm field school

The mean average monthly yield prior to the implementation of DFFS (Digital Farm Field School Approach) was 722.9 kg, while the mean yield following the implementation of DFFS increased to 937.4 kg. Statistical analysis reveals that the p-value associated with the comparison of average annual yields before and after DFFS is less than 0.05. Consequently, we can reject the null hypothesis (H_0) at the 5% significance level.

Table 6. Comparison of average monthly yield

Parameter	Group	N	Mean	Std. Dev.	Std. Error mean	DF	P	T
Average Monthly yield	After DFFS (2021)	50	937.4	71.934	508.651	88.50	0.017	2.429
	Before DFFS (2018)	50	722.9	51.201	362.052			

H_0 = The difference of average monthly yield between before and after implementing the DFFS Approach among the groups is equal to zero.

H_1 = The difference of average monthly yield between before and after implementing the DFFS Approach among the DFFS group is not equal to zero.

The introduction of the Digital Farm Field School Approach (DFFS) resulted in a notable increase in average monthly tea yields, rising from 722.9 kg to 937.4 kg. This improvement is largely due to effective technology dissemination and the cultivation of positive attitudes toward modern agricultural practices. DFFS equips tea smallholders with essential knowledge on improved harvesting, pre- and post-pruning, and bush

management techniques. Research by Erbaugh et al. (2010) highlights that educational interventions can significantly alter farmers' behaviours, encouraging them to adopt practices that enhance yield and quality. Additionally, the combined use of Integrated Pest Management (IPM) and balanced nutrient practices is vital for sustainable yield increases. Hashemi et al. (2008) demonstrate that these strategies can lead to healthier crops and improved production. When farmers feel empowered through knowledge, as noted by Dinpanah et al. (2010), they are more likely to embrace new technologies. Hence, farmers who exhibit high land productivity tend to be more receptive to integrating innovative farming techniques, particularly those enabled by the modern technologies they encounter through the Farmer Field School (FFS) approach. This adaptability is supported by findings from Godtland et al. (2004), which highlight the positive impact of technology adoption on agricultural efficiency. Similarly, Amarathunga et al. (2023) highlight that new methodologies foster a proactive attitude among Sri Lankan seed potato farmers. They emphasize the superiority of the Farmer Field Schools (FFS) Extension Approach over traditional methods for technology dissemination.

3.5 Analyzing the Relationship Between the Effectiveness of the DFFS Approach and Independent Variables

Table 7 displays the results of the multiple linear regression analysis, which aims to establish a relationship between the effectiveness of the DFFS approach and the independent variables.

The regression model was significant at a 0.05 significance level, P value $<$ alpha (0.05) value indicating that the regression model as a whole fit significantly at a 95% confidence level, R^2 value is 0.9203. It indicates that 92% of the variance in effectiveness is explained by ten independent variables in the model. There is a 0.0204 difference between R^2 and adjusted R^2 . Therefore, variations to the model after adding independent variables are very low.

Organizational Assistance

Organizational assistant results show a positive and significant relationship with DFFS effectiveness at the 1% significance level, with a p -value below 0.01. The public sector comprises ministries, departments of agriculture, and agricultural research centers. The non-profit and private sectors include NGOs, community boards, and aid projects that offer free extension services. In contrast, the private sector includes business firms, commercial farmers, trade associations, and consulting companies providing agricultural information. Organizational assistance significantly enhances the effectiveness of farm field schools (FFS) by providing crucial resources and training for farmers. For example, Jula Consultancy's trainers support cocoa farmers through certification training, ensuring quality education within the Digital Farmer Field School [Loes Witteveen, 2017]. The Kenya Seed Company Ltd also offers timely information on hybrid maize seeds via text, improving farmers' decision-making [Muriithi, Bett, and Ogaleh, 2009]. Services like Nokia Life deliver affordable agricultural updates through SMS, helping rural farmers access critical information on crop tips, weather, and market prices [Kante, Oboko, and Chepken, 2016]. Overall, organizational support facilitates

better information flow and training, leading to improved agricultural practices and farmer livelihoods.

Table 7. Multiple linear regression analysis results

Effectiveness	Coefficient	Standard Error	t	P <
Organizational assistance	0.375***	0.069	5.44	0.000
Facilitation Conditions	0.199**	0.095	2.09	0.043
Effort expectancy	0.213**	0.104	2.05	0.047
Affordability	0.000	0.000	0.84	0.408
Behavioral intention to use	0.138**	0.056	2.48	0.018
Gender	2.459**	1.060	2.32	0.026
Education level	1.312	1.132	1.16	0.254
Age	-0.348	0.217	-1.60	0.118
Household size	1.049*	0.600	1.75	0.088
Income	0.438***	0.081	5.42	0.000

(*** significant at 1%, ** significant at 5%, * significant at 10%)

Facilitation conditions

. Facilitation conditions significantly and positively influence the effectiveness of DFFS among farmers at a 5% significance level ($P < 0.05$). The facilitation of digital farm schools (DFS) significantly enhances their effectiveness by promoting collaboration and knowledge sharing among farmers. For instance, as highlighted by Madhuri et al. (2021), the availability of mobile phones and stable internet connections has increased interaction among farmer groups. These interactions help build social capital, empowering farmers through collective action. The exchange of knowledge and experiences within farmers' social networks enables them to learn about effective agricultural practices. As a result, better facilitation of these interactions can lead to improved agricultural outcomes and a greater adoption of innovative farming technologies.

Effort Expectancy

. Expectancy of effort significantly and positively affects the effectiveness of DFFS among farmers at the 5% significance level ($P < 0.05$). Effort expectancy influences the effectiveness of digital farm schools (DFFS) by shaping users' perceptions of how easily they can acquire knowledge. Factors like information clarity, ICT literacy, and ease of using digital devices contribute to this expectation. The findings show that a one-unit increase in effort expectancy enhances DFFS effectiveness. When farmers find digital tools user-friendly, they engage more effectively, leading to better learning outcomes. This highlights the role of ICT in empowering rural communities through timely and accessible information [Lokeswari, 2016].

Affordability.

The P value for affordability stands at 0.408, indicating it does not affect the effectiveness of Digital Farm and Food Systems (DFFS). While farmers need to afford digital devices and internet costs, many participate in DFFS with the help of friends or

neighbours who have the necessary tools. However, affordability does impact the adoption of digital farm schools, especially for economically constrained farmers. For example, Silva and Ratnadiwakara (2008) reported that high information search costs hindered farmers before mobile technology, leading to losses. In Sri Lanka, many smallholders struggle to afford internet access, limiting their use of digital tools [IPSSL, 2010]. Furthermore, Jayathilake et al. (2010) noted that technology costs hinder ICT use in agriculture. Wealthier farmers benefit from better access to ICT resources for market information (Mittal and Mehar, 2015). In Kenya, 42% of male and 39% of female mobile users cited the cost of devices as a barrier to mobile internet adoption [GSMA, 2021], highlighting the need to address affordability for the success of digital farm schools.

Behavioural intention to use

Facilitation conditions significantly and positively influence the effectiveness of DFFS among farmers at a 5% significance level ($P < 0.05$). The relationship between behavioural intention to use ICT and the effectiveness of farm field schools is significant, as both aim to improve agricultural practices. Behavioral intention, defined as a farmer's decision to engage with a particular technology [Engotoit, Kituyi, and Moya, 2016], plays a crucial role in this context. When farmers believe that using ICT tools, like mobile technologies, will enhance their performance, they are more likely to adopt these technologies effectively. Research indicates that positive expectations about ICT tools correlate with stronger intentions to use them, thereby reinforcing the learning from farm field schools [Engotoit, Kituyi, and Moya, 2016]. Furthermore, enhanced ICT access allows farmers to gain valuable market information, which supports their application of skills learned in farm field schools [Shrestha and Kautish, 2020]. Thus, fostering behavioral intentions to use ICT can significantly improve the outcomes of farm field school programs.

Gender influences on the effectiveness of the Digital farm field school approach

Gender significantly and positively influences the effectiveness of DFFS among farmers at a 5% significance level ($P < 0.05$). Gender significantly influences the effectiveness of the Digital Farm Field School (DFFS) approach, with men generally having greater access to and utilization of information and communication technologies (ICTs). For instance, Prodhan et al. (2015) found significant gender differences in ICT access in Gazipur District, Bangladesh. Globally, women are 12% less likely to use the Internet compared to men, and in Africa, the disparity widens to 25% (FAO, 2018). Additionally, the GSMA's Mobile Gender Gap Report (2021) noted that the gender gap in mobile phone ownership increased from 8% to 9% from 2017 to 2020. These disparities hinder the effectiveness of initiatives like DFFS, highlighting the need for targeted efforts to bridge the gender gap in digital access.

Household size influences the effectiveness of the Digital Farm Field School Approach.

Household size significantly affects the effectiveness of DFFS at the 10% significance level, as indicated by a p-value of 0.088. When household size is larger, farmers can receive assistance from family members, particularly children, to participate in online Zoom sessions.

Farmer income level influences the effectiveness of the Digital Farm Field School Approach

. Farmer income levels have a positive and significant effect on the effectiveness of Digital Farmer Field Schools (DFFS) at a 1% significance level, as indicated by a p-value of 0.000. Higher income allows farmers to access quality mobile devices for participating in Zoom sessions and to afford internet costs. Consequently, as farmers' incomes increase, the effectiveness of DFFS also improves. This finding aligns with the research by Kante et al. (2019), which establishes a significant relationship between income and internet use.

Education level influences the effectiveness of the Digital Farm Field School Approach

. The relationship between education level and the effectiveness of the Digital Farm Field School (DFFS) appears to be weak based on the above analysis. The relationship between education level and the effectiveness of the Digital Farm Field School (DFFS) is weak. With a P value of 0.254, education does not significantly influence participation in the DFFS, even at a 10% significance level. Although DFFS participants generally have higher education levels than those in the Non-Digital Farm Field School (NDFFS), this difference does not impact the effectiveness of the DFFS. This suggests other factors may be more influential in determining the success of the DFFS.

Age level influences on the effectiveness of the Digital Farm Field School Approach

. This study explores the relationship between age and the effectiveness of the Digital Farm School (DFFS) approach, finding that age has a negative but insignificant effect on its effectiveness (p-value = 0.118, coefficient = -0.348). This suggests that as age increases, DFFS effectiveness slightly decreases. Contrary to prior research, such as Prodhon et al. (2015) and GSMA (2021), which indicated better performance among younger individuals and males, this study shows that female farmers, particularly those in their 30s to 50s, often outperform males. Support from children and prior training contributed to the success of older farmers in using DFFS. Previous studies, like those by Polson and Spencer (1991) and Jain and Hundal (2007), highlighted that younger farmers are more adept at adopting technology. Additionally, education levels significantly affect ICT usage; Chung and Paynter (2002) pointed out that lower educational attainment slows the adoption of technologies. In conclusion, while age impacts DFFS effectiveness, factors such as gender, education, and familial support play a more critical role in successful ICT utilization. Enhancing educational opportunities and leveraging support networks could significantly improve the effectiveness of digital farming approaches, regardless of age.

4 Conclusions

The study comprehensively evaluated the effectiveness of the Digital Farmer Field School (DFFS) approach in enhancing agricultural practices among tea smallholders in the Kandy District.

- The findings clearly indicate that participation in the DFFS significantly improves ICT literacy, knowledge and practice adoption, land productivity, and average income when compared to non-participants. This emphasizes the potential of digital platforms in modern agricultural extension, especially amid the challenges posed by traditional methods.
- The multiple regression analysis revealed that a considerable 92% of the variance in DFFS effectiveness can be attributed to vital independent variables, including organizational assistance, facilitation conditions, and effort expectancy. This suggests that an enabling environment, characterized by adequate resource provision and support systems, is vital for maximizing the impact of DFFS on smallholder farmers.
- The positive relationship between these variables and DFFS effectiveness highlights the importance of structured support and training in facilitating the adoption of innovative agricultural practices.
- Conversely, factors such as family workforce, education level, and ICT affordability did not emerge as significant determinants of DFFS effectiveness, indicating that barriers such as access to resources and educational backgrounds may not play a critical role as anticipated in this context. This finding warrants further investigation into the specific mechanisms through which DFFS operates, emphasizing the need for tailored strategies that target existing barriers more effectively.

5 Implications

The DFFS approach has proven to be an effective model for enhancing agricultural knowledge and practices among tea smallholders, thereby contributing positively to their productivity and income levels. The study advocates for policymakers to promote the DFFS approach as a viable extension strategy, facilitating technology transfer and supporting various farmer groups in Sri Lanka. Through targeted engagement and resource allocation, stakeholders can ensure that the benefits of digital agricultural education reach broader segments of the farming community, ultimately leading to the sustainable development of the tea sector in the region.

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