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# Assessing the determinants and impact of financial record-keeping among smallholder vegetable farmers in the Eastern Cape Province: an empirical study

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The study explores the determinants and impact of financial record-keeping among smallholder vegetable farmers in the Eastern Cape Province of South Africa. Despite the critical role of vegetable farming in rural livelihoods and food security, many farmers lack proper financial management practices, particularly record-keeping, which limits their productivity, access to finance, and long-term sustainability. Using primary data collected from 150 smallholder farmers through structured questionnaires, the study employed descriptive statistics, logistic regression, and Propensity Score Matching (PSM) for analysis. Results revealed that most respondents were middle-aged men engaged in family-based farming with modest education levels and limited financial literacy. Although many kept informal records, only a few maintained formal financial documentations. Determinants significantly influencing record-keeping included education, access to extension services, credit availability, farm size, membership in farmer organizations, and financial training, while record-keeping difficulties had a negative effect. The PSM analysis showed that maintaining records increased productivity by 0.38 t/ha and farm income by ZAR 1,795 per season, both significant at the 1% level. The study concludes that financial record-keeping enhances smallholders' efficiency, profitability, and resilience. Based on the study, the policymakers should prioritize strengthening rural extension systems and linking farmers to financial institutions. Extension officers should be capacitated to integrate financial management support into their advisory services, while credit providers can incentivize good record-keeping practices as a criterion for loan access. This approach would improve both the financial discipline and productivity of smallholder farmers, enhancing their long-term sustainability.

## KEYWORDS

smallholder farmers, financial record-keeping, productivity, profitability, Eastern Cape Province, agricultural extension, financial literacy

## Introduction

Agriculture remains the cornerstone of economic and social transformation in Sub-Saharan Africa, serving as both a livelihood and a pathway to sustainable development. In many low- and middle-income countries, agriculture is the largest employer and a major contributor to food security, poverty reduction, and rural economic growth. It accounts for a

substantial share of national GDP and provides a primary source of income for millions of rural households. Mdoda and Christian (2021) emphasized that agriculture not only sustains livelihoods but also shapes the political and social fabric of developing nations, particularly in Sub-Saharan Africa. Similarly, Dhillon and Moncur (2023) and Shitaye et al. (2024) note that smallholder farming systems form the backbone of rural food production and remain central to ensuring both local and national food security.

In South Africa, agriculture continues to play a vital role in inclusive economic growth. The sector contributes about 2.3% to the Gross Domestic Product (GDP), accounts for 40% of export earnings, and employs approximately 4.6% of the national labour force (Statistics South Africa (Stats SA), 2021; Mdoda et al., 2024a,b). Beyond its macroeconomic value, agriculture serves as a buffer against food insecurity and poverty, particularly in rural provinces such as the Eastern Cape, Limpopo, and KwaZulu-Natal, where it provides employment, strengthens household resilience, and stimulates local economies. Wale and Mkuna (2023) highlight agriculture's role in redressing historical inequalities by providing opportunities to marginalized groups. Within this framework, smallholder farmers are vital to rural development. They produce staple and horticultural crops, generate employment, and sustain food systems that underpin local livelihoods. In the Eastern Cape Province, smallholder farming dominates the rural economy, focusing on crops such as maize, potatoes, cabbage, carrots, and tomatoes (Mdoda, 2017; Christian et al., 2024). However, despite its potential, the sector faces persistent challenges, including low productivity, poor infrastructure, limited financing, and weak market linkages, which undermine its contribution to sustainable growth (BFAP, 2023).

Yet, despite their indispensable role, smallholder farmers face persistent constraints that threaten their productivity and long-term sustainability. Several studies have shown that smallholder productivity in South Africa remains below potential levels despite numerous government interventions (Mujuru et al., 2022). These challenges are compounded by climate change, which threatens to reduce crop yields by up to 40% by mid-century (FAO, 2017; Mdoda et al., 2024a,b). Smallholders in the Eastern Cape are especially vulnerable to erratic rainfall, soil degradation, and resource constraints (Christian et al., 2024; Mujuru et al., 2022). In addition, inefficiencies in production and management practices continue to limit their ability to compete in modern agricultural markets (Obi and Ayodeji, 2020). The lack of strong agribusiness linkages and market-oriented production strategies further restricts farmers' ability to commercialize output and participate in value chains (Mariyono et al., 2020; Touch et al., 2024). These limitations highlight the need for capacity development in financial literacy, farm management, and data-driven decision-making to improve smallholder efficiency and resilience.

Financial record-keeping, defined as the systematic documentation of income, expenditure, assets, and liabilities, is a crucial yet often overlooked aspect of effective farm management. It provides a factual basis for decision-making, enhances access to credit, and promotes accountability and transparency (Njingun et al., 2023; Tham-Agyekum et al., 2010). Accurate records help farmers evaluate enterprise performance, identify profitable activities, manage cash flow, and plan investments. Doye (2004) identifies resource inventories, production accounts, and income-expenditure records as the core components of an effective record-keeping system. Furthermore, maintaining proper records strengthens farmers'

credibility with lenders and development agencies (Mwebesa et al., 2018) and involves using tools such as fixed asset registers and stock control books (Dudafa, 2013). However, despite its importance, record-keeping remains poorly practiced among South African smallholder farmers, who often rely on informal systems that omit critical financial information (Wulandari et al., 2023; Andarsari and Dura, 2018). Contributing factors include low literacy, limited financial awareness, poor infrastructure, and restricted access to banking services (Savitri and Saifudin, 2018; Adedapo and Adekunmi, 2019). The absence of proper records undermines credit access, profitability, and resilience, trapping farmers in cycles of low productivity and poverty (Manteaw et al., 2021). Enhancing record-keeping is thus both a managerial and developmental imperative.

Understanding the determinants of financial record-keeping is crucial for improving smallholder farm management. Record-keeping behaviour is shaped by socio-economic factors such as education, income, and age; cultural attitudes toward money; and farm characteristics like size and crop type. Many small-scale vegetable farmers, operating in informal markets, overlook record-keeping despite its role in reducing vulnerability to financial and market risks (Adedapo and Adekunmi, 2019; Dhillon and Moncur, 2023). Limited research, especially in the Eastern Cape, has examined these practices among South African smallholders, as most studies focus on commercial farming (Mdiya et al., 2025; Nontu et al., 2024; Malungane and Wegerif, 2025; Schneider and Cassol, 2020). This gap hinders targeted policy design. Strengthening financial record-keeping can enhance productivity, resilience, and sustainability, making it a key but underexplored driver of agricultural transformation. This study fills that gap by providing empirical insights to improve financial management among rural smallholders.

## Theoretical framework

The theoretical framework guiding this study on financial record-keeping among smallholder vegetable farmers in the Eastern Cape integrates the Theory of Planned Behaviour (TPB) and Social Cognitive Theory (SCT). These two theories offer complementary perspectives on the factors that influence individual behaviour, particularly in the context of financial management practices. These theories provide complementary perspectives: TPB emphasizes cognitive intention preceding actual behaviour of smallholder farmers, while SCT focuses on the interaction of personal, environmental, and social factors that reinforce behaviour of smallholder farmers. The integration of the Theory of Planned Behaviour (TPB) (Ajzen, 1991) and Social Cognitive Theory (SCT) (Bandura, 1986) provides a comprehensive lens for explaining smallholder vegetable farmers' financial record-keeping behaviour. According to Ajzen (1991) and Sok et al. (2021), TPB is a behavioural intention (BI)  $i$  that is influenced by attitude (Att $i$ ), subjective norms (Sn), and perceived behavioural control (Pb), expressed as in Equation 1:

$$B_I = \alpha + \beta_1 ATT + \beta_2 SN + \beta_3 PBC + \varepsilon. \quad (1)$$

Actual behaviour ( $B$ ) is then determined by intention and perceived control, i.e., Equation 2

$$B = \gamma_1 BI + \gamma_2 PBC + \mu. \tag{2}$$

In this study, farmers’ attitude reflects (positive or negative) perceptions of record-keeping usefulness, subjective norms denote perceived social or cultural pressures from peers, family, and community; and perceived behavioural control captures the perceived ease or difficulty of maintaining financial records, influenced by factors such as time, literacy, and access to record-keeping tools (Zhang et al., 2024; Daxini et al., 2019). These interact with socioeconomic factors like education, age, and farm size (Bechini et al., 2020; Muhammad et al., 2020). SCT on other hand, expands this reasoning by highlighting the reciprocal relationship between cognitive, behavioural, and environmental influences. Self-efficacy (SE), outcome expectations (OE), and social influence (SI) are central determinants of individual behaviour (Bandura, 1986; Erfanian et al., 2024). SCT asserts that individuals’ (farmers’) confidence in their abilities (SE) and expectations about the outcomes of their actions (OE) strongly predict persistence and adoption of new practices. This can be expressed as in Equation 3:

$$BI = \theta_0 + \theta_1 SE + \theta_2 OE + \theta_3 SI + \eta. \tag{3}$$

Observational learning promotes record-keeping adoption when farmers observe peers benefiting (Savari et al., 2024; Sewell et al., 2017). Yet, barriers such as low literacy, limited training, and time constraints hinder performance (Kalule et al., 2019; Ramirez et al., 2012). SCT extends TPB by integrating personal, social, and environmental interactions.

When integrated, TPB and SCT provide a comprehensive lens through which financial record-keeping behaviour can be understood. Behavioural intention and self-efficacy jointly influence actual record-keeping behaviour, while outcome expectations and social influence reinforce or weaken these

intentions. Endogenous variables (Atti, Sn, Pbc, SE, OE, SI) interact to predict the likelihood of engaging in financial record-keeping. Exogenous variables such as education, experience, training, and access to extension services (X) exert both direct and indirect effects. This is shown in below Equation 4:

$$B = \delta_0 + \delta_1 (ATT) + \delta_2 (SN) + \delta_3 (PBC) + \delta_4 (SE) + \delta_5 (OE) + \delta_6 (SI) + \delta_7 (X) + \epsilon \tag{4}$$

Where

X includes education, income, experience, and extension access. The model empirically examines how behavioural, social, and structural factors shape record-keeping, linking intentions and social context to actual practices (Figure 1).

This integration acknowledges that intention alone does not guarantee behaviour; confidence, expectations, and environmental support are also decisive. Therefore, the improved conceptual model (Figure 2) illustrates the direction of causality among constructs, showing how attitudes, norms, control, efficacy, expectations, and social influence interact to shape smallholder farmers’ financial record-keeping behaviour (Adedapo and Adekunmi, 2019; Lee and Tseng, 2024; Savari and Gharechae, 2020).

## Methodology

### Description of the study area

The study was conducted in South Africa’s Eastern Cape Province, a region characterized by diverse geography, ranging from coastal zones and fertile valleys to semi-arid plateaus, yet facing high poverty and food insecurity (Mdoda et al., 2024a; Mujuru et al., 2022). The Eastern Cape accommodates a population

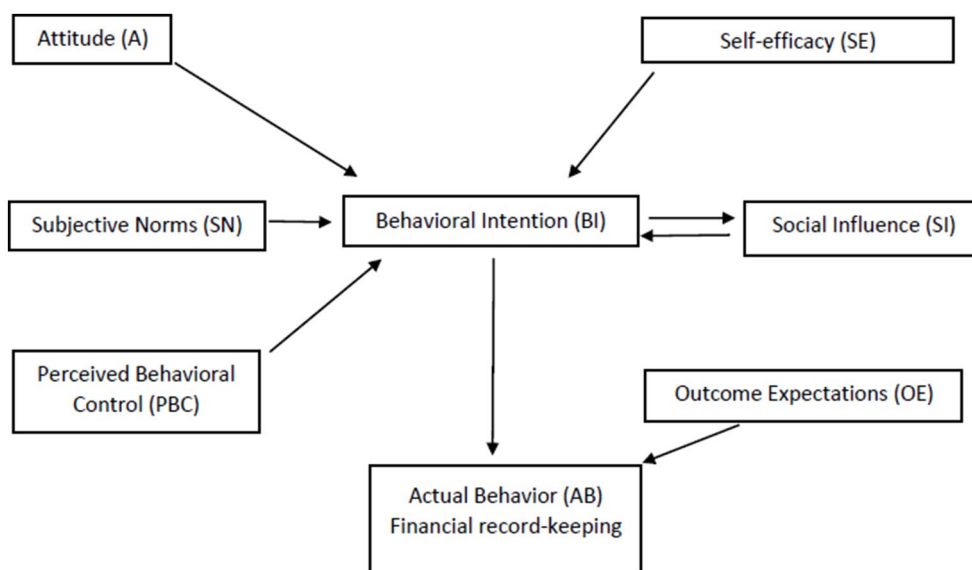


FIGURE 1 Theoretical framework.



FIGURE 2  
Map showing study sites. Source: adopted from Mdoda et al. (2023).

of more than 7.2 million people (Department of Water and Sanitation, 2024). The province is predominantly black African, representing over 85% of its residents, followed by colored communities at 7.6% and white populations at 5.6%. Individuals of Indian or Asian descent account for less than 1% of the provincial population. According to Nontu et al. (2024), the Eastern Cape continues to grapple with severe poverty and high unemployment levels, leaving a significant portion of its population living below South Africa's national poverty line of ZAR 624 per month. The province is the second largest province in the country (at 168,966 km<sup>2</sup>) after the Northern Cape (Nontu et al., 2024). The province only contributes 8% to the national GDP despite making 13.5% of the population.

There is much fertile land in the Eastern Cape, and agriculture remains important. The province has moderate climate which favours agricultural activities. Agriculture, including crop and livestock production, plays a crucial role in supporting rural livelihoods but is constrained by water scarcity, climate variability, and limited infrastructure and market access (Real Economy Bulletin of Provincial Review, 2022; Mdoda et al., 2024b). Focusing on smallholder vegetable farmers, the study examines how inadequate financial record-keeping limits profitability, cash flow management, and access to credit, aiming to strengthen financial literacy, farm management practices, and promote inclusive agricultural development and food security (Mdoda et al., 2024a; Real Economy Bulletin of Provincial Review, 2022). Figure 2 below shows the study area.

## Sampling procedure, frame, and sample size

A multi-stage sampling technique was employed to ensure representativeness across administrative and geographical levels within the province. This sampling procedure was divided into three stages. In the first stage, out of the six district municipalities in the province, two districts (OR Tambo and Alfred Nzo) were purposively selected due to their high concentration of smallholder farmers and notable socio-economic challenges. In the second stage, two local municipalities were purposively chosen from each selected district based on their active agricultural engagement and the presence of a significant number of smallholder vegetable farmers, resulting in a total of four local municipalities. The third stage involved the random selection of four communities per district, giving a total of 16 communities across the study area. At the final stage, a sample of 150 smallholder farmers was drawn from the Provincial Department of Agriculture's database of registered smallholder vegetable farmers using a stratified random sampling approach to ensure inclusion of both record-keeping and non-record-keeping farmers. Specifically, 11 farmers were selected from each community (approximately 7 record-keepers and 4 non-keepers), yielding an initial total of 176 respondents (11 × 4 communities × 2 municipalities × 2 districts). After data cleaning and removal of incomplete responses, the final effective sample consisted of 150 farmers (100 record-keepers and 50 non-keepers). This sampling design provided a scientifically sound and representative sample, capturing variations in farming practices, record-keeping behaviour, and

socio-economic conditions across administrative levels while minimizing selection bias.

$$n = \frac{Z^2 pq}{e^2} = \frac{1.95 \times 0.5 \times 0.5}{0.08^2} = 150$$

Where

$n$  is the sample size;  $Z$  is the confidence level ( $\alpha = 0.05$ , hence,  $Z = 1.96$ ). In this study,  $p$  was assumed to be 0.5 to represent maximum variability within the population of smallholder vegetable farmers. This assumption is common when no prior information exists about the proportion of farmers exhibiting the characteristic of interest, in this case, those keeping financial farm records.  $p$  is the proportion of the population containing the major interest,  $q = 1 - p$ , and  $e$  is the allowable error.

## Data collection

The study collected primary data from smallholder vegetable farmers using a structured questionnaire with closed-ended questions, administered by the researcher and three trained enumerators under supervision to ensure accuracy. A pre-test in Raymond Mhlaba Municipality evaluated relevance, validity, and completion time, informing revisions to improve clarity and alignment with objectives. Data cleaning removed incomplete or inconsistent responses. Primary data covered demographics, agricultural activities, resource use, income, farm records, and challenges in production and record-keeping. Secondary data from Department of Agriculture publications, official reports, published peer-reviewed journal articles, and farmer organizations complemented the primary dataset, providing a comprehensive foundation for analysis.

## Data analysis

Data was collected and coded in an Excel spreadsheet, then transported to SPSS version 29 and STATA 15. Descriptive statistics were performed for demographics and challenges faced by farmers using tables, frequencies, percentages, and means. A logistic regression analysis was performed to estimate the relationship between socio-economic and institutional factors and financial record keeping by smallholder farmers.

## Logistic regression model

The study used logistic regression to identify factors influencing financial record-keeping among smallholder vegetable farmers, modeling the binary outcome of whether farmers maintain records (Yes = 1, No = 0). Independent variables included education, income, farm size, and access to extension services. Logistic regression is advantageous for its interpretability, providing coefficients that show the direction and magnitude of predictors, and for producing probabilistic outputs. It accommodates both continuous and

categorical variables, remains robust with moderate multicollinearity, and has been widely applied in agricultural research to analyze farmers' decision-making behaviour (Mdoda et al., 2022; Dung, 2020; Sekele et al., 2020; Makamane et al., 2023; Malila et al., 2023).

The Logistic regression can be expressed as follows in Equation 5:

$$\varphi = f(x, \varepsilon) \quad (5)$$

Where

$\varepsilon$  is the error term and also a vector. A hypothetical mathematical model that explains the above logit function can be expressed (Chieh-Hua and Koppelman, 2001; Jones and Branton, 2005; Liao and Khew-Voon, 2007) as in Equation 6:

$$\varphi_{ik} = f(I_{ik}) = \frac{e^{S_{ik}}}{1 + e^{S_{ik}}}, \text{ for } S_{ik} = x_{ik}\alpha_{ik} \text{ and } -\infty < S_{ik} < +\infty \quad (6)$$

Where

$\varphi_{ik}$  is the dependent variable with a value of zero (0) for not keeping financial records and one (1) for keeping financial records by the  $i$ th smallholder farmer in the  $k$ th vegetable farmers;  $x_{ik}$  is the matrix of explanatory variables for the  $i$ th smallholder vegetable farmer keeping financial records in the  $k$ th vegetable farmers;  $\alpha_{ik}$  is the estimated set of parameters; and  $S_{ik}$  is the implicit keeping financial record index.

## Propensity score matching

The study used Propensity Score Matching (PSM) to assess the impact of financial record-keeping on smallholder vegetable farmers' productivity and profitability. PSM controls for selection bias by balancing treated and control groups based on observable characteristics. Farmers keeping records formed the treatment group, and those not keeping records the control group. This method has been successfully applied in similar agricultural studies (Lelisho and Lelisho, 2024; Weisburd et al., 2022; Tesfaye and Gutema, 2022; Eyasu et al., 2025; Li et al., 2023).

Propensity scores, estimating the likelihood of keeping financial records based on farm size, education, income, and resource access, were used to match comparable farmers. Differences in productivity and income were then analyzed to calculate the Average Treatment Effect on the Treated (ATT), providing a reliable estimate of how financial record-keeping influences smallholder farmers' profitability and productivity. The conditional probability of receiving a treatment given pre-treatment characteristics is as follows in Equation 7:

$$P(X) = Pr\left\{D = \frac{1}{X}\right\} = E\left\{\frac{D}{X}\right\} \quad (7)$$

Where

$D = \{0,1\}$  determines treatment exposure,  $X$  represents pre-treatment characteristics. The treatment effect reflects the variation in the welfare of irrigation participants and

non-participants. Hence, vegetable farmers keeping financial farm records  $T = 1$ , and who do not keep financial farm records  $T = 0$ , is shown in Equation 8:

$$T = Y_i(1) - Y_i(0) \tag{8}$$

Let  $Y_i^T$  the amount of income by treatment group (farmers keeping financial farm records), and  $Y_i^C$

The amount of income and productivity by the controlled group, then the difference in income and productivity between the treated and controlled group will be seen as in Equation 9:

$$\Delta_i = Y_i^T - Y_i^C \tag{9}$$

Where  $\Delta_i$ , the change in productivity and farm income as a result of the treatment of vegetable farmers. Equation 10 represents the Average treatment effect for the population (ATE) as shown in Equation 10:

$$\Delta_{ATE} = E(\Delta_i) = E\left(\frac{Y_i^T}{D} = 1\right) - E\left(\frac{Y_i^C}{D} = 0\right) \tag{10}$$

ATE shows the effect of productivity and farm income on vegetable farmers.

$$E\left(\frac{Y_i^T}{D} = 1\right): \text{Average productivity and farm income for vegetable farmers keeping financial farm records (Di = 1) or with treatment.}$$

$$E\left(\frac{Y_i^C}{D} = 0\right): \text{Average productivity and farm income of vegetable farmers who do not keep financial farm records or without treatment.}$$

Then the average effect of treatment on the treated (ATT) will be in Equation 11:

$$ATT = E\left(\frac{Y_i^T - Y_i^C}{D} = 1\right) = E\left(\frac{Y_i^T}{D} = 1\right) - E\left(\frac{Y_i^C}{D} = 1\right) \tag{11}$$

Implementing Propensity Score Matching (PSM) requires two key assumptions: Conditional Independence and Common Support. Conditional Independence assumes that record-keeping is determined only by observable characteristics, making outcomes independent of treatment after controlling for covariates. Common Support ensures overlap in covariate distributions between treatment and control groups. PSM begins by estimating propensity scores, probabilities of record-keeping, using a binary choice model, such as logistic regression, based on observed farmer characteristics.

The following Table 1 shows data collected for the factors influencing and the impact of farm financial records in the study.

## Results and discussion

This section is divided into two sections. The first section discusses the descriptive results, which profile vegetable farming, while the second section details the empirical results.

TABLE 1 Description of data collected.

Variable	Description	Variable type	Expected sign
<b>Dependent variable</b>			
Farm income	Total amount of vegetable sales (Rands)	Rands	+
Productivity	Total amount of vegetable yield produced (Kg)	Kilograms	+
<b>Independent variables</b>			
Age	Age of the vegetable farmer (actual years)	Continuous	+/-
Sex	Gender of the vegetable farmer, 1 = male, 0 = otherwise	Categorical	+/-
Marital status	Marital status of the farmer, 1 = Married, 2 = Single, 3 = Widowed	Categorical	+/-
Access to extension services	Farmers having access to extension services, 1 = Yes, 0 = No	Categorical	+
Member of farm organization	Being a member of farm organization, 1 = Yes, 0 = No	Categorical	+
Years spent in school	The actual years spent in school by the farmer	Continuous	+
Access to credit	Having access to credit by the farmer, 1 = Yes, 0 = No		+
Financial training received	Have financial training received by the farmer, 1 = Yes, 0 = otherwise	Categorical	+
Farm size	The actual farm size of the farmer	Continuous	+/-
Household income	The actual monthly household income	Continuous	+/-
Off-farm income	Having off-farm income, 1 = Yes, 0 = otherwise	Categorical	+/-
Difficulties to keep farm records	Experiencing challenges in keeping financial farm records, 1 = Yes, 0 = otherwise	Categorical	+/-
Distance to markets	The actual distance traveled to access markets	Continuous	+/-
Financial record activity	Having a financial record activity, 1 = If a farmer recorded his/her financial transactions, 0 = otherwise	Categorical	+/-
Keep financial records	Farmers keeping financial records, 1 = Yes, 0 = otherwise	Categorical	+/-
Occupation	Being a full-time farmer, 1 = yes, 0 = otherwise	Categorical	+/-
Family size	The actual number of people in the household	Continuous	+/-

## Demographic characteristics of the respondents

Table 2 below offers a comprehensive snapshot of the socio-economic characteristics of vegetable farmers in the study area. The demographic characteristics of smallholder vegetable farmers reveal socio-economic factors affecting financial record-keeping. Men dominate farming (79%), reflecting greater access to resources and extension services, while women face limited opportunities for financial management (Arends-Kuenning et al., 2021; Maziya et al., 2020). Most farmers are married (68%), highlighting shared household responsibilities (Wale and Mkuna, 2023). Access to extension services (70%) and farm organization membership (64%) exposes farmers to innovations and best practices. Only 36% maintain farm records, primarily through written documents (40%) or mental tracking (68%), showing that informal record-keeping prevails, consistent with Njingun et al. (2023).

Farmers' age and education influence financial record-keeping practices. With an average age of 52 years and 11 years of schooling, they possess basic literacy but limited technological adaptability (Maziya et al., 2020; Ge et al., 2023). Middle-aged farmers often rely on traditional methods like mental records due to familiarity and limited training access. The household size was very crucial for the study and was also used as a proxy for family labour. The average house size was 5 people per household, and this played a crucial role in providing family labour, which saves financial costs for smallholder farmers. Challenges such as limited financial literacy, small farm sizes (3 ha), moderate income (ZAR 3,786.67), and distance to markets (13 km) restrict the adoption of formal systems (Wale and Mkuna, 2023). These

demographic, economic, and infrastructural constraints hinder the transition from informal to formal financial record-keeping.

## Types of farm records kept by smallholder farmers

Figure 3 illustrates that smallholder vegetable farmers prioritize production over financial management. While 62% maintain production records to track crop yields, input use, and farm performance, only 21.28% keep financial records, limiting effective monitoring of income, expenses, and profitability (Njingun et al., 2023). Inventory (7.65%), health or vaccination (6.50%), and management records (2.57%) are maintained by very few farmers, indicating that administrative and resource-management activities are largely neglected (Njingun et al., 2023). Barriers such as limited financial literacy, insufficient training, and a lack of accessible record-keeping tools contribute to low adoption (Njingun et al., 2023). These findings highlight the need for targeted interventions to enhance financial literacy, provide record-keeping training, and supply practical tools for comprehensive farm and financial management, improving productivity, profitability, and decision-making (Njingun et al., 2023).

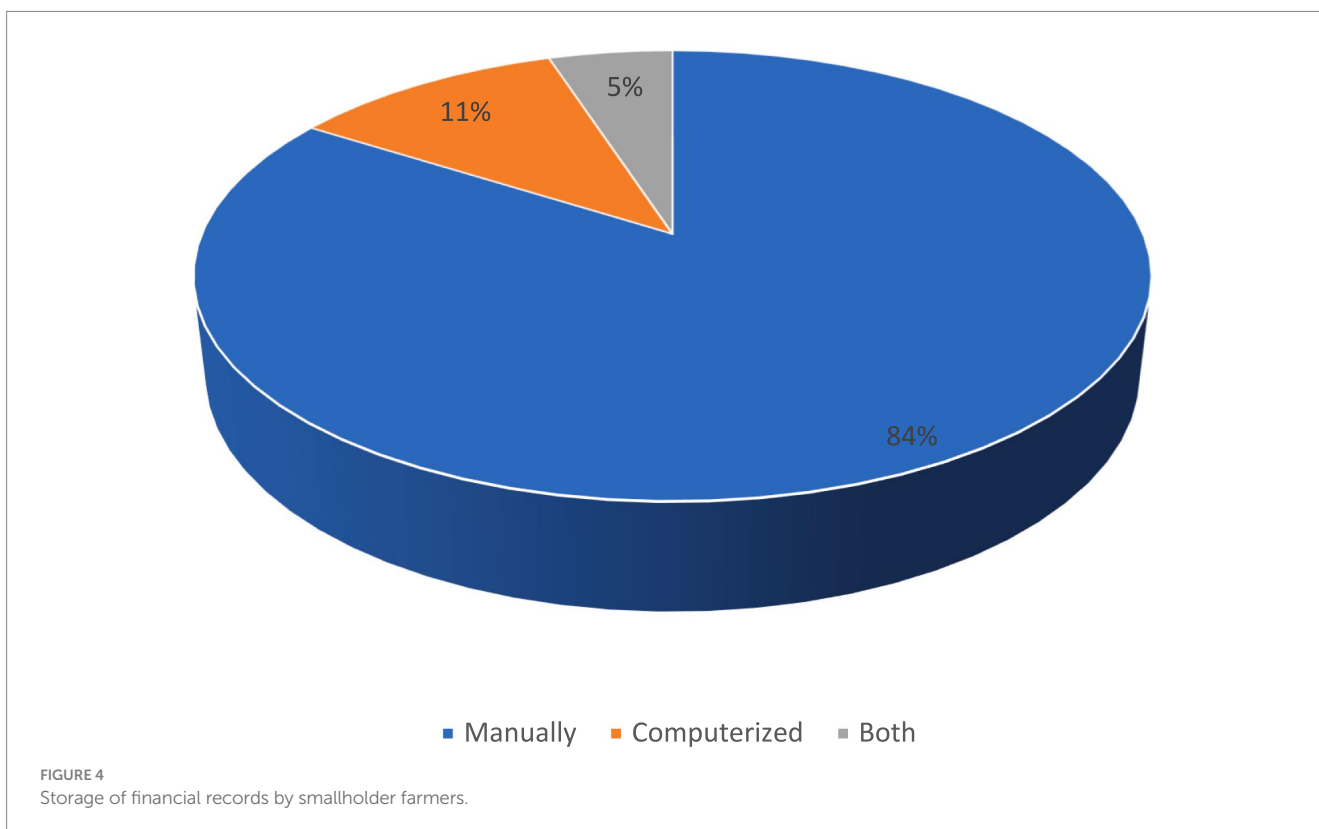
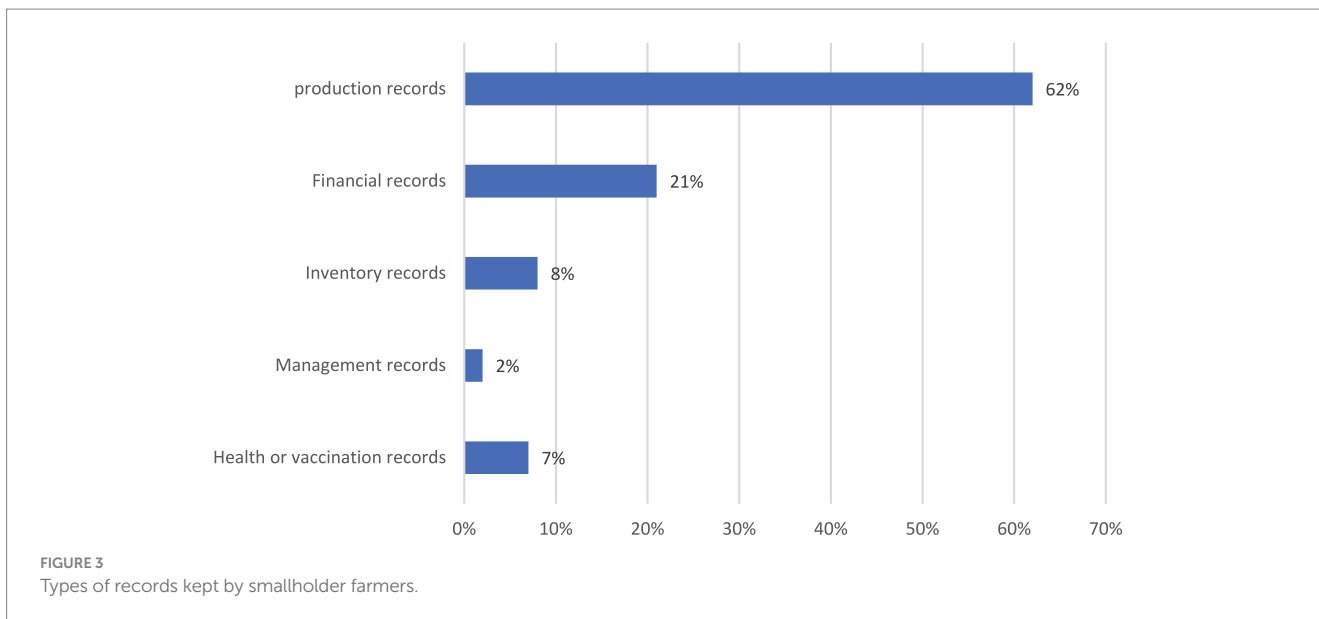
## Storage of financial records

Figure 4 shows the storage of financial records by smallholder farmers. The storage methods of farm records among smallholder vegetable farmers show a strong reliance on traditional, manual practices. The study found that 84% of farmers store records manually, limiting accuracy, efficiency, and timely access to financial information

TABLE 2 Socioeconomic characteristics of vegetable farmers in the study area.

Variable	Frequency	Percentage (%)
Gender: Male	119	79
Marital status: Married	102	68
Access to extension services: Yes	105	70
Member of Farm Organization: Yes	96	64
Keep farm/financial records on paper: Yes	60	40
Storage of financial record activity: Mentally	102	68
Occupation: Farming	96	64
Financial record training: Have attended financial record training	81	54
Access to credit: Yes	66	44
Financial record activity: If a farmer recorded their financial transactions	57	38
Difficulties in keeping records: Yes	96	64

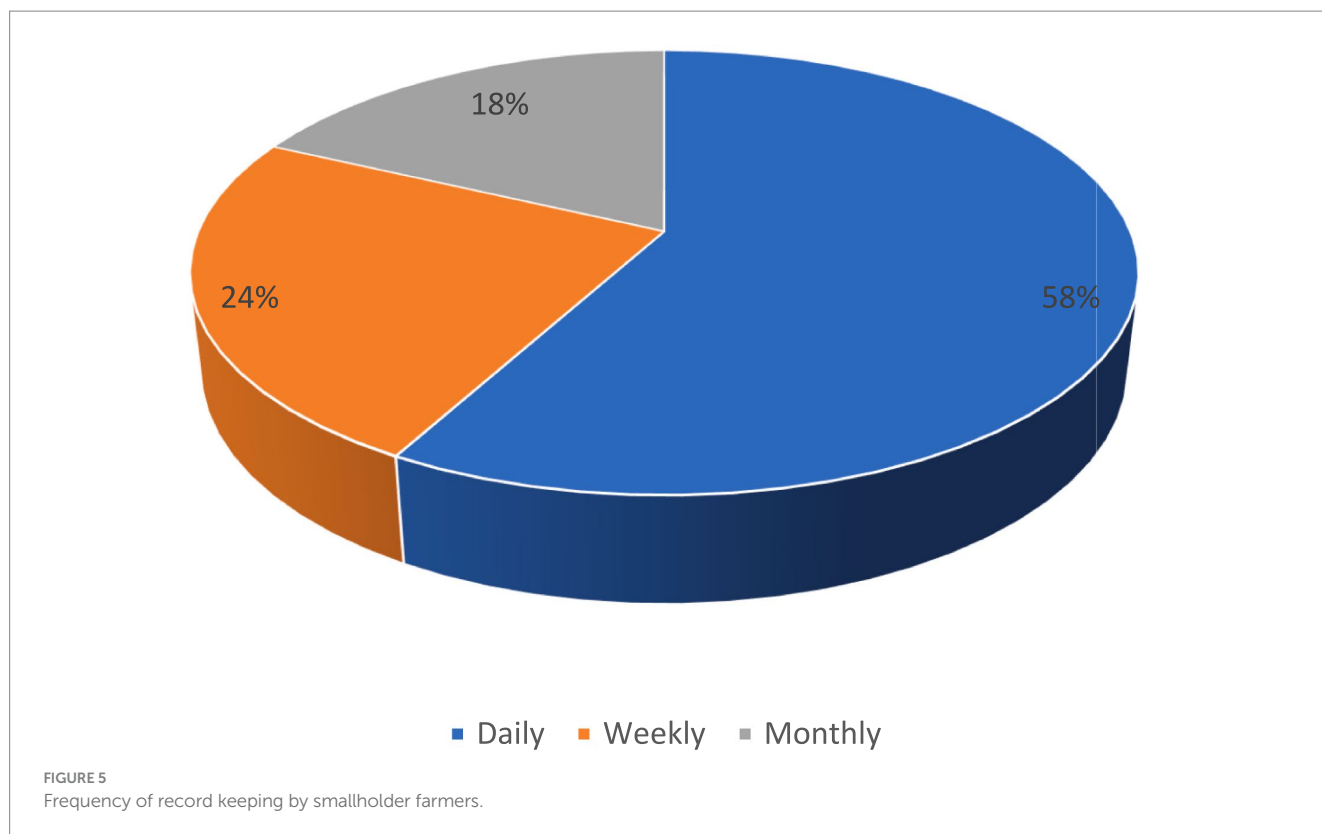
Variable	Mean	Standard deviation
Age	52.156	14.756
Years spent in school	11.319	7.520
Household size	5.219	3.653
Farm size	2.529	2.486
Distance to markets	12.641	6.123
Household income (farm revenue and social security)	ZAR3 786.67	38.269



(Njingun et al., 2023). Only 11% use computerized systems, reflecting barriers such as limited access to computers, low digital literacy, and perceived complexity or cost (Maziya et al., 2020; Ge et al., 2023). Just 5% combine manual and digital methods, indicating limited experimentation with hybrid systems (Njingun et al., 2023). These findings highlight the need for interventions providing digital literacy training, affordable tools, and guidance to transition from manual to hybrid or fully digital record-keeping, enhancing financial management, decision-making, and farm efficiency.

### Frequency of record keeping

The results on the frequency of financial record-keeping among smallholder vegetable farmers provide valuable insights into their financial management practices, as shown in Figure 5 below. The frequency of financial record-keeping among smallholder vegetable farmers shows variation with important implications for farm management. The study found that 58% of farmers maintain daily records, supporting trend analysis, cash flow management, and timely



decision-making (Adedapo and Adekunmi, 2019). About 24% record weekly, which may lead to minor inconsistencies, while 18% record monthly, creating significant gaps that limit financial oversight and access to credit. These findings highlight the need for interventions that promote consistent and accurate financial record-keeping to enhance farm management, financial planning, and decision-making among smallholder vegetable farmers.

### Benefits of keeping financial records by smallholder farmers

Figure 6 below shows the benefits of keeping financial records. Financial record-keeping provides significant benefits for smallholder vegetable farmers, improving farm management, decision-making, and long-term sustainability. The study found that 30% of farmers use records to make productivity projections, assess past performance, plan expenses, forecast income, and allocate resources, enhancing profitability (Manteaw et al., 2021). Additionally, 22% track agribusiness improvements, monitoring crop varieties, farming techniques, and resource use to adapt to challenges such as market fluctuations, production costs, and weather variability. 6% highlighted that records provide an accurate overview of farm operations, supporting cost management, productivity improvement, and strategic planning. Other benefits include understanding financial position (13%), evaluating resource efficiency (12%), and accessing credit or fulfilling tax obligations (7%). These findings demonstrate that proper record-keeping strengthens efficiency, informed decision-making, financial stability, and the resilience and growth potential of smallholder vegetable farms.

### Challenges faced by smallholder farmers in keeping financial records

The results from Figure 7 reveal a complex set of challenges that hinder smallholder vegetable farmers from effectively maintaining and keeping financial records. The study identified several challenges that limit effective financial record-keeping among smallholder vegetable farmers. The most common barrier, cited by 20% of farmers, is the perception that record-keeping is not beneficial, reflecting limited awareness of its role in financial management, credit access, and productivity. Time constraints (14%) highlight the demanding nature of farm work (Manteaw et al., 2021), while inadequate finances and low literacy or numeracy (12% each) restrict access to necessary tools and skills (Adedapo and Adekunmi, 2019). Psychological barriers, such as fear of discovering losses (10%), and practical difficulties, including misplacement of records (10%), recording errors (8%), and cumbersome paper systems (8%), also impede documentation. A small proportion (6%) indicated no specific reason.

### Factors influencing smallholder farmers in keeping financial records

Table 3 indicates a strong and statistically robust model for identifying the factors influencing smallholder farmers in keeping financial records. The logistic regression model demonstrates strong explanatory and predictive power for factors influencing financial record-keeping. The model's chi-square value of 262.30 with 76 degrees of freedom and a  $p$ -value of 0.0000 indicates high statistical significance, showing that the predictors collectively improve the

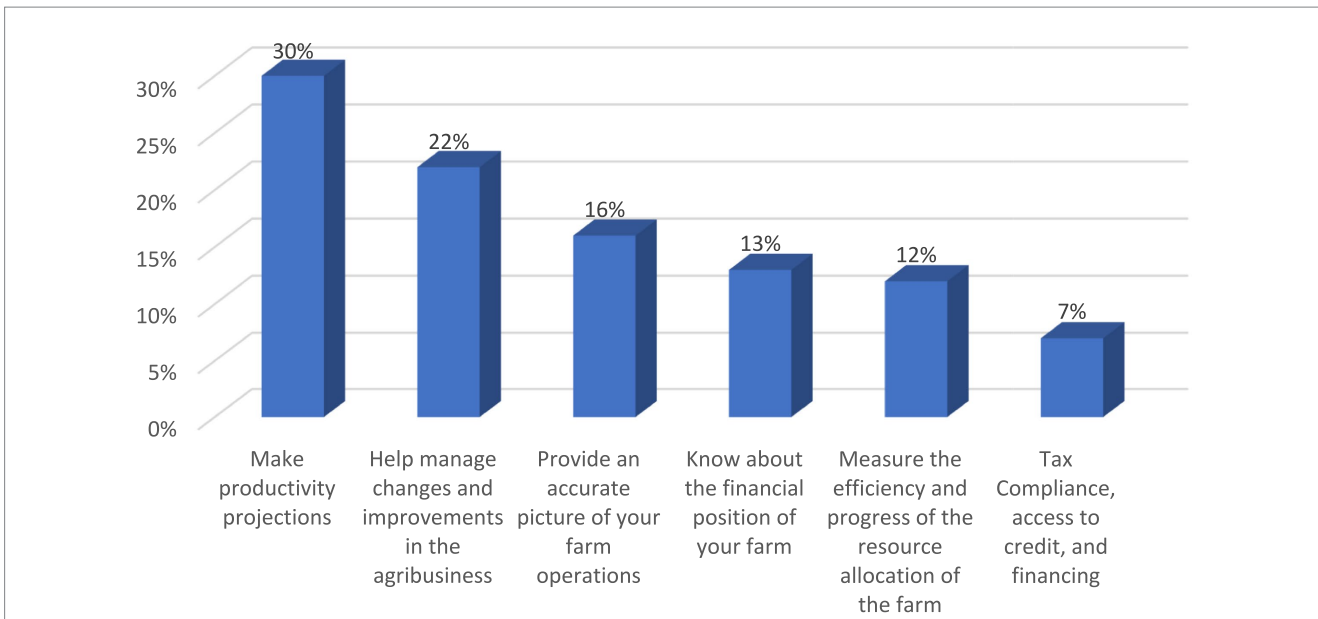


FIGURE 6 Benefits of keeping financial records by smallholder farmers.

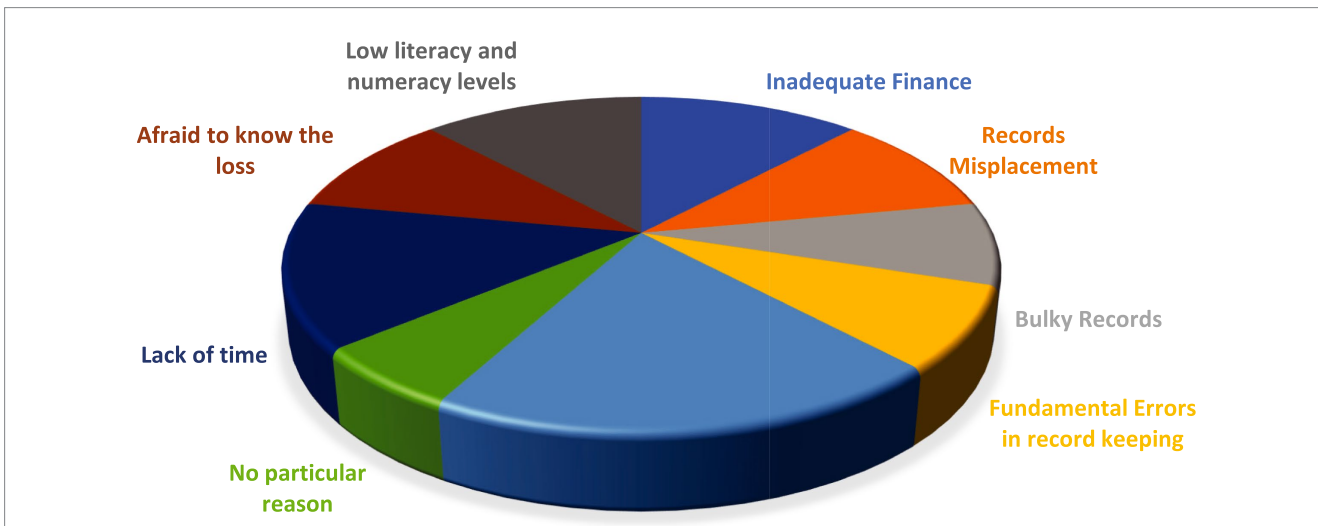


FIGURE 7 Challenges of keeping farm records.

model’s ability to distinguish between outcomes compared to a null model. A Nagelkerke  $R^2$  of 0.755 suggests that 75.5% of the variance in record-keeping is explained by the independent variables, reflecting excellent model fit. The  $-2$  Log Likelihood value of 769.5464 further indicates substantial reduction in unexplained variation. Additionally, the model’s overall prediction accuracy of 91% confirms robust classification of observations.

Years of formal education significantly increase the likelihood of smallholder vegetable farmers keeping financial records ( $p = 0.008$ ; marginal effect = 0.020), with each additional year raising the probability by approximately 2%. Education equips farmers with essential literacy and numeracy skills, enabling them to understand, manage, and interpret financial information effectively. More educated

farmers are also better able to appreciate the value of systematic record-keeping in farm management, enhancing decision-making, productivity, and income. These findings align with previous studies (Adedapo and Adekunmi, 2019; Njingun et al., 2023; Wulandari et al., 2023; Dung, 2020; Manteaw et al., 2021), which emphasize that education improves financial literacy, confidence, and perceived control.

Access to extension services significantly increases the likelihood of smallholder vegetable farmers maintaining financial records ( $p = 0.003$ ; marginal effect = 0.045), with regular contact raising the probability by 4.5%. Each additional visit or interaction with extension agents improves farmers’ knowledge, skills, and capacity to manage farm finances effectively. Extension officers provide training, technical

TABLE 3 Factors influencing smallholder farmers in keeping financial records.

Variables	Coefficient	Std Err	$P > z$	Marginal effects
Years spent in school	1.378	0.469	0.008***	0.020
Access to extension	0.695	0.145	0.003***	0.045
Age	0.703	0.228	0.014**	0.045
Access to credit	0.655	0.308	0.028**	0.037
Farm size	1.341	0.406	0.019**	0.042
Membership in a farm organization	1.322	0.490	0.000***	0.023
Financial recording training	0.513	0.131	0.032**	0.033
Difficulties in keeping records	-1.211	0.343	0.000***	0.048
Constant	-4.668	1.447	0.001	Accuracy of prediction: Overall (%) = 91
Observation: 150	Nagelkerke $R^2 = 0.755$	Wald $\chi^2(df = 76): 262.30$	Prob > $\chi^2 = 0.0000$	-2-Loglikelihood = 769.5464

\*\*\*:  $p < 0.01$ ; \*\*:  $p < 0.05$ .

support, and awareness that enhance perceived behavioural control and positive attitudes, key elements of the Theory of Planned Behaviour, while also strengthening self-efficacy as emphasized in Social Cognitive Theory. These results align with previous studies (Selamawit, 2017; Dung, 2020; Shitaye et al., 2024) that highlight extension services as a crucial institutional factor influencing farmers' access to information and adoption of best practices. Overall, extension services facilitate informed decision-making, improved financial management, and sustainable farm operations.

Age, used as a proxy for farm experience, positively influences financial record-keeping among smallholder vegetable farmers ( $p = 0.014$ ; marginal effect = 0.045), with each additional year increasing the likelihood by 4.5%. Older farmers are more inclined to maintain records due to accumulated experience, a deeper appreciation of the benefits of tracking financial activities, and increased responsibility in managing farm resources. This aligns with previous findings (Adedapo and Adekunmi, 2019; Tesfaye and Gutema, 2022) showing that experience enhances adoption of innovative practices, including financial record-keeping. Age also strengthens perceived control and positive attitudes, key aspects of the Theory of Planned Behaviour, while boosting self-efficacy, as emphasized in Social Cognitive Theory. The results suggest that while older farmers naturally adopt record-keeping, younger farmers may require targeted support and training to build confidence and cultivate consistent financial management practices early.

Access to credit positively influences financial record-keeping among smallholder vegetable farmers ( $p = 0.028$ ; marginal effect = 0.037), with farmers who have credit access being 3.7% more likely to maintain records. Credit access often requires financial accountability, including tracking loan disbursements and repayments, which indirectly encourages proper documentation and transparency. It also enables investment in tools, services, or training that support structured farm management, including record-keeping systems. These findings align with previous studies (Adedapo and Adekunmi, 2019; Dung, 2020) showing that access to credit promotes adoption of innovative practices. By enhancing perceived behavioural control and motivation, credit encourages adherence to systematic financial

management, consistent with the Theory of Planned Behaviour, while also boosting self-efficacy as described in Social Cognitive Theory.

Farm size has a significant positive effect on financial record-keeping among smallholder vegetable farmers ( $p = 0.019$ ; marginal effect = 0.042), with larger farms being 4.2% more likely to maintain records. As farm size increases, the complexity of operations such as hiring labour, purchasing inputs in bulk, and managing multiple sales channels necessitates structured record-keeping for effective oversight, resource allocation, and decision-making. This finding aligns with previous studies (Manteaw et al., 2021; Dung, 2020; Shitaye et al., 2024) showing that farmers with larger farms are more likely to adopt innovative technologies, including financial record-keeping, to enhance management and productivity.

Membership in farm organizations significantly enhances financial record-keeping among smallholder vegetable farmers ( $p = 0.000$ ; marginal effect = 0.023), with membership increasing the probability of maintaining records by 2.3%. Being part of a cooperative or farmer group provides access to training, peer influence, and social accountability, fostering knowledge exchange and encouraging adherence to good farming practices, including record-keeping. Farm organizations promote a culture of professionalism, transparency, and systematic financial management, enabling farmers to track income, expenses, and productivity more effectively. These findings are consistent with Ibok et al. (2024) and Kolade and Harpham (2014), who noted that group membership facilitates the rapid dissemination of agricultural innovations, peer learning, and the adoption of improved management practices.

Financial record-keeping training is positively associated with the likelihood of maintaining farm records ( $p = 0.032$ ; marginal effect = 0.033), indicating that a 1% increase in training raises the probability of keeping records by 3.3%. Targeted capacity-building programs focusing on financial literacy and practical bookkeeping skills enhance farmers' competence, confidence, and ability to apply knowledge in real farm management scenarios. Such training equips smallholder vegetable farmers with the skills needed to track income, expenses, and overall farm performance, improving decision-making and supporting business growth. These findings align with Wulandari et al. (2023), who emphasized that financial recording training

positively influences farmers' intentions, attitudes, and practices. The results highlight the critical role of structured training in strengthening perceived behavioural control, a key concept in the Theory of Planned Behaviour, while Social Cognitive Theory underscores how training enhances self-efficacy, reinforcing the adoption of systematic and accurate financial record-keeping practices.

Difficulties in keeping records negatively and significantly affect the likelihood of smallholder vegetable farmers maintaining financial records ( $p = 0.000$ ; marginal effect =  $-0.048$ ). A 1% increase in perceived or actual challenges reduces the probability of keeping records by 4.8%. These difficulties, including low literacy, lack of training, limited access to tools, and the complexity of record-keeping, act as barriers to the adoption and consistent use of financial farm records. The findings are consistent with [Owiny \(2019\)](#) and [Ibok et al. \(2024\)](#), who highlighted that constraints such as time, skills, and resources discourage proper documentation.

## Impact of financial records on smallholder farmers

The results in [Table 4](#) show that financial record-keeping significantly enhances smallholder vegetable farmers' productivity and farm returns. Record-keeping farmers achieved higher yields 0.38 t/ha (Radius Matching) and 0.40 t/ha (Kernel Matching), both significant at 1% indicating improved decision-making for inputs, resource allocation, and farm management. Economically, they earned an additional ZAR 1,795 (Radius) and ZAR 1,945 (Kernel) per season, reflecting better cost control, marketing efficiency, and reinvestment capacity. Consistency across matching methods suggests these effects are robust. These findings align with [Loki and Mdoda \(2023\)](#) and [Tesfaye and Gutema \(2022\)](#), highlighting the importance of financial literacy, training, and accessible record-keeping tools for sustaining productivity and profitability.

## Implications for agribusiness and food systems

The socio-economic profile and financial record-keeping practices of smallholder vegetable farmers have critical implications for agribusiness development and food system resilience. Male dominance and family-based farming highlight the need to address gender disparities and

empower women in financial decision-making. Reliance on informal or mental record-keeping limits access to credit, constrains investment planning, and restricts farm expansion, hindering agribusiness growth. Extension services and farmer organizations support capacity-building, but interventions must be targeted and inclusive to translate knowledge into practice. Structural constraints such as low education, small farm sizes, moderate incomes, and long distances to markets further restrict the adoption of effective record-keeping. Persistent challenges and low digital tool adoption reflect behavioural and resource-related barriers, including limited confidence and traditional practices. Without accurate financial data, farmers struggle to manage inputs, forecast production, and respond to market changes, increasing vulnerability in agri-food value chains ([Adedapo and Adekunmi, 2019](#); [Njingun et al., 2023](#); [Wulandari et al., 2023](#)). Promoting financial literacy and user-friendly digital tools can enhance record-keeping, profitability, and access to formal financial services, supporting sustainable commercialization, creditworthiness, and food system resilience.

## Conclusion and recommendations

The study assessed the determinants and impact of financial record-keeping among smallholder vegetable farmers in the Eastern Cape Province of South Africa. The results showed that most farmers were middle-aged men engaged in family-based farming with modest education levels and limited financial literacy. Although many maintained production records, few kept formal financial records, relying instead on informal or mental tracking systems. The main benefits of record-keeping included improved productivity projections, better financial control, informed decision-making, and enhanced access to credit, yet challenges such as low awareness, time constraints, literacy limitations, and inadequate support systems impeded adoption. Logistic regression analysis revealed that education, access to extension services, farm size, credit availability, membership in farmer organizations, and participation in financial training significantly increased the likelihood of keeping records, while record-keeping difficulties had a negative effect. Propensity Score Matching results further confirmed that farmers who maintained financial records achieved higher productivity and profitability, highlighting the practice's critical role in strengthening farm performance, efficiency, and resilience. Based on the study results, financial record-keeping is a vital management practice that

TABLE 4 Impact of keeping financial records by smallholder farmers.

Radius matching					
Outcome	Treatment mean	Control mean	ATT (Effect)	Std error	Significance
Productivity (t/ha)	2.34	1.96	0.38	59.20	0.004***
Farm returns (ZAR/season)	4,725	2,930	1795	128.40	0.008***
Kernel matching					
Outcome	Treatment mean	Control mean	ATT (effect)	Std error	Significance
Productivity (t/ha)	2.34	1.95	0.40	55.80	0.000***
Farm returns (ZAR/season)	4,925	2,980	1945	125.76	0.003***

\*\*\*Indicates significant level at 1%.

strengthens smallholders' decision-making, business growth, and access to financial services. Policymakers and development partners should integrate practical, gender-inclusive financial literacy training into agricultural extension programs. Linking credit access to proper record-keeping and investing in simple digital tools can promote financial transparency and reduce literacy barriers. Strengthening farmer organizations as hubs for peer learning and accountability can reinforce positive behavioural change. Embedding record-keeping into training and policy frameworks will professionalize smallholder farming, enhance competitiveness, and foster resilient, inclusive agribusiness growth in South Africa and beyond.

## Data availability statement

The data will be made available upon reasonable request from the corresponding author.

## Ethics statement

The studies involving humans were approved by the University of KwaZulu-Natal under the Humanities and Social Science Research Ethics Committee (HSSREC), and the protocol reference number is HSSREC/00005086/2022. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

LM: Validation, Conceptualization, Investigation, Resources, Writing – review & editing, Funding acquisition, Data curation, Project administration, Writing – original draft, Supervision, Software, Formal analysis, Visualization, Methodology. YN: Writing – original draft, Software, Writing – review & editing, Funding acquisition, Resources, Investigation, Project administration, Methodology, Formal analysis, Visualization, Validation, Data curation, Supervision, Conceptualization.

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## Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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