Socio-Economic Factors Driving the Adoption of Good Agricultural Practices (GAP) by Sugarcane Farmers: A Case Study of the Sevanagala District Secretariat Division

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ABSTRACT

The sugarcane industry is one of the vital components of the Sri Lankan agriculture sector. Application of Good Agriculture Practices (GAP) is a successful solution for almost all the challenges and difficulties faced by the sugarcane farming industry. However, the degree of GAP adoption among sugarcane farmers has been limitedly studied in Sri Lanka. Therefore, this study was conducted to evaluate the adoption level of GAP and the driving factors behind GAP adoption among sugarcane farmers in the Sevanagala Divisional Secretariat Division (DSD). A total of 100 sugarcane farmers residing in the Sevanagala DSD were recruited as the study sample using the stratified random sampling approach. The socio-demographic information, crop production activities, farmer characteristics, and information about the adoption of GAP were collected using a pre-tested interviewer-administrated questionnaire. The Chi-square test of association was used to identify the significant driving factors behind the adoption of GAP. The majority of farmers were males (83%) and had completed GCE O/L (53%) as their highest educational qualification. Around 44% of the farmers were belonging to the 51 to 60 years age group and had a farming experience of more than 25 years (81%). The sugarcane farmers reported a moderate GAP adoption level (48.5%), followed by another 30.3% of farmers with a high GAP adoption level. The results of the Ch-square test revealed that the farmer's gender, field extent, total yield, farmer's income, and attitudes toward GAP significantly influence ($P<0.05$) the adoption level of GAP. Most of the individuals that had a higher GAP adoption level were male (35.4%). Results further suggested that farmers with higher farming land extents, total yield and income had a significantly higher tendency to adopt GAP. In addition, sugarcane farmers with a moderate and higher attitude level on GAP also reported a higher GAP adoption level. According to the findings, lack of capital, technical knowledge, and skilled labour were identified as the major barriers against GAP adoption. Therefore, policymakers should focus on facilitating soft financial loans, while conducting awareness and training programs to promote GAP among the sugarcane farmers.

KEYWORDS: Sugarcane farmers, Good Agriculture Practices (GAP), Driving factors, Sri Lanka, Sugarcane farming industry

Introduction

Sugarcane is one of the most prominent and economically valuable agricultural crops globally, especially within tropical regions. The global sugarcane industry has shown a significant development from 1994 to 2018, due to the increasing demand for sugar consumption (Som-Ard *et al.*, 2021). The global annual sugarcane production has been estimated to be around 1600 million tonnes (Chandel *et al.*, 2011). Mostly, Brazil (37.0%), India (18.7%), China (5.4%), and Thailand (5.4%) act as the key contributors to global sugar production (Som-Ard *et al.,* 2021). In the Sri Lankan context, the sugarcane industry plays a vital role in the national economy. Sri Lankan sugarcane cultivation has widely spread in the dry zone, especially in Anuradhapura, Ampara, Moneragala, Badulla and Trincomalee districts, mainly due to the favourable environmental conditions for a higher yield (Dharmawardene and Krishnamurthi, 1992). At present, Pellwatte, Hingurana, Sevanagala and Kanthale remain the major four areas of sugarcane cultivation within Sri Lanka. The annual per capita consumption of sugar in Sri Lanka is around 30 kg and the total annual requirement of sugar is around 550,000 tonnes (CBSL, 2018). The national sugar requirement has been predicted to increase by 1% annually (Keerthipala, 2007). In 2018, Sri Lanka has only produced 42,940 tonnes of sugar (7%). Therefore, in 2018, around 575, 000t of sugar were imported at a cost of Rs.22.3 billion (CBSL. 2018). The total extent of sugarcane cultivation in Sri Lanka has been estimated to be less than 30,000 ha. Despite the high potential for sugarcane cultivation within Sri Lanka, the local sugarcane industry meets only about 9% of the total annual sugar requirement. This has resulted in numerous adverse impacts on the equilibrium of the Sri Lankan economy (CBSL, 2018).

The sugarcane industry is facing multiple challenges that directly affect productivity, not only at the local level but also at the global level. The adverse effects of climate change and global warming have had a crucial effect on the reduction of sugarcane yield. Prolonged drought conditions and intensification of pest and disease attacks often hinder the growth and development of sugarcane, thereby restricting the potential yield. In addition, elevated production costs, poor land use practices, less availability of facilities, low accessibility to novel farming technologies, higher labour costs, and inadequate knowledge of precision farming technologies have been identified as the major problems faced by the sugarcane farmers at the global level (Tabriz *et al.*, 2021). Most of the time, sugarcane cultivations are maintained as rainfed cultivations, especially in Sri Lanka, which remains highly susceptible to climate change (Nissanka and Sangakkara, 2009). The expected average sugarcane yield among Sri Lankan farmers is around 140 tonnes/ha under irrigated cultivation and 70 tonnes/ha under rainfed cultivation. However, the total annual yield of local sugarcane cultivation remains at 55 tonnes/ha, which is significantly lower than the total potential yield in Sri Lanka (Dharmawardene and Krishnamurthi, 1992).

The low yields of sugarcane cultivation and less product diversification have emerged as the major challenges faced by the sugarcane sector in Sri Lanka. In turn, this has led to an inadequate and low-quality supply of sugarcane to the sugar manufacturing sector and inefficient utilization of sugarcane by-products.

In addition, the inequality in the cost of sugarcane harvest, lack of development-oriented measures in the industry, environmental concerns, industrial managerial problems, lack of research and technology transfer, and unfavourable local regulations have resulted a tremendous pressure on the local sugarcane cultivation system (Keerthipala, 2007). Therefore, the majority of sugarcane farmers are not receiving an adequate income.

Good Agriculture Practices (GAP) offers a promising approach to uplift and develop the sugarcane cultivation sector. Standard practices taken to ensure food security, food quality, food safety, and food supply from farm to consumer, while reducing environmental and social impacts on agriculture have been defined as GAP (Hobbs, 2003). According to the FAO, GAP includes a wide variety of practices, including crop protection, crop and fodder production, soil management, irrigation management, proper harvesting practices, energy and waste management, processing and storage of agricultural products, human welfare and safety, and landscape conservation (Ghosh and Braun, 2020). Successful adoption of GAP has proven to elevate the productivity of agricultural systems while ensuring sustainability (Poisot *et al.,* 2007). A recent study conducted by Djajadi *et al.* (2017), has evidenced the effectiveness of utilizing liquid fertilizers in sugarcane to increase yield and profitability. Furthermore, adopting GAPs, especially integrated pest management practices (Muliasari and Trilaksono, 2020; Wicaksono, 2012) and cultural practices (Tyasmoro *et al*., 2024), has been reported to secure a higher yield and to elevate the environmental performance in sugarcane cultivation. A recent study conducted in Indonesia has shown that the yield of sugarcane cultivation could be increased up to 10.1% from the average of 7% by applying GAP (Tyasmoro *et al*., 2024). Thus, the application of GAP in sugarcane cultivation can elevate its effectiveness and total yield, along with sustainability. However, knowledge and attitudes of the farming community on GAP, availability of fertilizers, financial capability, market value for the yield, irrigation systems, labour availability, nature of the extension services and infrastructure facilities have been reported to influence the adoption level of GAP by sugarcane farmers globally (Sennuga *et al*., 2020).

In the Sri Lankan context, GAP has been introduced to the local farming systems more than a decade ago. Selection of quality seeds, soil management and evaluations, application of recommended straight fertilisers, utilisation of organic fertilisers, effective irrigation management, crop retention, integrated pest management, and effective postharvest handling practices are some of the GAPs that are followed by Sri Lankan farmers (Senanayake and Rathnayaka, 2015). Though Sri Lankan farmers have an understanding of the GAP and its importance, they seem to have limited knowledge of the different criteria and applications of GAP. Therefore, a notably lower GAP adoption level can be seen among Sri Lankan farming communities, especially among the sugarcane farmers (Malkanthi, 2021).

To promote sustainable and effective sugarcane cultivation in Sri Lanka, it's important to increase the GAP adoption level of local farmers strategically.
Evaluation of the existing GAP adoption level among the sugarcane farming community and identification of the major driving factors behind the adoption of GAP is essential to implement this concept effectively.

However, limited studies have focused on filling this knowledge gap in Sri Lanka. Therefore, the current study was conducted to assess the GAP adoption level and identify the critically influencing driving factors on GAP adoption among sugarcane farmers in the Sevanagala DSD, Sri Lanka.

Methodology

Study Area

This study was conducted in the Sevanagala DSD, which is located in the Moneragala district of Sri Lanka, as shown in Figure 1. Sevanagala is one of the leading Sri Lankan sugarcane cultivation regions situated in DL_{1b} agroecological region (Punyawardena *et al.*, 2003). Sugarcane cultivation remains widely popular in this area, after the establishment of the second largest sugar processing company in the early 1980s. At present, the sugarcane cultivation in this area is conducted under both rainfed and irrigated conditions. The Udawalawa Irrigation System is the main irrigation system channel that provides water for the Sevanagala DSD (Prasanna and Shiratake, 2013). The majority of sugarcane farmers residing in the Sevanagala DSD are small-scale farmers, who cover around 4000 ha of sugarcane (Samaraweera, 2011).

Data Collection

A total of 100 sugarcane farmers residing in three villages located in the Sevanagala DSD were recruited as the study sample, adhering to the stratified random sampling technique. A pre-tested structured interviewer-administered questionnaire was used for the primary data collection via face-to-face interviews. The questionnaire consisted of four major sections, a) socio-demographic information of the farmers, b) farming characteristics c) attitudes on GAP for sugarcane cultivation and d) GAP practices adopted by the sugarcane farmers within the Sevanagala DSD.

Data Analysis

All collected data were double-checked and verified on the same day for completeness and consistency. Subsequently, the data were entered into SPSS (version 23), while adhering to quality control procedures by trained personnel. Descriptive analysis techniques were used to summarize the socio-demographic data crop production-related data and farm characteristics. The Chi-square test of association was used to evaluate the significance of the association between the GAP adoption level and the selected socio-demographic factors of Sugarcane farmers in the Sevanagala DSD at a 95% level of confidence. All statistical analyses were performed in SPSS (version 23).

Results and Discussion

Socio-Economic Characteristics of the Sugarcane Farmers

Among the sugarcane farmers, 83% of the majority were males, while the rest of the population was females (17%).

The majority of the farming community had completed Ordinary-level education (53%), followed by another 28% of farmers who had completed only primary education, as shown in Table 1. Meanwhile, only 1% of sugarcane farmers were degree-holders.

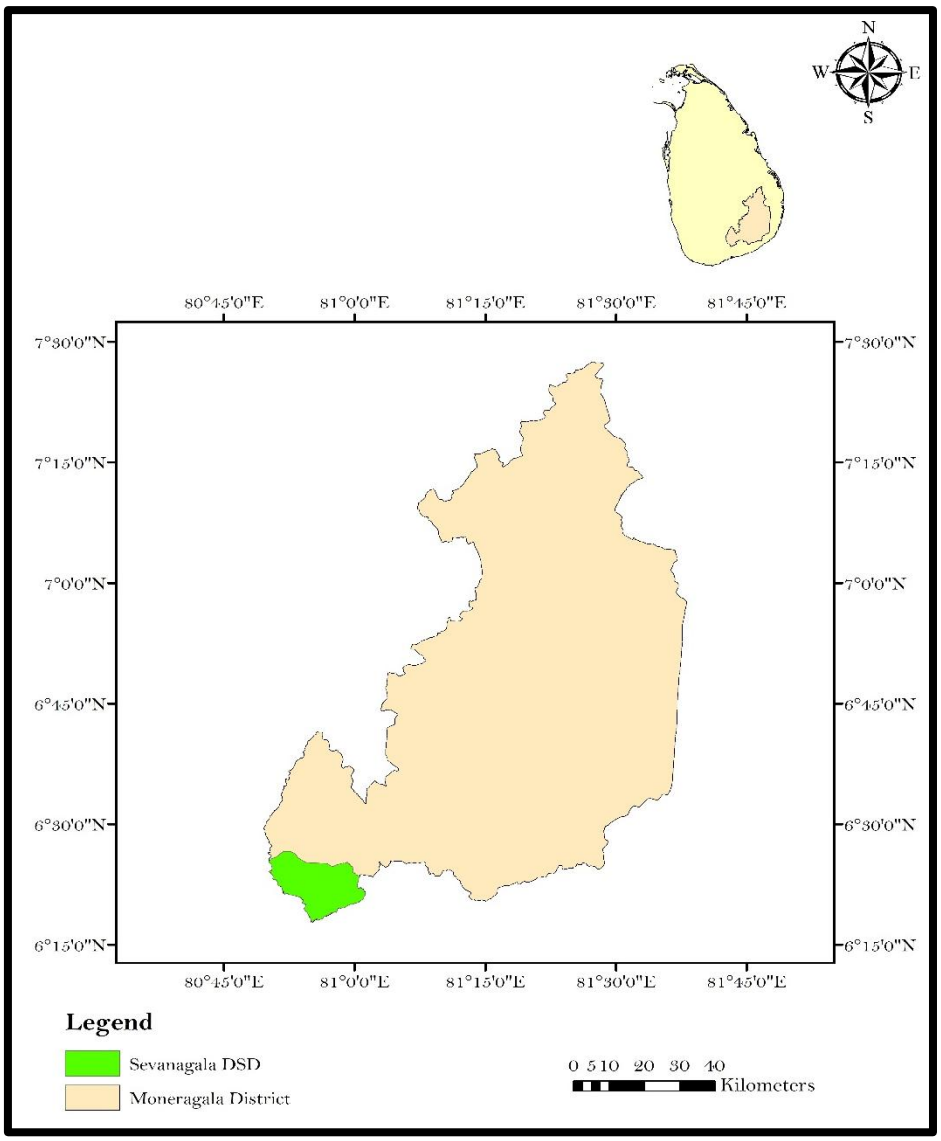

Figure 1: Location of the Sevanagala DS Division

Most of the participants had been engaging in Sugarcane farming for more than 25 years (81%) while about 3% of the farmers had 5-10 years of farming experience. Farmers belonging to the 51-60 years age group were dominant among the sampling population, accounting for around 44%.

Furthermore, around 25.3% of the farming community were in the age group of 41-50 years, while a significant minority was over the age of 61 years (6.1%), as shown in Table 1.

The study revealed that the primary income source for the majority was agriculture (71%) and about 19% of farmers were self-employed. Further, around 7% and 3% of the farming community were engaged in private and government jobs, respectively as their major income source. The monthly income of most of the sugarcane farmers was between Rs. 20,000 and Rs. 50,000 (42%), followed by 30% of farmers with an income of Rs. 50,000–Rs. 100,000.

Table 1: Socio-Economic Characteristics of the Population

Parameter		Percentage (%)
Gender	Male	83
	Female	17
Education Level	Primary Education	28
	O/L	53
	A/L	15
	Diploma	3
	Degree or Higher	1
Experience in Farming (Years)	5 - 10	3
	11 - 15	8
	16 - 25	8
	> 25	81
Age Group (Years)	20 - 30	19
	31 - 40	6
	41 - 50	25
	51 - 60	44
	> 61	6
Main Source of Income	Agriculture	71
	Private Jobs	7.
	Government Jobs	3
	Self-Employment	19
Monthly Income (Rs.)	< 20,000	10
	20,000 – 50,000	42
	51,000 – 100,000	30
	> 100000	18

Crop Production Activities and Farm Characteristics

A higher proportion of sugarcane cultivation was done under rain-fed cultivation practices (65%), while 35% was maintained under irrigated conditions. Furthermore, almost all the sugarcane farmers in the study population were following conventional farming techniques (99%), while only 1% of the farmers were following organic farming (Table 2). Most of the Sugarcane farmers cultivated around 2-4 acres of land (80%), followed by 17% of farmers cultivating more than 4 acres. A significant minority (3%) were cultivating sugarcane in a land extent of less than 2 acres. Among the farmers, around 63% had sugarcane cultivations of 3–5 years of age, while around 20% of the cultivations were less than 3 years old. Only 2% of the cultivations were more than 10 years of age (Table 2).

According to the findings, intercropping was not popular among the selected sugarcane cultivation community (24%), while the majority of sugarcane farmers (76%) did not practice intercropping in their cultivations. Among the intercropping farmers (n=24), maize and vegetables were been used equally for intercropping (42%), while others selected peanut (8%) and cowpea (8%) as the intercropping crop varieties. Conventional irrigation practices had been followed by a larger proportion of the farming community (65%), instead of micro irrigation techniques (35%). The study showed that around 88% of sugarcane was harvested as factory cane, while the rest (12%) was being harvested for seed requirements. Sugarcane harvesting was mostly done by human labourers (84%), while only 16% of farmers used machines for harvesting. Nevertheless, the majority of farmers were able to secure an average yield of 100-150 MT/ha (53%), followed by an average yield above 150 MT/ha (31%). Meanwhile, only 16% of farmers had an average yield below 100 MT/ha (Table 2). The majority of farmers (49%) earned around Rs. 50,001-Rs. 1,000,000 per acre from sugarcane cultivation, followed by another 30% of farmers with an income above Rs. 1,000,000 per acre. Only 21% of the farming community received a lower income between Rs. 100,000-Rs. 500,000 per acre from sugarcane cultivation.

Table 2: Farming Characteristics of the Study Population

Parameter		Percentage %
Irrigation Nature	Rain Fed	65
	Irrigated	35
Farming Method	Conventional	99
	Organic Farming	1
Total Land Extent under Cultivation (acres)	< 2	3
	2-4	80
	> 4	17
Age of Cultivation (Years)	< 3	20

	3-5	63
	5-10	15
	>10	2
Intercropping	Yes	24
	No	76
Intercropping Crop Variety	Maize	42
	Vegetables	42
	Peanut	8
	Cowpea	8
Average Yield (MT/ha)	<100	16
	100 - 150	53
	>150	31
Harvesting Type	Factory Cane	88
	Seed Cane	12
Harvesting Method	Human Labour	84
	Using Machines	16
Income (Rs. /ac)	100,000 – 500,000	21
	500,001 – 1,000,000	49
	1,000,000 <	30

Attitudes of Sugarcane Farmers on Good Agricultural Practices

The entire study population (100%) agreed with the fact that the adoption of GAP is important in increasing the yield (Table 3). Further, a higher proportion of the sugarcane farmers accepted that GAP adoption would elevate the quality of sugarcane harvest (91%) and cut down the costs of production (78%), as shown in Table 3. In addition, the majority of the respondents disagreed with the fact that GAP adoption in sugarcane cultivation is a waste of time (80%) and an additional burden on them (80%). Meanwhile, a notable fraction of the sugarcane farmers accepted that the use of organic fertilizers can secure a satisfactory yield (74%). Interestingly, around 71% of the study population were satisfied with the support provided by the government extension officers in adopting GAP. Around 82% of the study population denoted a higher degree of positive attitudes toward GAP, as shown in Figure 2. Meanwhile, around 14% of the sugarcane farmers had a moderate level of attitudes on GAP, while a significant minority of the study population (4%) revealed a poor attitude level on GAP (Figure 2).

Table 3: Attitudes of the Study Population on GAP

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Following GAP is important to increase the yield of sugarcane.	0	0	0	100.0	0
Following GAP is important to elevate the quality of sugarcane.	0	1.0	8.0	86.0	5.0
Following GAP can decrease the cost of inputs and labour.	4.0	8.0	10.0	77.0	1.0
Following GAP in sugarcane cultivation is a waste of time.	10.0	70.0	6.0	10.0	4.0
Adopting GAP in sugarcane cultivation is an additional burden.	21.0	59.0	3.0	16.0	1.0
Organic fertilizers can provide a satisfactory yield of sugarcane if used properly.	3.0	8.0	15.0	64.0	10.0
Government officers are supporting us in adopting GAP in sugarcane cultivation.	0.0	3.0	26.0	63.0	8.0

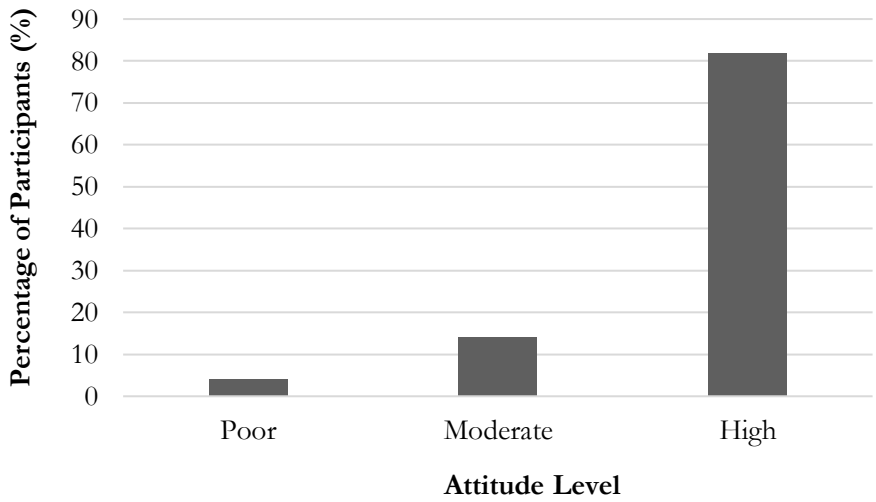

Figure 2: Attitude Level of Sugarcane Farmers on GAP

Adoption Level of Good Agricultural Practices

The findings of the study revealed that the majority of sugarcane farmers have a moderate adoption level of GAP (49%), followed by another 30% of farmers with a higher GAP adoption level. However, about 21% of the study population showed a poor GAP adoption level, as shown in Figure 3.

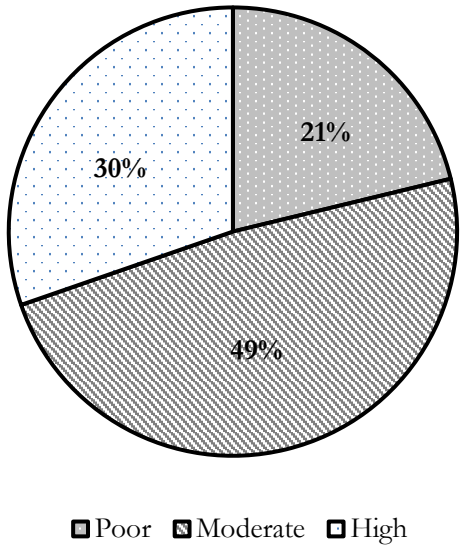

Figure 3: Attitude Level of Sugarcane Farmers on GAP

Socio-Economic Driving Factors Affecting the GAP Adoption in Sugarcane Cultivation

According to the Chi-square statistics, the adoption level among the studied sugarcane farmers denoted significant associations with gender, extent of cultivation, attitudes on GAP, average yield and income of the sugarcane farmers ($P<0.05$). The male farmers had a significantly higher GAP adoption level ($P=0.045$), compared to females (Table 4). The age of farmers did not reveal any significant association with the adoption of GAP in sugarcane cultivation ($P=0.094$). Meanwhile, the education level of farmers ($P=0.876$) and farming experience ($P=0.131$) did not reveal any significant influence on GAP adoption for sugarcane cultivation. However, a previous study conducted in Indonesia revealed that the GAP adoption level significantly increases with the higher education level of sugarcane farmers (Astari *et al.*, 2019). Meanwhile, a similar study conducted in Jamaica has shown that the number of years in farming and their experience significantly influence the GAP adoption level of sugarcane farmers (Palmers, 2011).

Interestingly, the farming method (conventional or organic farming) did not indicate any significant associations with the GAP adoption level of the study population ($P>0.05$). As intercropping was not a common cultivation practice among the study population, it did not significantly influence ($P>0.05$) the GAP adoption level. Nevertheless, the extent of cultivation significantly affected the GAP adoption level of the selected Sugarcane farmer population ($P=0.049$), as shown in Table 4. The results of the Chi-square analysis revealed that the farmers who maintain higher extents of sugarcane cultivation tend to indicate significantly higher GAP adoption levels.

The yield of sugarcane was found to be a significant driving factor for the GAP adoption level of sugarcane farmers. The sugarcane farmers with higher yields depicted a higher level of GAP adoption. The majority of farmers who had an income of more than Rs. 510,000 per acre had a moderate to higher GAP adoption level, suggesting that the income generated from sugarcane cultivation has a significant influence on the GAP adoption level. According to Palmer (2011), the total acreage of land used to produce the sugarcane crop, the level of dependence on sugarcane as a major source of income and the profit received per acre from the sale of sugarcane denote a significant influence of the GAP adoption level of sugarcane farmers. The findings of the current study indicate that almost 50% of farmers who had moderate and poor attitudes toward GAP depict a poor GAP adoption level, while the majority of farmers with higher attitudes toward GAP reveal a significant moderate (P=0.025) to high GAP adoption level (Table 4). This confirms the fact that a higher attitude level toward GAP is crucial to achieving a higher GAP adoption level among the sugarcane farmers in Sevanagala.

Table 4: Results of Chi-Square Test of Association

Parameter		GAP Adoption Level			P value
		Poor	Moderate	High	
Gender	Male	19.3	45.8	34.9	0.045
	Female	41.2	52.9	5.9	
Education	Illiterate/Grade 5	25.0	50.0	25.0	0.876
	O/L	18.9	43.4	37.7	
	A/L	20.0	60.0	20.0	
	Diploma	33.3	33.3	33.3	
	Degree	0.0	100.0	0.0	
Experience in Farming (Years)	5-10 years	0.0	66.7	33.3	0.131
	11-15 years	0.0	75.0	25.0	
	16-25 years	50.0	50.0	0.0	
	>25 years	21.0	44.4	34.6	
Age (Years)	20-30	15.8	68.4	15.8	0.094
	31-40	16.7	83.3	0.0	
	41-50	24.0	48.0	28.0	
	51-60	20.5	31.8	47.7	
	61<	33.3	66.7	0.0	

Farming Method	Conventional	21.2	47.5	30.3	0.585
	Organic farming	0.0	100.0	0.0	
Extent of Cultivation	2 ac	66.7	33.3	0.0	0.049
	2-4 ac	25.0	47.5	26.3	
	4<ac	5.9	29.4	64.7	
Intercropping	Yes	29.2	45.8	25.0	0.526
	No	18.4	48.7	31.6	
Yield (MT/ha)	100	37.5	62.5	0.0	<0.001
	100 - 150	22.6	56.6	18.9	
	150 <	9.7	25.8	64.5	
Income (Rs./acre)	100000-500000	42.9	47.6	0.0	<0.001
	510000-1000000	20.4	65.3	12.2	
	1000000 <	6.7	20.0	73.3	
Attitude Level	Poor	50.0	25.0	25.0	0.025
	Moderate	50.0	35.7	14.3	
	High	14.6	51.2	32.9	

Conclusions

The findings of this study disclosed that the GAP adoption level of sugarcane farmers in Sevanagala was at a moderate level. Among the socio-economic and farming-related characteristics, only gender, extent of cultivation, attitudes toward GAP, average yield and income of the sugarcane farmers denoted significant associations with the GAP adoption level among the studied sugarcane farmers. Meanwhile, the education level, farming experience, age, primary source of income, monthly income, and farming methods did not reveal any significant influence on the GAP adoption level of farmers in the Sevanagala region. Farmers with a large sugarcane cultivation extent, positive attitudes toward GAP, higher yield and income reported a significantly higher GAP adoption level. Limitations in capital, technical knowledge and skilled labour could be identified as the major barriers to adopting GAP by the sugarcane farmers. Therefore, conducting awareness programmes and training workshops on GAP are highly essential to promoting GAP among the sugarcane farmers in Sevanagala DSD. Also, it's important to supply extension services and improve the resource accessibility of farmers, such as financial support and low-interest loans.

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