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Integrated Pest Management Practices in Somalia to Reduce Pesticide Use in Banana Production

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Abstract
Banana cultivation is an essential source of life for Somalia. Diseases and pests affecting banana production are causing yield reductions, thereby negatively impacting the livelihoods of banana producers in Afgoye. This research aims to reveal the pesticide-related problems faced by the farmers who grow bananas in Somalia and their pesticide knowledge. The study further explores farmers' training levels and training levels on integrated pest management (IPM), whether this training translated into IPM applications, and examines the socio-demographic factors affecting their IPM practice. The research was carried out with 378 banana growers living in Lower Shabelle. A binary logistic regression method was used. Results showed that 75% of participants received IPM training via cooperatives, and 48% did not use pesticides. All participants used one form of the IPM method during banana cultivation. Education, land ownership, number of the family workforce, annual farming income, and home consumption rate had a positive and significant effect on IPM adoption. Age, farming experience, and using credit for banana production negatively impacted IPM adoption. However, this impact was not statistically significant.

Keywords Agricultural extension · Binary logistic model · Farm management · Fruit production · Sustainability

Introduction

A banana is a soft fruit that grows in equatorial and subtropical regions. Bananas originated in Southeast Asia and spread from the Eastern part of India. Banana is the fourth most crucial food after rice, wheat, and corn (Thangavelu and Mustaffa 2012). Bananas are grown on approximately 10 million hectares in 135 countries. According to the United Nations Food and Agriculture Organization (FAO 2018), the average banana planted area in the world between 2015 and 2020 was 5.2 million hectares. Despite the large production volume, only approximately 16% of global production is exported. World banana production increased by 1.2% in 2018 reaching 116 million tons (Okoli 2020).

Banana cultivation is one of the critical products for Somalia. Banana exports reached their highest level in 1990. In the 1960s, the area where bananas were planted in Somalia was 11,000 ha. However, banana production areas decreased to 1350 ha in 2020. Banana production in 2020 was 23,025 tons, and its share in the world was 0.02% (FAO 2018). The world average banana yield was 2234 kg/ha as the average for 2015–2020. The highest banana yields belong to Syria (8071 kg/ha), Bhutan (6787 kg/ha) and Nicaragua (5949 kg/ha). The average banana production of Somalia for the same period was 1706 kg/ha (FAO 2018).

Integrated Pest Management (IPM)

Insect damages caused can significantly reduce the marketing ability of bananas (Shankar et al. 2016). Integrated pest management (IPM) strategies are increasingly used in banana farming to reduce the excessive and indiscriminate use of insecticides and herbicides.

IPM is an integrated ecological method that uses all available pest control approaches to keep and reduce agricultural pests below the economic harm threshold (Chand 2021). IPM involves using all accessible pest control methods and other techniques that inhibit the growth of pest populations while providing the least possible hazard to health and the environment (FAO 2017).

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There are many studies in the literature on IPM applications. However, research on IPM practices by banana growers in Somalia is scarce. Satyagopal et al. (2014) discussed the most important natural enemies of banana pests in banana production in India. The authors underlined that IPM is a globally accepted method for developing sustainable agriculture. According to the study, plant protection integrates cultural, physical, mechanical, biological, botanical, and chemical strategies. The authors stressed that it is necessary to try natural methods before using chemical pesticides to protect the producers' interests in the long term.

Various factors can affect producers' acquisition of IPM. Ceylan et al. (2010) analysed the factors affecting the adoption of IPM in Turkey. According to the study, the farm size, non-agricultural income, source of IPM information, producer age, and education level statistically and significantly affected the implementation of IPM. One of the most important findings was that a unit increase in the training period increased the probability of the producer implementing IPM by 6.75 times. Maheswaran et al. (2019) studied the relationship between the knowledge of banana growers about IPM and their economic motivation. The study determined that economically motivated producers aimed for profit maximisation in production because they focused on economic benefits and were more inclined to learn and apply IPM. At the same time, producers with higher levels of education were more willing to learn about IPM than producers with lower education.

This research was carried out in the lower Shabelle province, particularly in Afgoye district, where bananas are widely cultivated in Somalia. The aims of this research were to:

- Examine the socio-economic characteristics and agricultural knowledge of the farmers who apply and do not implement the IPM in Somalia;
- Investigate the types of IPM practise carried out and the scope of training provided;
- Examine factors influencing farmers' decisions to adopt IPM practices.

As stated earlier, the banana is the primary fruit in southern Somalia. In addition to meeting the nutritional needs of the people, it significantly contributes to the country's economy through domestic and foreign trade and employment. Despite this importance, production areas have decreased substantially. Resulting, the fight against diseases and pests has become more pressing. The research results are valuable for increasing the efficiency of banana production, protecting human health and the environment, and sustaining the income of households that grow bananas.

Materials and Methods

Study Area and Sampling

This research was carried out in Afgoye district of Lower Shabelle province, where banana cultivation is common in Somalia. Lower Shabelle (Shabeellaha Hoose) is located in the south of Somalia. Its area is 25,285 km^2, and the province's population was 1,400,000 as of 2007 (17% urban, 60% rural and 23% nomadic) (FSNAU 2013). The population mostly lives in villages. The number of farms was around 70,000 and its size is reported to be about 2.7 ha. The region's population is divided into four parts: the agricultural, the agricultural and livestock, the nomadic, and the urban population. Afgoye is the capital of Lower Shabelle.United Nations Population Fund (UNFPA) (2014) estimated the total population of Afgooye district to be 134,892. It is located approximately 30 km west of Mogadishu, the country's capital.

The population of the research consists of banana producers in Somalia. The study sample was selected from among the growers living in Lower Shabelle. A simple random sampling method was used. Face-to-face interviews were conducted in 2021 with 378 farmers.

Thompson's formula was used to determine the sample size:

$$n = \mathrm{N}p(1-p)/(\mathrm{N}-1)(d^2/z^2) + p.(1-p)$$

In the formula:

n:	the total sample size,
N (134,892):	the total population,
p=	0.5,
d:	the accepted error (assumed to be 5%), and
z:	based on the confidence level (1.96 for 95%).

The use of the formula gives the total sample size as 378.

The research is based on quantitative data and the relational screening design used. A questionnaire was used to collect data. During the questionnaire preparation phase, the relevant literature was screened, and questions were prepared to reflect the factors affecting the pesticide application processes and the IPM applications of banana producers. The questionnaire was finalised by taking expert opinions. The survey consisted of five sections and 42 questions. In the first part, 12 questions were about the participants' demographic information. In the second part, nine questions were about the production and use of bananas. In the third section, 10 questions aimed to measure the knowledge about banana pests and pest management. In the 4th sec-

tion, two questions aimed to measure the IPM knowledge and training. The 5th and last part included eight questions about pesticide use, safety, information, and education. All questions in the survey were closed-ended and multiple-choice questions.

The internal consistency coefficients (Cronbach's Alpha) of the 30 items, excluding the demographic variables, were calculated to measure the reliability of the questionnaire. The Cronbach's Alpha of each item ranged between 0.60 and 0.79, showing that the scale is reliable.

Data Analysis

The related variables and their relationships were analysed with descriptive statistics. Additionally, binary regression was employed to reveal the factors influencing IPM practices of producers in banana production. Binary logistic regression is a logistic regression analysis with dependent variables containing binary responses. It reveals the correlation between one or more explanatory and binary response variables. Explanatory variables can be either categorical or metric. The category examined in the dependent variable is generally coded with Y = 1. Y = 0 indicates the other category (Hosmer and Lemeshow 2000).

The model was determined as follows: (1)

$$P\,(Y) = \frac{e^{\beta_{0+}\beta_1 X_1 + \ldots + \beta_n X_n}}{1 + e^{\beta_{0+}\beta_1 X_1 + \ldots + \beta_n X_n}}$$

Where:

P:	the probability of Y occurring
e:	natural logarithm base
β_0:	interception at the y-axis
β_n:	regression coefficient of X_n
X_1:	predictor variable
X_1	predicts the probability of Y

In the logistic regression equation, P represents the probability of the event being observed. The ratio of the probability of an investigated event to the probability of other events outside itself is called the odds ratio (OR). The odds ratio is expressed as Exp(β) in the logistic regression equation. Since the odds ratio is the probability of an event occurring to the probability of not occurring (Gujarati 1999), exp (β_p) indicates how many times the Y variable is likely to be observed with the effect of the X_p variable, or by what percentage.

Results and Discussions

Table 1 summarises the demographic findings of the participants. Most of the participants were male (60.5%). More than half (51%) were aged 41–60 years, and two-thirds (61.5%) were aged 41 years and older. Most participants were high school graduates (29%), but 18% were literate. One-third (33.5%) of the participants received less than $100/month, and the other third (34.5%) earned between $101–200. This confirmed that they were small-scale and subsistence producers.

Table 1 Demographic findings

Variables	Groups	Frequency	%
Sex	Female	149	39.5
	Male	229	60.5
Age (years)	18–30	23	6.0
	31–40	123	32.5
	41–50	147	39.0
	51–60	45	12.0
	61+	40	10.5
Education	Illiterate	13	3.5
	Literate	68	18.0
	Primary education	59	15.5
	Secondary school	98	26.0
	High school	110	29.0
	University	30	8.0
Marital status	Single	16	4.0
	Married	362	96.0
Household size (person)	1–3	40	10.5
	4–6	176	46.5
	7 ≤	163	43.0
How many household members are working?	1	100	26.5
	2	144	38.0
	3	89	23.5
	4 ≤	45	12.0
Income level (US$)	≥ 100	127	33.5
	101–200	130	34.5
	201–300	64	17.0
	301 ≤	57	15.0

Consistent with the findings of this study, a similar study conducted with banana producers in Uganda found that between four and nine people lived in the producers' houses, and most of the banana producers were high school graduates (Bagamba et al. 2003). Aguilar (2014) found in his research in the Philippines that most of the banana growers received 7–13 years of formal education, the average age was 44 years, between three and 16 people worked in the banana business in the household, and women were involved in banana cultivation as much as men. Likewise, Ssennyonga et al. (2005) found that women work in the banana business as much as men in Uganda. However, in contrast, the participants were predominantly primary school graduates.

The findings presented in Table 2 confirmed that approximately two-thirds of the participants (64.5%) had

Table 2 Findings on banana cultivation

Variables	Groups	Frequency	%
Banana farming experience (years)	1–10	113	30.0
	11–20	244	64.5
	21 ≤	21	5.0
Farm ownership	Owner	200	53.0
	Renter	76	20.0
	Sharer	102	27.0
Group or organisation membership	Farmer organisations	204	54.0
	Saving group	110	29.0
	Marketing cooperative	64	17.0
Distance to nearest producers' market (km)	1	295	78.0
	2	36	9.5
	3	45	12.0
	5	2	0.5
Distance to nearest input store/market	1	196	52.0
	2	62	16.5
	3	85	22.5
	5	35	9.0
Sale points	Local merchant	176	46.5
	National merchant	22	6.0
	Cooperative	123	32.5
	Neighbour	57	15.0

11–15 years of experience. Again, slightly more than half (53%) owned the orchards. 27% of them were shareholders. Producers at similar rates had rented the orchards (20%) or produce based on the partnership (27%). All participants were members of an organisation or group. 54% were farmer organisation members, 29% were the savings group, and 17% were the marketing cooperative or marketing group.

Half of the producers (52%) lived 1 km, and 91% lived within 3 km from the producers' market. This finding confirms that farmers sold their products locally. Consequently, a substantial portion of the producers sold to the local merchant (46.5%), and the others sold to the local cooperatives (32.5%) and neighbours (15%). Likewise, banana farmers supplied the inputs within a maximum radius of 3 km.

Table 3 shows that the total income (annual) of nearly half of the farmers from the bananas sold was between $10,001 and $20,000. Only 9% of the banana farmers earned $30,001 and above. The average salary after taxes in Somalia was $390, making up about $4500 in annual income per person (Livingcost.org data 2022), Considering that at least two or more people work in the family, the study confirms that Somali banana producers had earnings below the national average.

Bananas were the primary family livelihood for the participating farmers. So much so that for nearly half of the participants (47.5%), the ratio of banana income to total family income was 50% and more. About two-thirds

Table 3 Financial background of participant farmers

Variables	Groups	*N*	%
The total value of bananas sold ($)	4000–10,000	60	16.0
	10,001–20,000	195	51.5
	20,001–30,000	89	23.5
	30,001 ≤	34	9.0
The ratio of banana sales in family income (%)	1–25	121	32.0
	26–49	77	20.5
	50 ≤	180	47.5
Credit usage for banana production	Used	262	69.5
	Did not use	116	30.5
Home consumption rate	None	151	40.0
	Less than 50%	168	44.5
	More than 50%	59	15.5

(69.5%) used loans in the previous year. As seen in the previous section, low incomes make farmers use loans. Nearly 40% of the participants never consume the banana they produce in their homes.

Locally grown bananas play an indispensable role in people's daily diets. For example, in Vanuatu, bananas are the second highest consumed food after rice, with approximately 172 g/day, contributing 8.5% of daily energy (Vanuatu National Statistics Office 2021). In the Marshall Islands, between 32 and 45% of households consume bananas, with higher proportions in rural areas (EPPSO 2021). Aguilar (2014), in his research in the Philippines, found that banana cultivation constitutes the central part of farmers' income in this business. Ssennyonga et al. (2005) found that 47% of bananas produced in Uganda were consumed at home, and 35% were sold. This result confirms the current research that the producing families consumed 44.5% of the banana.

Banana Pests and Diseases

The banana plant is exposed to many diseases and pests, and bananas grown in Somalia also suffer from these diseases and insects. Shankar et al. (2016) emphasised that bananas are susceptible to insect pests. Their study stated that some insects, pests, and diseases are highly contagious and can quickly spread over a broad region. The damage is mostly permanent after insect invasion or disease transmission. It is difficult to control them and can cause compelling harm to the banana plant at different stages of its growth. Researchers have stated that some insect pests significantly harm banana yield potential.

Table 4 lists the major pests and insects that Somali producers have to deal with. In the current study, farmers reported that bananas were most affected by insects (60%) and weeds (20%) in the previous harvest season. The disease that damaged the most during harvest season

Table 4 Banana pests and diseases

Variables	Groups	*N*	%
The most harmful diseases in the previous year	Insects	227	60.0
	Diseases	40	10.5
	Snails	20	5.5
	Weeds	76	20.0
	Birds	15	4.0
Diseases that cause the most damage during harvest season	Stemboror	233	61.5
	Brown leaf spot	51	13.5
	Brown plan-thopper	47	12.5
	Bacterial leaf blight	47	12.5
Major insect and disease pests affecting banana	Fruit fly	34	9.0
	Banana moth	32	8.5
	Bacterial leaf blight	55	14.5
	Banana aphid	257	68.0
The severity of insects and pests affecting bananas in the previous year	None	28	7.5
	Low	57	15.0
	Mild	246	65.0
	Severe	47	12.5
Amount spent on pesticides in the previous year ($)	1–100	112	29.5
	101–200	179	47.5
	301 ≤	86	23.0
Average pesticide cost (per ha/$)	–	356.4	–
The share of pesticide cost in the total production cost (per ha/$)	–	10.54%	–

was 'stemboror' (61.5%), and the major insect affecting bananas was 'Banana aphid' (68%).

Nearly two-third (65%) of farmers reported a mild pest invasion. Consequently, roughly half of them (47.5%) spent between $101–200 on pesticides. Shankar et al. (2016) exemplified the insect pests that damage and reduce the yield of bananas as 'Fruit fly', 'Banana aphid', 'moths/caterpillars', 'parasitoid hymenoptera', 'leafcutter ant', 'pseudostems', '*Cosmopolites sordidus* Germar' '*Thrips florum* Schumtz', 'banana stalk', besides some of the non-insect pests damage banana plants. These include banana snails, ants, mites, rodents, and nematodes. This study's finding supported available research and highlighted once again that the banana aphid is a widespread pest, causing significant damage to the yield. They are found almost everywhere bananas are grown (Elayabalan et al. 2013; Hu et al. 1996).

Pesticide Use and IPM Training

Research showed that although farmers used pesticides and herbicides, the belief in their effectiveness was not strong.

Table 5 Pesticide use and integrated pest management (IPM) training

Variables	Groups	*N*	%
Effect levels of insecticides used in the previous year	Effective	83	22.00
	Don't know	78	20.5
	Not effective	36	9.5
	I didn't use any pesticides	181	48.0
Amount of pesticide Use in the last 5 Years	Increased	147	39.0
	Decreased	231	61.0
IPM Training	Yes	274	72.5
	No	104	27.5
Source of IPM training	Extension officers	62	22.5
	Cooperatives	130	47.5
	Agricultural ministry officers	27	10.0
	Pesticide/drug dealers	55	20.0

Only one-fifth of the respondents believed pesticides were effective, while many did not have a clear idea. Pesticide prices are high. Application is labour-intensive, thus creating a high cost for farmers. Thus farmers' expectations of pesticides arises. Underdeveloped and developing countries import pesticides. Therefore, the prices of pesticides increase with the fluctuations in the economy, increasing the farmers' production costs. Pesticide consumption has decreased due to its possible effects on human health in developed countries. It has reduced in developing countries due to increased production costs and adverse impact on exports due to the possibility of high residues. In the current study, farmers reported that pesticide use was at its lowest in the last 5 years, although they mostly sold in local markets. The findings overlap with a study examining the IPM application behavior of vegetable producers in Bangladesh (Gautam et al. 2017). Both studies concluded that short-term IPM training improved farmers' knowledge and attitudes on pesticide management. They used pesticides more safely and reduced the amount and number of pesticide applications.

In the survey, three-quarters of the farmers had received IPM training. Cooperatives played an active role in providing this training. Agricultural cooperatives support member producers in many ways and also undertake the task of training them about acquiring green technologies. For example, Liu et al. (2022) found a positive and significant relationship between agricultural cooperative membership and adopting IPM practices in the Sichuan Citrus Planting Cooperative sample (Table 5).

Table 6 summarises non-pesticides applications. The most frequently used (40%) of these applications were bio-pesticide applications such as neem. One of the bioinsecticides used as an alternative to synthetic insecticides is the compounds obtained from the neem tree. More than 550 pest species are controlled with neem extract even though

Table 6 Non-pesticide applications against banana pests and diseases

Variables	Groups	*N*	%
Non-pesticide applications	Use of a pest-resistant variety	76	20.0
	Stale seedbed	28	7.5
	Application of *Trichoderma* to seeds or seedlings	47	12.5
	Bio-pesticide applications such as neem	170	45.0
	Manual weeding at recommended growth stage	57	15.0
Reasons to use non-pesticide applications	Less expensive than pesticides	155	41.0
	Better for the environment	27	7.0
	More effective than pesticides	113	30.0
	Protects beneficial insects	83	22.0
Belief in the existence of beneficial insects	There are beneficial insects	319	84.5
	There are no beneficial insects	59	15.5
Killing beneficial insects increases banana pests	Agree	255	67.5
	Disagree	55	14.5
	Do not know	68	18.0

they have become resistant to synthetic pesticides. It is an economical and environmentally friendly alternative to chemically synthesized commercial pesticides (Chaudhary et al. 2017). The second most common application (20%) was the use of the pest-resistant variety.

The main reason for non-pesticide applications is the participants' belief that these applications are cheaper than pesticides (41%). There is common belief is that these applications are more effective than pesticides (30%). The belief that IPM applications protect beneficial insects remains valid (22%). Still, the rate of those who chose these applications because of their environmental friendliness remained at only 7%. The vast majority (84.5%) of participants believed that beneficial insects do not harm the banana. Therefore, most participants (67.5%) agreed that killing these beneficial insects would increase the number of banana pests.

Mgenzi (2003) investigated the effects of IPM applications on banana yield and pests with 31 banana growers in Tanzania. Consistent with the findings of this research, they also found that the farmers accepted the neem application. Neem use increased the output and reduced pests. However, the authors also pointed out the high transportation cost of the neem and emphasised that this cost should be reduced. Again, in line with the findings of this study, their study found that manual sorting increased yield. Researchers have commented that the benefits of IPM may alleviate cost concerns.

Bagamba et al. (2003) also reported that the neem method was effective in the fight against pests. Bagamba et al. (2003) found that the reason for not applying IPM was high prices. Authors argued that the increasing need for a workforce at harvest and planting times needs to leave more time for IPM applications. In line with the findings of this study, Aguilar (2014) found that most participants who had IPM training applied some IPM in the Philippines.

Vinatier et al. (2012) confirmed that manual sorting and removing the sorted residues from banana orchards reduced the number of pests. Banana growers in Uganda use different IPM techniques (Ssennyonga 2005). Authors pointed out that farmers should trust that they benefit from IPM and thus should trust this technology.

Factors Influencing Farmers' Decision on Practices of IPM

A binary logistic regression model was used to identify factors that significantly affected banana producers' decision to adopt IPM., The degree and direction of predicted parameters for IPM training are shown in Table 7, which includes descriptive variables, coefficients, standard deviation, Wald X^2, odd ratio, and p values. The five of nine descriptive variables have partial effects on the level of probability or predominance in the ratio of 0.05, which can be regarded as significant. These variables are the size of the farm, nonfarm income, the source of information about pest management, age, and education level. All of the significant variables have expected marks.

According to the model, three factors (age, experience, and using credit for banana cultivation) negatively affect participation in IPM training. Studies often report that as farmers age, they become more conservative and are less open to new ideas and developments (Kabir et al. 2017; Talukder et al. 2017). In this research area, 61.5% of the farmers were aged over 41 years. Fewer family members with an advanced age negatively affected ($\beta = -0.219$) adoption of IPM.

Current findings coincide with recent research undertaken in Myanmar, where age had a negative and insignificant effect (Aung et al. 2020). Age comes with experience. As the farmers aged, they relied more on their experience than modern techniques and training. Farming experience, too, negatively ($\beta = -0.092$) influenced the intention to adopt IPM practices. Producers with longer years of experience in banana cultivation were less likely to adopt IPM methods. Contrary to the current finding, a study conducted in Myanmar and Bangladesh showed that longer years of farming experience increased farmers' rate of adopting the IPM method (Aung et al. 2020; Kabir and Rainis 2015). Nevertheless, these effects were not statistically significant. There is a non-significant but negative relationship between access to credit and adoption decisions. Banana producers are small farmers who often need loans to meet produc-

Table 7 Variables hypothesised to influence farmers' decision to adopt IPM

Variable name	Description	Type
Dependent variable ADOPTIPM (Adoption of IPM)	If farmers adopt IPM practice [1 = Yes, 0 = No]	Binary
Age	Age of the banana farmer (years)	Continuous
Education	Number of years of formal schooling (years)	Continuous
FEXPR	Number of years of farming experience (years)	Continuous
Landown	Landownership [1 = Owner, 0 = Other]	Binary
NFW	Number of family workforce	Continuous
ANFINCOME	Annual income from banana production ($)	Continuous
CUFBP	Credit usage for banana production [1 = Yes, 0 = No]	Binary
HCONNRATE	Home consumption rate (%)	Continuous
MEMBERSHIP	Group or organisation Membership [1 = Marketing Cooperatives, 0 = Others]	Binary

Table 8 Factors affecting producers' adoption of IPM

Variable Name	β	SE	Wald's X2	*p*	OR
Age	–0.219	0.468	0.539	0.495	0.747
Education	*1.190*	*0.578*	*10.782*	*0.001*	*6.865*
Farming experience	–0.092	0.468	0.004	0.935	0.927
CUFBP	–0.290	0.493	0.224	0.336	0.811
Land ownership	*0.482*	*0.213*	*4.185*	*0.01*	*1.804*
NFW	*1.271*	*0.406*	*7.001*	*0.009*	*3.763*
ANFINCOME	*1.30*	*0.061*	*389*	*0.05*	*1.210*
HCONNRATE	*0.53*	*0.072*	*4.152*	*0.024*	*1.750*
MEMBERSHIP	0.219	0.468	0.539	0.495	0.747
Constant	–5.137	2.568	12.704	0.000	0.005

Figures in italics represent odds ratios that are greater than 1 which indicates that the event is more likely to occur as the predictor increases.
Diagnostics
Number of observations = 121
LR $chi^2(36) = 53.28$
Prob > $chi^2 = 0.0317$
Pseudo $R^2 = 0.1191$
Log likelihood = –197.04373

tion costs. Pesticide expenditures can hold a significant proportion of production. For example, pesticides account for 10.54% of the total cost in Nepal (Shrestha et al. 2018). Producers who can access loans may incline to chemical control, which is more accessible, instead of applying labour-intensive IPM methods, thanks to the financial leeway provided by the loan. Similarly, the increase in Bangladeshi vegetable producers' access to credit negatively affects their IPM adoption decision (Rahman 2022) (Table 8).

In the research, 89% of the participating families had four or more people, but only 35.5% had two or fewer working family members. This finding implies that families have many children, but the number of working individuals is low. The number of labour in the family has a positive and statistically significant effect. This means larger families are more accepting of IPM methods. IPM require more manual handling and labour than conventional methods. Therefore, larger households are 3765 times more favourable towards adopting IPM (Aung et al. 2020).

Land ownership often affects farmers' IPM decisions. Farmers who own their land can make extended plans and invest more confidently. Therefore owning the land encourages farmers to adopt IPM. Current research shows that banana farmers owning their land are 1.8 times more likely to adopt IPM. Two consequent research undertaken in Bangladesh support this finding (Kabir et al. 2017; Talukder et al. 2017).

The previous section already stated that Somalian farmers highly rely on banana production, and banana income has a large share of the household income. Bananas are also a critical food item in the Somalian diet and are consumed in large quantities by the producers at home. For this reason, farmers favourably approach using IPM to protect the household's health. Consequently, a one-unit increase in banana consumption at home increases farmers' probability of applying IPM by 1.7 times. Likewise, a one-unit increase in banana income in household income increases the likelihood of using IPM 1.2 times.

Cooperatives are set up to aid farmers. They help farmers sell their produce, reduce costs, organise training, etc. Numerous research showed that cooperative membership affected IPM adoption positively and significantly because

it increased farmers' awareness and adoption rate of adopting IPM (Kabir and Rainis 2015; Talukder et al. 2017). In our research, the effect of cooperative membership, like the literature, was positive. However, this effect size was minimal and non-significant. In the research, 75% of farmers (274) received IPM training. Almost half of the farmers who received IPM training did so from cooperatives (130). However, only 17% of farmers (64) were cooperative members. Those two numbers did not match. Therefore, further inquiry revealed that cooperatives provided this training to members and non-members. When they released a call for training, cooperative membership was optional for attendance since 32% were selling to a cooperative. Farmers' organisations (state and local authorities) may have commissioned cooperatives with IPM training. The effect of cooperative membership on IPM adoption was positive but insignificant due to this discrepancy.

Conclusions

This research examined the socio-economic characteristics of banana farmers in Somalia. In addition, their knowledge, practices and the factors affecting IPM application were examined. Research has shown that most Somali banana growers have received IPM training, and a significant proportion has applied at least one IPM method. The most important factor that prompted farmers to apply IPM was the effectiveness of the training given by the cooperatives. The main reasons were the high cost of pesticides and the lack of trust in their efficacy. On the other hand, IPM applications are time-consuming and labour-intensive. Results revealed that IMP was preferred for cost reasons rather than environmental friendliness.

Based on these study findings, the following recommendations can be made for practitioners, managers and future research. The government and non-governmental organisations need a plan and program to combat banana pests in a more effective and environmentally friendly way. The monthly income of banana growers is meagre, so it is challenging for them to implement IPM individually. Therefore, states must support these producers.

Along the same line, findings showed that largely cooperatives provide IPM training. They should be supported to increase the trainings quality and frequency. It is necessary to ensure producers with lower education and income levels who cannot access IPM training. Findings obtained elsewhere should be cited as examples to dispel doubts about the efficacy of IPM. Attention should be drawn to the environmental benefits of IPM. For this purpose, government-supported pilot applications should be made, and their visibility should be ensured. Facilitating practices should be developed for the effects of IPM to be seen and for IPM applications to become widespread. IPM products should be given free of charge or at attractive prices. This policy should continue at least until trust is established in IPM practices.

Conflict of interest I.B. Gurbuz, A.M. Abdullahı and G. Ozkan declare that they have no competing interests.

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