WILLINGNESS TO IMPLEMENT A HYDROPONICS SYSTEM AMONG UP-COUNTRY VEGETABLE FARMERS IN SRI LANKA

***M.S.S. Perera*[1*], *P.J.S. Fernando*[1], *P.R.S. De Silva*[2], *K.D. Munugoda*[3]**

[1]*Department of Business Economics, University of Sri Jayewardenepura, Sri Lanka*
[2]*Department of Computer Science, University of Sri Jayewardenepura, Sri Lanka*
[3]*Centre for Forestry and Environment, University of Sri Jayewardenepura, Nugegoda, Sri Lanka*

INTRODUCTION

Sri Lanka's diverse agro-ecological zones are optimal for the cultivation of a variety of vegetable crops. Also, high-input vegetable farming is prevalent in the Central Highlands DS Divisions of Nuwara Eliya, Welimada, Bandarawela, and Uva Paranagama (Diyabalanage et al., 2017). Vegetable cultivation is a critical component of the Sri Lankan economy. Additionally, vegetable farming contributes significantly to the subsistence sector, with rice serving as the primary crop (Esham et al., 2018). On the other hand, the agricultural sector's contribution to GDP has declined dramatically over the last three decades, falling to less than 7.3% (Thibbotuwawa, 2019). The primary causes of this situation are changing weather patterns, natural disasters (droughts, floods, and more), policy changes at the federal level, rising production costs, and a shrinking workforce. Apart from that, governments' swift response to the post-pandemic economic crisis impacted the agricultural communities significantly (Kadirgamar et al., 2021; Silva & Broekel, 2016).

Traditional agriculture, as a primordial method of food production and farming, makes use of indigenous knowledge, land use, traditional equipment and natural resources, as well as organic fertiliser and farmers' cultural beliefs (Reijntjes et al., 1992). Additionally, half of the world's population continues to rely on it as their primary agricultural source of food and productivity (Altieri & Nicholls, 2017). In the context of Sri Lanka, traditional agriculture was able to feed the entire island for decades, owing to the farmers' wisdom and experience. Due to its low productivity, low-income traditional agriculture consumes a disproportionate share of the economic resources available to high-income modern agriculture. Additionally, current traditional practices fall short of meeting local food demand (Dharmasena, 2010).

For its part, modern technology has proven itself capable of keeping up with the growing demand for food among the world's population. Agriculture innovations such as novel crop varieties, micro-irrigation, indoor cultivation (polytunnels and greenhouses), vertical, soil-less, and hydroponic farming have resulted in increased agricultural output and lower food prices in developed countries (Pretty et al., 2003). As a result, novel farming systems have emerged as an appealing response to rising food demand and concerns about food insecurity, both in the eyes of the general public and investors, due to their potential to alter the traditional agricultural paradigm fundamentally. On the contrary, most Southeast Asian countries, including Sri Lanka, continue to rely on traditional production technologies, including agrochemicals, in all major commercial vegetable-based cropping systems, despite technological advancement (Weerakkody & Mawalagedera, 2020). Recently, there has been an interest in introducing innovative agricultural practices to Sri Lankan farmers, owing to the ill-advised prohibition of artificial fertilisers and pesticides, combined with the economy collapsing due to COVID-19 and a decline in exports and tourism. As a result, domestic and international organisations have conducted extensive research on the subject, but none has been adopted commercially (Ranasinghe, 2020).

For decades, an extensive body of research literature has existed and grown in size, providing ex-post evaluations of factors influencing the adoption of specific practices and technologies to inform decisions aimed at effecting socially beneficial technical change on farms (Feder et al., 1985). While it is unlikely that a single universal model for predicting adoption rates will be developed, policymakers and programme managers continue to struggle to forecast anticipated adoption rates for new technology or practice, even when evaluating a specific innovation (Knowler & Bradshaw, 2007). In 2006, Edmeades and Smale developed an empirical model using data from East African banana growers. Nonetheless, the time, money, and expertise required for the data-intensive surveying and model creation process may be unavailable to agricultural agency decision-makers making critical decisions about research, extension, or resource conservation programmes. This model demonstrates that less complicated procedures are required to initiate such projects. Numerous authors' evidence thus far supports the notion that willingness to engage in novel agriculture is contingent on profit orientation, profit timing, risk orientation, environmental orientation, and enterprise-specific influences on the ability to learn about the innovation (advisory support, group involvement, existing knowledge, and practise awareness), among others. (Blazy et al., 2011; Knowler & Bradshaw, 2007; Silva & Broekel, 2016).

The current study aims to address a significant theoretical challenge that has dominated the field for many years: determining farmers' willingness to pay for hydroponic farming and the socioeconomic factors that influence their perceptions of hydroponic farming as a novel agricultural practice in Sri Lanka's Upcountry Intermediate Region, more precisely in the Badulla and Bandarawela divisional secretaries.

METHODOLOGY

The Badulla district was chosen as the study area due to the high degree of homogeneity among vegetable farmers in terms of crop mix, climate, and geography, but a high degree of heterogeneity in terms of willingness and demographic factors. This investigation used a pre-tested structured questionnaire survey and a random sample of 324 participants from the agricultural community. Characteristics of the farmers who participated in the study are summarised in Table 2. The survey took place between August 2021 and February 2022. The structured questionnaire was created to elicit information about the participants' experiences with agricultural practices, extension services, and new technology. As a result, the questionnaire's final questions focused on farmers' willingness to pay for hydroponic farming. Additionally, farmers who were unfamiliar with this method of farming were educated about it prior to completing the final section of the questionnaire.

Stata®/MP 16.0 for Windows was used to analyse the revealed data statistically (Revision 02 Jul 2019). As recommended by the existing literature, independent variables such as farmer's age, gender, land size, education, and training received were combined with a hypothesised variable (spillover) to develop a multinomial logit model to better understand the key factors affecting farmers' willingness to pay for hydroponic systems (Blazy et al., 2011; Perera et al., 2017). Variables considered in this statistical model are illustrated in Table 1. Those variables were modelled among participants who were willing to install hydroponics systems without financial aid (dwilling), participants who were willing to install hydroponic systems with financial aid (willing), and participants who were unwilling to install hydroponic systems under any circumstances (unwilling).

Table 1

Description of the selected variables for the statistical analysis (n=324)

Variable	Description	Type of Measurement
spillover	Availability of polytunnels in the Grama Niladari division	0 = no 1 = yes
gender	Farmer's gender	0 = male 1 = female

age	Farmer's age	years
training	Training received regarding hydroponics farming	0 = no 1 = yes
education	Famer's higher education status (Degree of Degree+)	0 = no 1 = yes
land	Total land extent	perch

RESULTS AND DISCUSSION

As demonstrated in Table 2, agriculture accounts for approximately three-quarters of the respondents' income (76%). The World Bank's poverty criteria classify the population in question as a "Lower Middle-Income Community" (less than US$ 3.20 per day per capita). Nonetheless, the survey reveals that farmers are confronted with financial constraints to maintain their fields as production costs, particularly fertilisers and pesticides, continue to rise.

In terms of water accessibility, nearly half of the respondents (54%) have access to municipal water systems, while slightly more than a quarter (26%) have access to surface water (rivers, streams, irrigation ditches, open canals, ponds, reservoirs, and lakes). Also, according to the vulnerability index developed by Punyawardena et al. (2013), the Central Province is moderately vulnerable to climate change and unfavourable weather patterns. A minority of the respondents use groundwater from wells (12%) and rainwater (2%) for irrigation practices. It is also worth noting that the study region is not experiencing severe drought conditions as a result of development initiatives such as the Uma Oya reservoir and "Divi Neguma."

A sizable majority (92%) of farmers have access to some form of agricultural extension service, and a significant proportion is satisfied with it. They do not, however, express favourable sentiments about government organisations. Additionally, nearly three-quarters (78%) of respondents stated that there is a tremendous demand in the country relative to production and access to metropolitan and local marketplaces.

The high proportion of the selected population is somewhat familiar with modern agricultural techniques, such as polytunnels, drip irrigation, soil-less farming and more. Finally, when asked whether they are willing to make the financial investment required to construct a hydroponics system on their farm, 42% (n=136) said "Yes" if competent technical help is available. Nevertheless, out of 188 non-willing participants, 50% (n=94) indicated an interest in implementing such a system on their farms if financial and technical assistance were provided.

Table 2
Summary statistics of the farmers interviewed in the study

Variable	Measurements
Total number of farmers	324
Number of female farmers	100
Number of male farmers	224
Famer's age (range)	12-81 yrs
Landholdings (range)	10-480 perches
Practised time period (range)	9 months-100 yrs
Main crops	Beans, Bell pepper, Cabbage, Brinjal (eggplant), Carrot, Potato, Beetroot, Kohlrabi, Capsicum, Paddy, and Cut flowers

Harvest (range)	300-40,000 kg yr^{-1}
Agriculture as a major source of revenue	227
Agricultural monthly revenue (range)	Rs. 10,000.00-400,000.00
Number of willing participants to implement hydroponic systems	136
Willingness to pay for a hydroponic system(range)	Rs. 10,000.00-400,000.00

Likelihood ratio statistics indicate that the proposed model's specifications fit the data reasonably well (l=-337.37). Also, the chi-square value (X^2=0.04) and pseudo R square (R^2=0.03) indicate that the mode is acceptable. The multinomial logit model's findings in Table 3 indicate that age (p=0.04) and training (p=0.02) are highly significant when participants who were willing to install hydroponics systems without financial aid are compared with participants unwilling to install hydroponic systems under any circumstances. Moreover, their education status seems to be particularly significant for participants who were willing to install hydroponic systems with financial aid compared with participants unwilling to install hydroponic systems under any circumstances (p=0.04).

Table 3
Parameter estimates of multinomial logit model

Variable	**dwilling /unwilling**	**willing /unwilling**
Intercept	1.91	1.44
Spillover		
No	Ref	Ref
Yes	0.12	0.05
Gender		
Male	Ref	Ref
Female	0.28	-0.17
Age	-0.07**	-0.04
Age^2	0.00	0.00
Training		
No	Ref	Ref
Yes	-0.95**	-0.30
Education		
No	Ref	Ref
Yes	-0.27	-0.63**
Land	-0.00	0.00

Note. Participants who were willing to install hydroponics systems without financial aid=dwilling, participants who were willing to install hydroponic systems with financial aid=willing, and participants who were unwilling to install hydroponic systems under any circumstances=unwilling.
**P<0.1; **P<0.05*

CONCLUSIONS/RECOMMENDATIONS

This study has found that age, training, and education emerged as reliable predictors of willingness toward hydroponics farming. In spite of its limitations, the study certainly adds to our understanding of the willingness to pay for hydroponic farming. The current challenge is to implement hydroponic systems among farmers in order to gain an understanding of the productivity of hydroponic farming over currently practised methods. These findings will be crucial in formulating strategies for controlling and addressing the difficulties we are currently dealing with, ultimately bringing us to the road of economic recovery following the epidemic.

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ACKNOWLEDGMENTS

1. *University research grant, University of Sri Jayewardenepura (ASP/01/RE/MGT/2021/49)*
2. *Regional Agriculture Research & Development Center (RARDC)-Bandarawela*