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Measuring the economic performance of smallholder organic maize farms; Implications for food safety and security

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The use of chemical inputs in conventional agriculture is associated with some health and environmental issues. This led to a call for more sustainable and environmentally friendly agriculture without health issues. However, there is low participation in organic farming in Nigeria, which could be linked to less knowledge about its profitability. The study investigated smallholder organic maize farming profitability in Northern Nigeria. We employed descriptive statistics, profitability analysis, and a multiple regression model to analyse data collected from 480 maize farmers. The results revealed that organic maize farmers had a gross profit of USD 604.81 per hectare, a 0.46 profit ratio, a 0.54 gross ratio, a 0.32 operating ratio, a benefit-cost ratio of 1.85, and a 0.85 return on capital invested. Thus, organic maize farming is a productive and profitable venture. Organic manure, compost manure, farm size, selling price, cooperative membership, extension contact, access to credit, irrigation, education, and major occupation were factors that enhanced organic maize farming's net profit. However, seed and transportation costs negatively influenced organic maize farming's net profit. Therefore, government and development agencies must intervene to make organic farming more sustainable and profitable by subsidizing seed costs and providing financial assistance to farmers.

1. Introduction

Agricultural activities in Nigeria and most developing nations are mainly on a small-scale level. More than 80% of Nigerian farmers are smallholders, who are responsible for over 85% of the food produced locally in the country and contribute to the nation's GDP (Mgbenka & Mbah, 2016; Obetta et al., 2020). Nigerian farmers, just like others in sub-Saharan Africa, practice conventional agriculture where chemical inputs such as chemical fertilizers, pesticides, and herbicides are used. Chemical inputs serve as agents of pollution to the environment and their residual effects on crops also affect the nervous system, respiratory system, and gastrointestinal tract of human beings (Anitha et al., 2009).

Due to the negative impacts, such as the poisoning of about 30 million people, leading to the death of 220,000 people yearly (Muhammad et al. 2016), associated with conventional agriculture, organic farming is gaining recognition and is emerging as an alterna-

tive farming system in the 21st century. There is an increase in consumer concerns about the safety and quality of foods, which prompts them to seek organic foods (Vasileva et al., 2019). Organic food is desired by consumers due to environmental production practices, biodiversity conservation, and animal welfare practices that do not harm the environment (Vasileva et al., 2019). Researchers and policymakers are now interested in organic agriculture and organic food. For instance, the International Federation of Organic Agricultural Movements (IFOAM) was created to encourage and develop organic farming. Also, the Association of Organic Agriculture Practitioners of Nigeria (formerly Nigerian Organic Agriculture Network (NOAN)) was created to draw up organic standards for the farming of crops, snails, aquaculture, and livestock for Nigerian local markets.

Organic food is produced without using chemical fertilizers and pesticides and grown without radiation (Pandey et al., 2019). Organic farming practices include composting, green manure, animal manure, cover cropping, nitrogen-fixing, and crop rotation, which enrich soil fertility. It further includes mulching, natural soil amendment, organic pesticide to control pests, organic insecticide to control insects, the use of natural enemies to control weeds, and the planting of pest-resistant plant varieties. It has health and environmental benefits by producing safe food and maintaining soil quality, respectively (Stein-Bachinger et al., 2021). It also provides safer water for the soil, supports animal health and welfare, and combats erosion. Organic farming attracts a high price due to its health and environmental benefits (Suwanmaneepong et al., 2020). Thus, an increase in organic maize production in Nigeria and other countries can enhance economic growth.

Maize is an important cereal grain that serves as food for man, feed for animals, and a means of livelihood for people. Currently, a larger proportion of maize output in Nigeria is from conventional agriculture. Therefore, there is a need to engage in maize farming in such a way that its product is free from health and environmental risks that are associated with the use of chemical inputs. Hence, organic maize farming would be the best choice in this situation as it enhances and promotes a healthy ecosystem and minimizes the adverse effects of chemical usage on natural resources (IFOAM, 2006).

In recent times, food safety concerns and the importance of organic farming are gaining attention and discussion among researchers and stakeholders. However, there is less documented information on how profitable organic agriculture is, especially organic maize farming. In addition, there are diverse reports on the profitability of organic agriculture. A few studies have revealed that conventional farming has a higher profit than organic farming (Dobbs & Smolik, 1996; Pham & Shively, 2018). Some authors reported that organic and conventional farming yielded the same revenue (Chavas et al., 2009; Helmers et al., 1986). Several studies have shown that organic agriculture is more profitable than conventional agriculture due to the organic price premium (Delate et al., 2003; Delbridge et al., 2011; McBride & Greene, 2009). Recently, it was reported that although organic rice farming had a higher production cost than conventional farming, organic farming was more profitable due to the higher price tag for organic rice (Suwanmaneepong et al., 2020).
From the foregoing, there are scanty studies on the profitability of organic maize production, especially in Nigeria, where information on profitability and its drivers is required for the development of organic maize farming. This study, therefore, fills the research gap in assessing the profitability of organic maize production enterprises in Northern Nigeria and their driving factors. However, the findings will serve as a policy reference point for promoting organic farming, food safety, and food security.

2 Methodology

2.1 Study area

This research was carried out in Northern Nigeria. The people of this region are known for farming cereals, especially maize, and legumes.

2.2 Sampling procedure

A multi-stage sampling procedure, which involved the selection of smaller groups and sampling units at each stage, was employed to get the maize farmers who served as respondents for this research. This involved the selection of two states (Niger and Kaduna) with the highest share of maize production in Nigeria to get the required respondents and a good representation of the population. From each state, four local gov-

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ernment areas (LGAs) were randomly selected. We further randomly selected three communities from each of these LGAs. However, to get the maize farmers to participate in organic farming, we employed the snowball technique to select twenty farmers at the last stage of the sampling procedure, resulting in a total of 480 maize farmers in the study areas.

2.3 Data collection techniques

A structured questionnaire was used to collect data from smallholder maize farmers. Farmers' age, gender, income, primary and secondary occupation, household size, level of education, marital status, membership in a cooperative association, years of farming experience, total farm size, access to credit, and access to extension services are among the socioeconomic data collected. Data on production information such as total outputs, revenue generated from the output, the number of inputs used in its production, and the amount spent on them were also collected.

2.4 Data analysis

To achieve the stated objectives of this study, we employed descriptive statistics, gross profit analysis, net profit, profit ratio, operating ratio, gross ratio, benefit-cost ratio, and a multiple regression model as means of data analysis.

2.4.1 Descriptive statistics

Descriptive statistics such as pie charts, tables, means, and percentages were used to present the results.

2.4.2 Profitability analysis

Gross profit analysis: The collected gross profit of organic maize farming was determined using gross profit analysis. It is the difference between revenue accrued from organic maize farming and the variable cost incurred in producing it. It is expressed as:

$$Gross\ profit\ (GP) = Total\ revenue - Total\ variable\ cost \quad (1)$$

Where:

Total revenue is the returns from organic maize farming in the study area and is calculated as the total output multiplied by the price per unit of the product that is, TR = P * Q (Falola et al., 2022b).

The total variable cost of organic maize farming is the sum of all variable input costs.

Net profit: Because net profit analysis considered the fixed cost of organic maize farming, it is used to ascertain the actual (net) profit after deducting all costs of production (Falola et al., 2022a). The fixed costs were derived by depreciating the fixed items using the straight-line method.

$$Net\ profi = Total\ Revenue - Total\ Cost \quad (2)$$

Or

$$Net\ profi = Gross\ profit - Total\ fixed\ cost \quad (3)$$

Profit ratio: This shows the financial viability, health, and performance of organic maize farms. It compares the net profit to the total revenue from sales of organic maize. It is expressed as:

$$Profitability\ Ratio = \frac{Net\ profit}{Total\ Revenue} \quad (4)$$

Gross ratio: It is a profitability ratio that gauges the organic maize farm's overall success. It indicates the ability of an organic maize farm to generate enough income to cover the total cost. The higher the returns per naira, the smaller the ratio, and vice versa. It is expressed as:

$$Gross\ Ratio = \frac{Total\ Cost}{Total\ Revenue} \quad (5)$$

Operating ratio: It measured the ratio of total variable costs to total revenue. A low ratio indicates the high profitability of the organic maize farm and vice versa (Mukaila, 2022). It is estimated as:

$$Operating\ Ratio = \frac{Total\ Variable\ Cost}{Total\ Revenue} \quad (6)$$

Return on capital invested: It measures the proportion derived as profit per unit of currency invested in organic maize farms. It is expressed as:

$$Return\ on\ capital\ invested = \frac{Net\ profit}{Total\ cost} \quad (7)$$

The benefit-cost ratio: This was further used to investigate the profitability of organic maize production. It is determined by dividing total revenue by total expense.

$$Benefit\ cost\ ratio = \frac{Total\ revenue}{Total\ cost} \quad (8)$$

2.4.3 Multiple regression model

We used the net profit from organic maize farming, which is continuous, as a proxy for the profitability of the farm enterprise. Multiple regression is the best fit in this regard as it can perfectly predict the explanatory variables driving the outcome, that is net profit. The model is explicitly estimated as:

$$NP = \beta_0 + \beta_1 OM + \beta_2 CMan + \beta_3 SD + \beta_4 TC + \beta_5 FS + \beta_6 SP + \beta_7 EXT + \beta_8 EXP + \beta_9 Ag + \beta_{10} AC + \beta_{11} IR + \beta_{12} ED + \beta_{13} HS + \beta_{14} MO + \beta_{15} CM + \mu_i \quad (9)$$

The definition of variables used in the multiple regression model with their expected signs is presented in Table 1.

3 Results

3.1 Profitability of organic maize farming

The results of the profitability analysis of organic maize production are presented in Table 2, while the share of each input in total cost is shown in Figure 1. As shown in Figure 1, the cost of labour accounted for 24.77%, the cost of renting land accounted for 24.49% of total costs, and the cost of equipment such as hoes, cutlasses, and watering cans accounted for 9.35% of the total production cost. Furthermore, the cost of organic maize seed accounted for 8.94% of the total production cost, the cost of organic manure accounted for 7.86%, storage costs accounted for 7.19% of the total cost, the cost of transportation accounted for 7.11%, and the cost of compost manure accounted for 6.48%. In addition, biocontrol costs accounted for 2.87%, and the cost of sacks accounted for 0.95% of the total production cost incurred in organic maize farming.

The average total variable cost incurred during organic maize farming production was USD 282.82 per hectare, which accounted for 58.97% of the total cost.

The average total fixed cost incurred during organic maize farming production was USD 196.76, which accounted for 41.03% of the total variable cost. Organic maize production earned an average total revenue of USD 887.63 per hectare. The gross profit from the production of organic maize farming was USD 604.81 per hectare. The net profit from the production of organic maize farming was USD 408.04 per hectare. Organic maize farming had a relatively high gross ratio of 0.54, a profit ratio of 0.46, a return on capital invested of 0.85, and a BCR of 1.85. The enterprise recorded a low operating ratio of 0.32, which is an indication of a profitable venture.

3.2 Determinants of organic maize farming net profit

The multiple regression results are presented in Table 3. The results revealed that the model is well-specified and has a good fit, which is shown by the significant F-value. Furthermore, 65.17% of the variation in the net profit of organic maize farms was explained by the explanatory variables included in the regression model. However, organic manure, compost manure, farm size, cooperative membership, extension contact, access to credit, irrigation, education, and major occupation were positively significant, indicating that an increase in them will increase the net profit of organic maize farms. While seed and transportation costs had a negative influence on the net profit of organic maize farms, an increase in them will result in a reduction in the net profit of the enterprise.

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Table 1. Definition of variables used in multiple regression model with their expected sign

Variable name		Description	Unit of measurement	Expected sign
NP	Net profit	Farmer's net profit made from organic maize farming.	Naira	
OM	Organic manure	Quantity of organic manure used	Kg	+
Cman	Compost manure	Quantity of compost manure used	Kg	+
SD	Seed	Cost of seed	Amount (Naira)	-
TC	Transportation cost	The cost incurred by farmers is to move farm inputs to the farm and take maize to the markets to sell.	Amount (Naira)	-
FS	Farm size	Farmland under cultivation	Hectare (10,000m^2)	+
SP	Selling price	The selling price of organic maize	Amount (Naira)	
EXT	Access to extension	Access to agricultural extension services	Number of contacts	+
EXP	Experience	Number of years spent in farming	Years	+
Ag	Age	Age of farmers	Years	+/-
AC	Access to credit	Access to credit from formal and informal sources	Amount borrowed	+
IR	Irrigation	Organic maize farmers use water irrigation systems or watering cans to wet the soil.	Dummy (1, if a farmer used irrigation, 0, otherwise)	+
ED	Education	The educational level of farmers	Years in school	+
HS	Household size	The number of persons living in the same household.	Number of people	+
MO	Major occupation	Having maize farming as a major occupation	Dummy (yes = 1, no = 0)	+
CM	Cooperative membership	Membership in cooperative association by farmers	Dummy (Member = 1, non-member = 0)	+

Source: Author's compilation.

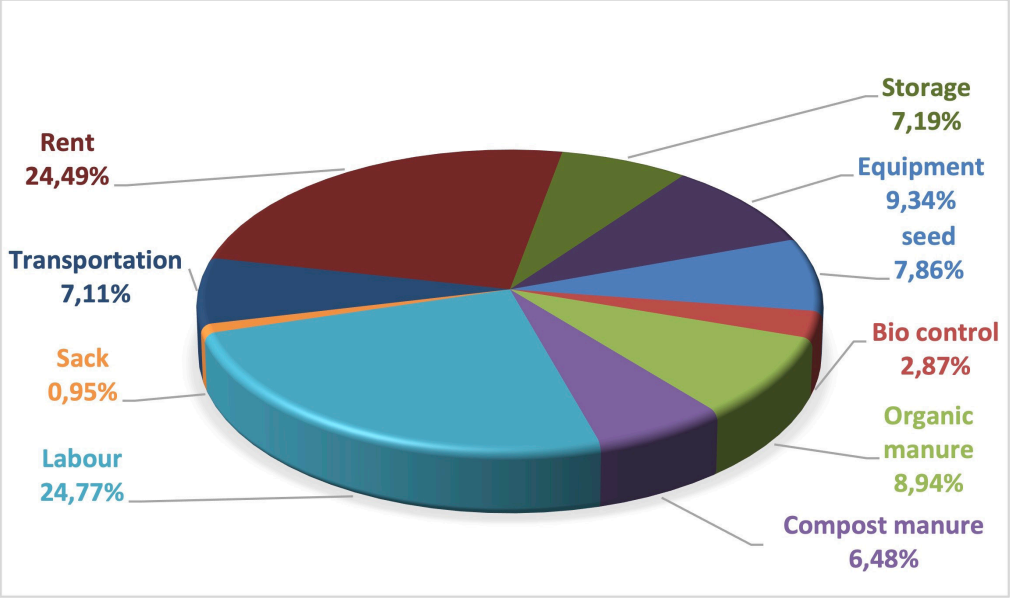

Figure 1. Shares of the total cost of organic maize farming

Table 2. Profitability of organic maize farming

Variables	Amount (₦/ha)	Amount (USD/ha)
Total revenue (A)	365,258.30	887.63
Seed	17,641.67	42.87
Biocontrol	5,654.17	13.74
Organic manure	15,504.17	37.68
Compost manure	12,795.83	31.1
Labour	48,878.30	118.78
Sack	1,883.33	4.58
Transportation	14,022.73	34.08
Total variable cost (B)	116,380.20	282.82
Rent	68,333.33	166.06
Storage	4,193.33	10.19
Others (hoe, cutlass, and watering can)	8,441.67	20.51
Total Fixed Cost (C)	80,968.33	196.76
Total Cost (D = B + C)	197,348.53	479.58
Gross profit (E = A– B)	248,878.10	604.81
Net profit (F = E – C)	167,909.77	408.04
Profit Ratio (G = F/A)	0.46	
Gross Ratio (H = D/A)	0.54	
Operating Ratio (I = B/A)	0.32	
Return on Capital Invested (J = F/D)	0.85	
Benefit-Cost Ratio (K = A/D)	1.85	

Source: Survey data, 2021.

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Table 3. Determinants of organic maize farming net profit

	Coef.	Std. Error	t	P>t
Organic manure	1177.17***	121.201	9.71	0.000
Compost manure	1684.5***	471.977	3.57	0.001
Seed cost	0.04240***	0.01618	2.62	0.010
Transportation cost	-0.05120*	0.03048	1.68	0.097
Farm size	519.954**	228.286	2.28	0.025
Selling price	0.56249**	0.27579	2.04	0.044
Access to extension service	3648.97**	1803.85	2.02	0.046
Experience	4.95101	53.4302	0.09	0.926
Age	48.3384	57.1349	-0.85	0.399
Access to credit	0.00161*	0.00094	1.71	0.091
Irrigation	4190.53***	1185.25	3.54	0.001
Education	1705.08***	530.673	3.21	0.002
Household size	115.796	169.260	0.68	0.495
Major occupation	3094.85**	1200.41	2.58	0.011
Cooperative membership	504.427**	226.752	2.22	0.028
Constant	-9513.46	3038.61	-3.13	0.002
F	11.74			
Prob > F	0.0000			
R-square	0.6517			
Adj R-squared	0.5974			

*** (P<0.001), ** (P<0.05), * (P<0.1)

Source: Survey data, 2021

4 Discussion

Considering the labour-intensive nature of agriculture in most developing countries, the cost incurred is a significant factor in agricultural production. The cost of labour employed on organic maize farms had the largest share of total production costs in organic maize farming. This supports the finding by Sapkota et al. (2018) that labour accounted for a significant share of the cost of production in maize farming. The land is also an important factor of production in agriculture, especially in crop farming. The cost of renting land accounted for the second highest proportion of total production costs in organic maize farms. This was followed by the cost of farming equipment such as hoes and cutlasses used in weeding and planting, and watering cans used in manual irrigation of organic maize farms during the dry season. The next input in terms of the cost of production share is the cost of organic manure. Farmers used organic manure to supply needed nutrients to the plants instead of chemical fertilizers with health implications. This was followed by the cost of organic maize seeds. The share of organic seed per hectare in this study was higher than the cost of seed reported by Sapkota et al. (2018) in conventional maize farming. Next to this is the cost of storing farm inputs and output (organic maize) before it is ready for market. This was followed by the cost incurred in transporting farm inputs to the farm and farm output to the point of sale. The farmers incurred a smaller portion of their production cost in compost manure, which could be because most of the farmers prepared it themselves from weeds and other organic materials freely available on the farm. The cost of biocontrol and the cost of sacks were second to the last and last in the share of production costs in organic maize farming, respectively.

The variable costs accounted for a larger proportion of the total cost of production in organic maize farming, as the farmers incurred a variable cost and a fixed cost of USD 282.82 and USD 196.76 per hectare, respectively. The farmers made a high gross profit of USD 604.81, out of the total earned revenue of USD 887.63 per hectare, After the fixed costs incurred in the enterprise were deducted, organic maize farms had a positive net profit value (USD 408.04). These values were higher than the profit reported in conventional maize farming by Zalkuwi et al. (2010) in Nigeria; Sapkota et al. (2018) and Dahal and Rijal (2019) in Nepal; and Ferdausi et al. (2014) in Bangladesh. This was because of the high price paid for organically produced maize by consumers. This supports Suwanmaneepong et al. (2020), who found that organic farms made a higher profit due to the high price of organic foods. Furthermore, the farmers had a high gross ratio (0.54), which is an indication that the enterprise is profitable. According to the profit ratio (0.46), 46% of the total revenue generated by organic maize production was profit. The farmers used thirty-two percent of gross income as operating expenses, which was very low and further indicates a profitable venture.

In addition, for every USD 1 invested, USD 0.85 was made as returns from organic maize farming. Organic maize farms also had a BCR greater than 1. Therefore, from this study, it can be inferred that the practice of organic maize farming is profitable and economically viable. This supports previous findings that organic agriculture is profitable (Delbridge et al., 2011; McBride & Greene, 2009).

Regarding the determinants of organic maize profitability, the coefficient of organic manure was positively related to organic maize farming net profit. Effective use of organic manure increases maize fruiting, curb size, and output (Wang et al., 2017; Wang et al., 2020). Organic manure application is an important aspect of organic farming in Nigeria and other developing countries; thus, an increase in its application to the farm will simultaneously increase organic farm yield and, consequently, profit made. Therefore, the application of organic manure is an enhancing factor for the net profit of maize farming enterprises. In the same vein, the coefficient of compost manure application was positive in relation to organic maize farming net profit. This implies that the net profit of organic maize farming enterprises increases alongside compost manure usage. Thus, farmers who applied compost manure had a higher net profit than others. This is because compost manure will increase soil nutrients needed for the growth of maize to have a higher yield, which will consequently result in high revenue and net profit. In addition, compost manure had a low cost as most farmers prepared it on their farms; thus, its use reduced the cost of production, which, in turn, enhanced the net profit of the enterprise.

The coefficient of seed cost was negatively related to organic maize farming enterprise net profit. Organic seed is an important aspect of organic maize farming, accounting for a sizable portion of total production costs. Therefore, any increase in its price would increase the cost of production and consequently result in a reduction in net profit from organic maize farms. Similarly, the coefficient of transportation cost was negative in relation to the net profit of organic maize farms. This suggests that an increase in the cost incurred through the movement of inputs to the farm and moving farm output (maize) to the market will reduce the net profit of organic maize farming. This conforms with the apriori expectation as transportation costs are a vital cost in agriculture considering the location of farms (rural areas) and the location of major markets (semi-urban and urban areas). Thus, transportation costs add to the variable costs incurred in any agribusiness enterprise and reduce the income available at farmers' disposal. This supports the findings of Liverpool-Tasie et al. (2017) and Mukaila et al. (2022) that transportation costs reduce farm business profitability.

The coefficient of farm size had a positive relationship with the net profit of organic maize farm enterprises. This implies that the net profit of organic maize farms increases alongside farm size. Thus, large organic maize farms made a higher net profit than their counterparts with small farm sizes. A large farm enjoys economies of scale through the purchase of inputs such as organic maize seeds and organic manure, which reduce the cost of production and consequently enhance the net profit of the farm. This supports the findings of Ariyo et al. (2020) that profitability increases alongside farm size. Furthermore, the coefficient of selling price had a positive relationship with the net profit of organic maize farms. This implies that

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the selling price of organic maize enhanced the net profit of the enterprise.

This is because revenue derived from organic maize farms depends on the premium paid for the product. Suwanmaneepong et al. (2020) also reported that organically produced crops had a high price tag, which consequently enhanced net profit.

The coefficient of agricultural extension contacts also had a positive relationship with the net profit of organic maize farms. This implies that the net profit of organic maize farms increases as the probability of accessing agricultural extension services increases. The extension service is a vital means of getting relevant farming information to farmers and a means by which farmers relate their challenges to researchers (Akanbi et al., 2022; Falola et al., 2022b). They also train farmers in sustainable farming practices such as organic agriculture. Therefore, farmers who could access extension services are likely to have a higher net profit than those who could not access agricultural extension services. The coefficient of access to credit was positive in relation to the net profit of organic maize farming. This implies that the probability of having access to credit will increase the net profit of the organic maize farming enterprises. This is because financial assistance through credit or loans enhances farmers' investment and productivity (Falola et al., 2022c).

High investment and productivity will, in turn, lead to high revenue generated from the enterprise and, consequently, net profit. Thus, organic maize farmers who accessed credit facilities had a higher net profit than their counterparts who could not access credit. This is in tandem with the findings of Jonah et al. (2020) that access to credit facilities increases farm profit efficiency.

Furthermore, the coefficient of irrigation was also positive in relation to organic maize net profit. This implies that the use of irrigation systems enhances the net profit of organic maize farms. Constant application of water at the appropriate time plays an enormous role in crop growth and yield. Unavailability of water (rain), especially at the early planting stage, results in dead crops and a great loss in the farm enterprise. Thus, farmers who did not only rely on rain as a source of water for the growth of maize but also artificially added water to their farms made a higher net profit than those that did not engage in irrigation. The coefficient of education was positive in relation to the net profit of organic maize farms, which implies that educated organic maize farmers made a higher net profit in their production than their counterparts who had no formal education. Education influences farmers' access to information, decision-making, and productivity (Akanbi et al., 2022; Mukaila et al., 2021). These would consequently influence their total revenue and net profit as educated farmers would be able to combine production inputs in the right manner. This is in line with Tanko and Alidu (2017) that education enhances farm profit.

The coefficient of major occupation was also positively related to the net profit of organic maize farms. This implies that having maize farming as a major occupation increased the net profit of the enterprise. This supports Mukaila et al. (2022), who recently found that having a farm business as a major occupation enhanced the profitability of the enterprise. This could be a result of the full concentration given to the farm business. The coefficient of cooperative membership was positive in relation to the net profit of organic maize farms. This indicates that being a member of a farm cooperative organization increases the net profit of organic maize. This could be a result of several reasons: getting financial assistance from the organization; enjoying economies of scale; and training, as these, are among the core principles of cooperative organisations. A similar finding was reported by Jonah et al. (2020) that cooperative membership increases farm profit efficiency.

Conclusion

This study revealed that organic maize farmers produced at an economical and profitable level. Organic maize farming had a high gross profit, net profit, profit ratio, gross ratio, benefit-cost ratio, and return on capital invested, as well as a low operating ratio, which shows that organic maize farming is a productive and profitable venture. The factors that resulted in the high profitability of the agribusiness enterprise are organic manure, compost manure, farm size, selling price, cooperative membership, extension contact, access to credit, irrigation, education, and major occupation. However, the net profit of organic maize farms

reduces as the seed and transportation costs increase. This is an indication that the high cost of seeds and transportation are significant inhibitors to organic maize farming profitability.

Given these findings, there is a need to promote organic farming, which is found to be profitable, among farmers. Thus, government and development agencies must intervene to make organic farming more sustainable and profitable by subsidizing seed costs and providing financial assistance to farmers. It is also critical for sustainable organic farming to have efficient inter- and intra-state transportation systems that are subsidized. These would enhance participation in organic farming, reduce the cost of production and make organic food items affordable to the general populace, which is needed for food safety and security.

Conflict of Interest

The authors declare that there is no conflict of interest.

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