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Does the adoption of sustainable agricultural practices matter for household food security? Evidence from rural Burkina Faso

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Abstract

In Sub-Saharan Africa, food insecurity remains a major challenge, partly due to low agricultural productivity. Sustainable agricultural practices (SAPs) offer a promising pathway to improve food security among rural households. However, few studies have examined their contributions in this region. This research analyses the determinants of the adoption of SAP and their individual and combined effects on household food security. To achieve this, a multinomial endogenous treatment effect regression model was applied to data from the Permanent Agricultural Survey of 5 023 agricultural households. The data covers the 2020–2021 agricultural season and were collected by the Ministry of Agriculture and Hydro-Agricultural Development of Burkina Faso. The results show, on the one hand, that the adoption of SAPs is influenced by household socioeconomic and demographic factors, plot-specific characteristics and agroecological zones. On the other hand, the results show that the adoption of SAPs improves household food security, with a greater positive effect in the case of combined adoption. Our results suggest that efforts to improve household food security should focus on promoting the combined adoption of SAPs more than their isolated adoption.

Key words: sustainable agricultural practices, food security, multinomial endogenous treatment effect regression model, Burkina Faso

1. Introduction

In Sub-Saharan Africa (SSA), food security remains at the centre of development policies. This region is facing particularly alarming food insecurity. In 2022, more than a quarter of the population (26.6%) of the region was severely food insecure, a much higher rate than in Latin America and the Caribbean (12.6%) or Southeast Asia (2.6%) (FAO 2024). This situation affects rural households in particular, whose livelihoods heavily depend on agriculture (FAO 2023). One of the major causes of this food insecurity is low agricultural productivity. In 2017, the average yield was just 1.2 tons per hectare, increasing only modestly to 1.6 tons per hectare in 2022, which is well below the estimated global average of 4.2 tons per hectare (World Bank 2024).

However, achieving food sustainability in SSA is faced by environmental degradation, the effects of climate change and the low recyclability of organic matter (Jaleta *et al*. 2018; Khonje *et al*. 2018). These constraints, compounded by institutional and infrastructural inadequacies, lead to low yields, declining farm incomes, food insecurity and poverty (Teklewold *et al*. 2013). The adoption of sustainable agricultural practices (SAPs) has therefore emerged as a promising pathway to increase productivity, improve incomes, and enhance household food security and well-being (Khonje *et al*. 2018; Manda *et al*. 2016). SAPs are defined as ecologically sound and economically viable techniques that promote resource conservation and improve soil fertility, moisture and nutrient availability (Knezek *et al*. 1988; Kassie *et al*. 2015).

Theoretically, food security is multidimensional, encompassing availability, access, utilisation and stability (FAO 2006; Clapp *et al*. 2022). Sen's capability theory emphasises that access to food depends not only on production but also on individuals' capacities to seize economic opportunities (Sen 1985). Moreover, Sustainable Development Goal (SDG) 2 emphasises the link between food security and sustainability, stressing the need to preserve natural resources and limit the effects of climate change. Thus, Schumpeterian theory suggests that the adoption of agricultural innovations such as SAPs can improve productivity and reduce production costs, thereby contributing to poverty reduction and increased food security (Schumpeter 1983).

Empirically, the effects of SAP adoption on food security remain mixed. Several studies have shown positive effects, notably increased productivity, income, and therefore household food security (Manda *et al*. 2018; Goshu *et al*. 2023; Mulugeta Habtewold & Heshmati 2023). Some studies show that the effect is even greater when farmers combine several SAPs (Abdallah *et al*. 2021; Sawadogo *et al*. 2025). Kerr *et al*. (2019), on the basis of a review of 56 articles published between 1998 and 2019, noted that, in 78% of cases, the adoption of SAPs was associated with improved household food security and nutrition in low- and middle-income countries. However, adoption costs, technological barriers and initial asset endowments may limit smallholders' participation and undermine food security (Schneider & Gugerty 2011).

To analyse the effect of SAP adoption on household food security, Burkina Faso was chosen as the setting for our investigations. In this country, agriculture employs nearly 63% of the working population (Institut National de la Statistique et de la Démographie [INSD] 2022). However, a significant proportion of the rural population is struggling to meet its basic needs (Sawadogo *et al*. 2022). According to MAAH (Ministry of Agriculture and Hydro-Agricultural Development 2020), the number of people affected by food insecurity rose from 153 000 in October 2016 to nearly 1.2 million in October 2019. The poor performance of this sector, compounded by the effects of climate change and the vulnerability of smallholders, threatens the sustainability of food systems (Alvar-Beltrán *et al*. 2020; Maré *et al*. 2022). Faced with these challenges, the adoption of SAPs by farmers is more than a necessity.

Empirical evidence on the effects of SAP adoption on farmers' well-being remains limited in Burkina Faso. Most studies have focused on determinants of adoption and factors affecting SAP intensification (Alvar-Beltrán *et al*. 2020; Ayantunde *et al*. 2020; Maré *et al*. 2022). To our knowledge, a few studies have focused on the effects of SAP adoption on food security (Kone & Uzmay 2024; Sawadogo *et al*. 2025). Sawadogo *et al*. (2025) examined individual SAP adoption and the number of SAPs adopted, whereas Kone and Uzmay (2024) considered the combined adoption of two SAPs. Both studies focus primarily on dietary diversity and the subjective dimension of food security. This research uses a composite food security index (CARI), which captures multiple dimensions of food security. In addition, it also contributes to a more comprehensive understanding of SAP adoption by examining whether these practices are more effective when adopted individually or in combination. This research postulates that the combined adoption of SAPs further improves food security for rural households in Burkina Faso.

The remainder of the article is structured as follows. Section 2 presents the empirical strategy, followed by a discussion of the econometric results in Section 3. Section 4 concludes the article with the policy implications of the findings.

2. Methodology

2.1 Assessing household food security

Several indicators are used in the literature to assess household food security, such as the food consumption score (FCS), the household dietary diversity score (HDDS), the food expenditure, undernourishment and coping strategy indices (CSI and rCSI), the household food insecurity access scale (HFIAS), the household hunger scale (HHS), and self-assessed food security (SAFS) (N'Diaye 2014). However, identifying a single indicator capable of comprehensively measuring household food security remains difficult. For this reason, several authors suggest combining different tools (e.g. Cafiero *et al*. 2014).

In this context, the World Food Programme (WFP) has proposed the consolidated approach to reporting food security indicators (CARI), a composite indicator that provides an overview of the overall food security status of households (WFP 2014). It is calculated by combining the diversity and frequency of household food consumption, the share of household food expenditure, and coping strategies for food insecurity. The household food security index is constructed via an algorithm based on a simple arithmetic average of the scores assigned to the various indicators, measured on a four-level scale. According to this classification, households are divided into four categories: food security (score of 1), limited food security (score of 2), moderate food insecurity (score of 3), and severe food insecurity (score of 4) (WFP 2014) (see Table 1). The construction of the index is described in the table below. For the accompanying analysis, the CARI indicator was dichotomised into two categories: food security and food insecurity (Butaumocho & Chitiyo 2017; Tossou 2022). Given that the index has already been constructed, we created a binary variable by placing in a first group households identified as strictly food secure, and in a second group food-insecure household.

2.2 Modelling the effects of SAPs on food security

Agricultural technologies are often introduced in the form of "packages" that can be adopted either in isolation or in a complementary manner (Feder *et al*. 1985). In this research, the analysis focuses on the individual or combined adoption of three main SAPs: intercropping, organic fertiliser and soil and water conservation techniques (SWCT). This adoption dynamic is understood through the theory of random utility (Greene 2002), according to which households choose the option that maximises their utility, U_{ij}, depending on their characteristics, those of the farm and those of the environment. A farmer i will thus choose a practice j over an alternative practice k, if $U_{ij} > U_{ik}$, $k \neq j$.

Table 1: Indicator combinations and description of the general food security classification according to the CARI method

Domain	Indicator	Calculation	Food safety (1)	Marginal food security (2)	Moderate food insecurity (3)	Severe food insecurity (4)
Current status	Food consumption	$FCS_i = \alpha_i x_i$	Acceptable		Limited	Poor
Coping capacity	Economic vulnerability: FES	$FES = \frac{food\ expenses}{food\ expenses\ +\ non\ food\ expenses}$	Less than 50%	50% to 65%	65% to 75%	Over 75%
	Asset depletion: Livelihood coping indicator	$CSI = \sum strategy_i(frequency_i * severity)$	None	Stress strategies	Crisis strategies	Emergency strategies

Notes: FCS = Food consumption score; FES = Food expenditure share; CSI = Coping strategy indices
Source: WFP (2014)

However, technology adoption is not random. Farmers self-select according to observable and unobservable factors, such as their innate managerial and technical abilities, which can pose an endogeneity problem (Abdulai & Huffman 2014). Ignoring these biases can distort the estimation of the true effect of SAPs. To remedy this, the analysis uses the multinomial regression model with the endogenous treatment effect (METE) proposed by Deb and Trivedi (2006a, 2006b) (see also Abdallah *et al*. 2021; Manda *et al*. 2016).

The model takes into account both the interdependence of adoption decisions and the selection bias resulting from observed and unobserved characteristics. METE is used because it can easily be extended to model binary outcomes as opposed to the multinomial endogenous switching model (Khonje *et al*. 2018). This model is carried out in two stages. In the first stage, adoption decisions are modelled, and in the second stage, the effects of SAPs on food security are estimated. The selection and outcome models are jointly estimated via the simulated maximum likelihood method.

Following Deb and Trivedi (2006a, 2006b), let U_{ij} be the indirect utility associated with the j^{th} SAP package, with $j = 0,1,2 \dots J$ for household i:

$$U_{ij}^{*} = z_i' \alpha_j + \sum_{k=1}^{j} \delta_{jk} l_{ik} + n_{ij}, \tag{1}$$

where z_i is a vector of covariates at the household level, along with social capital, financial capital, plot characteristics, etc.; α_j is the vector of corresponding parameters to be estimated; n_{ij} are the independently and identically distributed error terms; and l_{ik} is the latent factor that incorporates unobserved characteristics common to SAP adoption and outcomes (CARI). Following Deb and Trivedi (2006a), let $j = 0$ be the non-adopters (control group) and let $U_{i0}^{*} = 0$. Since U_{ij}^{*} is not observed, we observe the choice of the SAP package as a set of binary variables, d_j, which are collected by a vector $d_j = (d_{i1}, d_{i2} \dots d_{iJ})$. Similarly, suppose that $l_j = (l_{i1}, l_{i2} \dots l_{iJ})$. The probability of treatment can then be represented as follows:

$$\Pr(d_i | z_i, I_i) = g(z_i' \alpha_1 + \sum_{k=1}^{J} \delta_{1k} l_{ik} + z_i' \alpha_2 + \sum_{k=1}^{J} \delta_{2k} l_{ik} + \cdots + z_i' \alpha_j + \sum_{k=1}^{J} \delta_{jk} l_{ik}), \tag{2}$$

where g is an appropriate multinomial probability distribution. Following Deb and Trivedi (2006a), we assume that g has a multinomial logit structure, defined as follows:

$$\Pr(d_i | z_i, I_i) = \frac{\exp(z_i' \alpha_j + \delta_j l_{ij})}{1 + \sum_{k=1}^{J} \exp(z_i' \alpha_k + \delta_k l_{ik})}, \tag{3}$$

where $\Pr(d_i | z_i, I_i)$ denotes the probability of adopting SAP, j, from a set of seven alternative SAP combinations.

The second step of the model consists of estimating the effect of adopting different SAP packages on the outcome variable. The equation of the expected outcomes for individual i is formulated as follows:

$$E(y_i | d_i, x_i, I_i) = x_i' \beta + \sum_{j=1}^{J} \gamma_j d_{ij} + \sum_{j=1}^{J} \lambda_j l_{ij} \tag{4}$$

In this equation, y_i is the result in terms of food security status for household i ; and x_i denotes a set of exogenous covariates associated with the parameter vectors, β. The parameters γ_j represent the effects of the treatment relative to non-adopters. More specifically, the coefficients γ_j measure the effects of SAPs on the food security status of farming households. If the decision to adopt SAPs is endogenous, assuming that d_{ij} is exogenous leads to inconsistent estimates of γ_j. Since $E(y_i|d_i, x_i, I_i)$ is a function of latent factors, l_{ij}, the outcome is affected by unobserved characteristics that also influence selection into the treatment. When λ_j, the factor load parameter, is positive (negative), the treatment and outcome are positively (negatively) correlated with unobserved characteristics; that is, there is positive (negative) selection, with γ and λ being the associated parameter vectors, respectively.

Although, in theory, the model parameters can be identified even when the regressors in the treatment equations are identical to those used in the outcome equation, Deb and Trivedi (2006a) recommend the use of exclusion restriction variables or instruments to ensure more robust identification. The identification of the METE model relies on the use of instruments such as access to extension services and membership of a farmer's organisation. These instruments are intuitively expected to influence outcomes indirectly through the adoption of SAPs. Indeed, they have been used as instruments in several previous works (Di Falco *et al*. 2011; Khonje *et al*. 2018).

2.3 Data sources

The data used for this research come from the Permanent Agricultural Survey (EPA) conducted by the Ministry of Agriculture and Hydro-Agricultural Development (MAAH) of Burkina Faso through the Directorate General of Sectoral Studies and Statistics (DGSS) and cover the 2020–2021 season.

The survey was conducted via a two-stage stratified sampling method for sample selection. The primary sampling unit (PSU) was the village and the secondary statistical unit (SU) is the agricultural household. The final sample size was 5 304 households in 884 villages. At the first level, the primary units (PUs) were drawn with probability proportional to size and without replacement. At the second level, households were selected via simple random sampling without replacement. Each household in the same primary unit had the same probability of appearing in the sample. After data cleaning, households with incomplete information required to construct the CARI index were excluded, resulting in a final sample of 5 023 farming households covering the entire country.

On the basis of the literature, three main categories commonly observed in the country were identified: intercropping, soil and water conservation techniques (SWCT), and the use of organic fertiliser (Tankoano & Sawadogo 2022). Intercropping refers to the simultaneous cultivation of at least two crops on the same plot of land. SWCTs include zaï, half-moons, stone ridges, small dams and hedgerows, which are widely used in the rural areas of Burkina Faso (Sawadogo *et al*. 2025). The adoption of SAPs is defined here as a household's use of one of these three SAPs, or a combination of two or three SAPs, during the 2020–2021 agricultural season. It is therefore a categorical variable that takes values of 1, 2, ..., 7 if the household has applied at least one of these practices or a combination of SAPs on one of its plots, and 0 if not.

The plot corresponds to any unit of land cultivated by the producer. Our control variables are chosen on the basis of the literature (Feder *et al*. 1985; Teklewold *et al*. 2013; Asfaw *et al*. 2019) and are described in Table 2.

Table 2: Description and descriptive statistics of the variables

Variables	Description	Average	SD
Dependent variables			
Food security	1 if the household is food-secure and 0 otherwise	0.544	-
Explanatory variables			
Household characteristics			
Gender	Gender of head of household (1 = male; 0 = female)	0,930	-
Age	Age of head of household (years)	49.559	14.464
Active members	Number of working members in the household	2.783	3.711
Literacy	1 if the head of household is literate	0.362	-
Household physical and financial capital			
Animal traction	1 if the household uses animal traction and 0 otherwise	0.801	-
Credit	1 if the household has access to agricultural credit, 0 otherwise	0.16	-
Farm income	Gross farm income of the household (FCFA)	876 666.12	1 165 426.2
Off-farm activity	1 if the head of household is engaged in a non-agricultural activity, and 0 otherwise	0.448	-
Plot characteristics			
Land tenure security	1 if the household owns at least one secure plot (traditional or modern), and 0 otherwise	0.686	-
Cultivated area	Total cultivated area in hectares	4.678	4.988
Sahelian zone	1 if household is located in the Sahelian zone and 0 otherwise	0.218	-
Sudanese zone	1 if household is located in the Sudanese zone and 0 otherwise	0.254	-
Sudano-Sahelian zone	1 if household is located in the Sudano-Sahelian zone and 0 otherwise (reference)	0.686	-
Instrumental variables			
Farmer's organisation	1 if the head of household is a member of a farmer's organisation, and 0 otherwise	0.283	-
Extension services	Access to agricultural extension services (1 = yes; 0 = no)	0.340	-

Source: Survey data (2021)

3. Results and discussion

3.1 Descriptive statistics

Figure 1 shows that, overall, a minority adopted no SAPs (27.37%). The adoption rates are 8.70% for intercropping, 33.40% for organic fertilisation, and 10.60% for SWCT. In addition, 6.90% of the households had adopted both intercropping and organic fertilisation, whereas 5.50% had combined intercropping with SWCT. In addition, 5.30% of the households adopted organic manure and SWCT simultaneously. However, only 2.20% adopted all three practices at the same time.

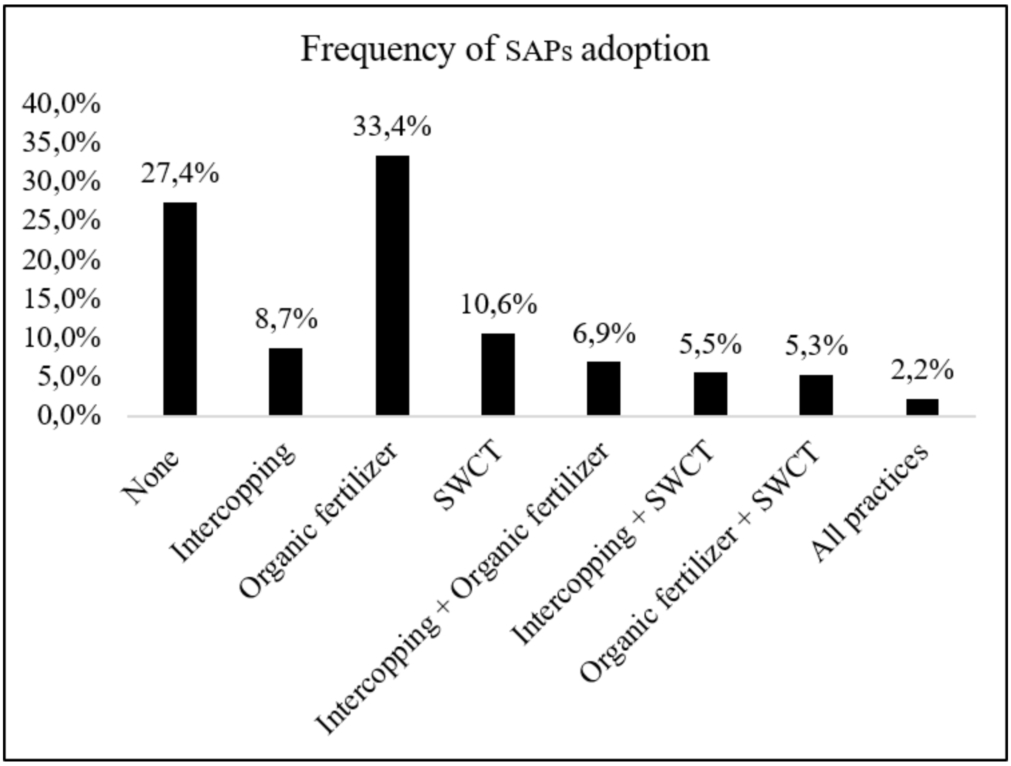

Figure 1: Frequency of SAP adoption
Source: Survey data (2021)

An analysis of household food security, presented in Figure 2 according to the different modalities of adoption of SAPs, highlights contrasting effects. The isolated adoption of organic fertiliser appears to be the most favourable, with 61% of households experiencing food security, a 12-point gain over non-adoption (49%). Combinations that integrate this practice, notably with SWCT or with intercropping, also lead to significant improvements, reaching 60% and 54%, respectively. In contrast, the isolated use of SWCT has no significant effect (49%), whereas intercropping alone results in only a marginal gain (50%). Finally, the simultaneous adoption of all three practices generates an improvement (56%), but this improvement is still lower than that for certain targeted combinations.

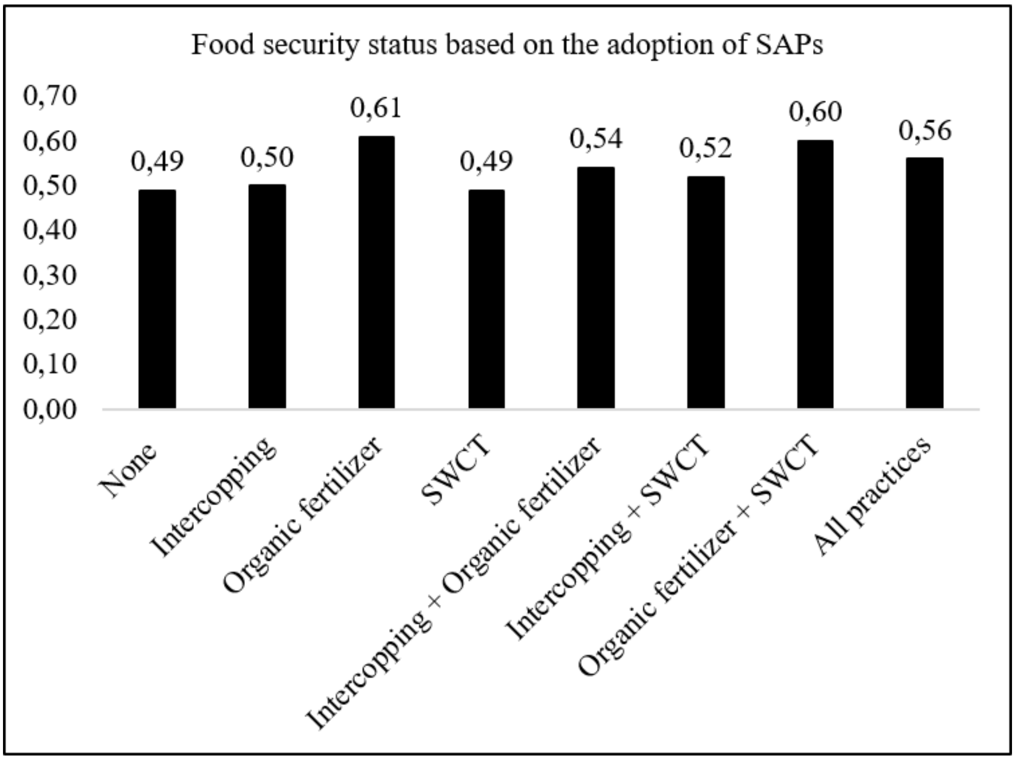

Figure 2: Distribution of household food security according to SAP adoption
Source: Survey data (2021)

3.2 Econometric results

Table 3 presents the results of the mixed multinomial logit estimation, corresponding to the first stage of the METE. The reference modality chosen is non-adoption, against which the various alternatives are compared. The Wald test ($x^2 = 732.96$; $\text{Prob} > x^2 = 0.000$) indicates that the model fits the data well and implies that the null hypothesis that all regression coefficients are zero is rejected. Furthermore, the selection correction coefficients (λ) presented in Table 4 (selection correction term) are significant, indicating selection bias related to unobservable factors and justifying the use of the METE model.

3.2.1 Factors affecting the adoption of sustainable agricultural practices

The results of the selection equation from the mixed multinomial logit model (Table 3) show that age has a negative effect on the joint adoption of intercropping and SWCT and the combination of organic fertilisation and SWCT. This can be explained by the fact that, while effective in reducing soil erosion and improving yields, SAPs are labour-intensive. In Burkina Faso, limited agricultural mechanisation increases reliance on manual labour, potentially constraining its adoption among older farmers. Ng'ombe *et al*. (2017) reach similar conclusions.

Membership of a farmer organisation facilitates the adoption of organic fertiliser, SWCT, and the combined adoption of SWCT and intercropping. Indeed, farmers' organisations offer producers a space for exchange and mutual support. In Burkina Faso, access to agricultural inputs and training often depends on the producer's membership of a farmer's organisation. Several studies (Manda *et al*. 2018; Setsoafia *et al*. 2022) have confirmed this effect.

Access to agricultural extension services also plays an important role in SAP adoption. It increases the likelihood of adopting organic fertiliser, the combination of organic fertiliser and SWCT, and the joint adoption of all three SAPs. Agricultural extension services are an important source of information on agricultural technologies in Burkina Faso, facilitating farmers' access to information about these technologies and their use. This result corroborates that of Kone and Uzmay (2024).

The level of education has a negative effect on the decision to adopt a combination of intercropping and organic fertiliser. Higher levels of education often lead to employment opportunities outside agriculture. Therefore, educated farmers may be more inclined to turn to more stable or better-paid income-generating activities, thereby reducing their interest in adopting SAPs. Kone and Uzmay (2024) reach the same conclusions. However, these results contrast with those of Gebremariam and Tesfaye (2018), who argue that more educated households are more aware of the benefits of new technologies.

Access to credit has a positive effect on the adoption of organic fertiliser and SWCT combinations. In developing countries such as Burkina Faso, farmers often face major difficulties in acquiring inputs. Access to credit is therefore an essential lever for overcoming these constraints. However, Ng'ombe *et al*. (2017) found mixed effects, suggesting that the effect of credit access depends on the technology combination adopted and its expected benefits.

Our results indicate that high agricultural income is negatively associated with the joint adoption of organic fertilisers and SWCT. This can be explained by the fact that higher agricultural income can lead to the persistence of traditional practices, particularly if farmers perceive SAPs as risky or if they consider their current methods to be sufficiently profitable. This finding contrasts with that of Goshu *et al*. (2023), who show that higher-income agricultural households are more likely to adopt these innovations due to their greater capacity to bear associated costs and risks.

Non-agricultural activities have a negative effect on the adoption of SAPs. This suggests that, when a household engages in non-agricultural activities, its likelihood of adopting organic fertiliser alone, adopting both intercropping and organic fertiliser, and adopting organic fertiliser combined with SWCT decreases. This trend can be explained by the fact that non-agricultural activities divert time and effort away from agricultural activities, reducing investment in agricultural technologies and the availability of labour. This result is consistent with those of Manda *et al*. (2018) and Kone and Uzmay (2024). However, Setsoafia *et al*. (2022) show that participation in non-agricultural activities promotes the adoption of soil conservation measures.

Land tenure security positively affects the adoption of several SAPs. More specifically, it increases the likelihood of adopting intercropping alone, adopting SWCT, and adopting the combination of intercropping and SWCT. This result can be explained by the fact that farmers with secure long-term access to land are more likely to adopt SAPs, as they can anticipate their long-term benefits. This is consistent with Kassie *et al*. (2013). However, land tenure security negatively affects organic fertiliser use. One possible explanation is that farmers with greater tenure security face less uncertainty and can therefore prioritise investment in cash crops over organic fertilisation practices.

The total cultivated area has a negative effect on the adoption of intercropping alone, and in combination with SWCT and organic fertiliser, but is positively associated with the use of organic fertiliser and its combination with SWCT. Intercropping improves land-use efficiency and is often favoured by households with limited land (Sawadogo *et al*. 2022). Consequently, households with multiple plots tend to be less likely to adopt this technology and its possible combinations with other technologies. However, Manda *et al*. (2018) noted that households with larger areas of land are more likely to adopt SAPs than those with less land.

The use of draft animals is positively associated with SWCT adoption. These animals facilitate soil preparation, particularly for the installation of SWCT structures such as stone ridges or half-moons, which require more intensive tillage, as well as for the transport and spreading of manure, making organic fertilisation more accessible. By reducing the drudgery of agricultural work, draft animals therefore encourage farmers to invest more in these sustainable practices. These results are consistent with those of Manda *et al*. (2018) and Goshu *et al*. (2023).

Finally, although most of the coefficients associated with the gender of the head of household are positive, this variable is not significantly associated with the adoption of SAPs.

3.2.2 Effects of adopting SAPs on household food security

Table 4 presents the estimates of the effect of SAPs on household food security. For comparison purposes, the outcome variables are estimated under the assumptions of exogeneity and endogeneity of the adoption variable. Under the assumption of exogeneity of the adoption variable, the results show that, compared with non-adoption, SAP adoption contributes to better food security, with more significant results for most technology combinations. However, drawing causal conclusions on the basis of the assumption of exogeneity of the SAP adoption variable can be misleading, as it neglects the effect of unrecorded confounding variables.

The average effects of adoption, after unobservable factors are considered, yield slightly different results (Table 4). In general, the adoption of SAPs improves household food security compared with non-adoption. The effect is even more pronounced for the adoption of at least two SAPs. The results indicate that households that adopt SWCT alone are 13.70% more likely to be food secure. In addition, households adopting combinations of intercropping and SWCT, organic manure and SWCT, and the entire technology package are 34.10%, 20.90% and 28.20% more likely to be food secure than non-adopters, respectively. Compared with the exogeneity-based estimates, those accounting for unobserved characteristics are greater, suggesting that ignoring endogeneity would underestimate the real effect of adoption.

The potential reason for this positive effect is that SAPs, in addition to restoring degraded soils, have the capacity to enrich soils, increase production and, in turn, improve the food status of households. With the adverse effects of climate change, agricultural land is becoming increasingly unusable. In this case, the adoption of SAPs becomes more than a necessity. They are essential to ensure sufficient and stable food production for households in the long term. The simultaneous adoption of several SAPs offers farmers advantages linked to the complementarity between these techniques, particularly the better use of soil nutrients and water for production. This approach is particularly relevant for addressing the challenges of water stress, ongoing land degradation and low soil fertility in Burkina Faso.

These findings align with Sen's theory of capabilities, as the adoption of SAPs influences several production factors such as soil fertility, water management and diversification, thereby strengthening households' ability to sustainably improve their food security. They also highlight the role of SAPs as a lever for contributing to the achievement of SDG 2 (Zero Hunger) by promoting more productive and resilient agricultural systems.

Table 3: Factors explaining the adoption of SAPs

Variables	$A_1F_0SWCT_0$		$A_0F_1SWCT_0$		$A_0F_0SWCT_1$		$A_1F_1SWCT_0$		$A_1F_0SWCT_1$		$A_0F_1SWCT_1$		$A_1F_1SWCT_1$	
Gender	0.364	(0.25)	-0.044	(0.16)	0.171	(0.22)	0.025	(0.25)	-0.174	(0.26)	0.398	(0.31)	0.776	(0.53)
Age	-0.001	(0.00)	-0.002	(0.00)	0.002	(0.00)	-0.000	(0.00)	-0.01**	(0.00)	-0.009*	(0.00)	-0.001	(0.00)
Age squared	-0.000	(0.00)	0.000	(0.00)	0.000	(0.00)	-0.000	(0.00)	0.000	(0.00)	0.000	(0.00)	0.000	(0.00)
Active members	-0.060	(0.06)	-0.039	(0.04)	-0.003	(0.06)	-0.055	(0.07)	-0.011	(0.07)	0.061	(0.07)	-0.071	(0.11)
Literacy	-0.180	(0.12)	0.008	(0.08)	0.078	(0.11)	-0.301*	(0.14)	-0.032	(0.15)	0.030	(0.15)	0.147	(0.21)
Animal traction	0.104	(0.15)	-0.141	(0.10)	0.286*	(0.14)	0.022	(0.16)	0.120	(0.17)	-0.115	(0.17)	-0.007	(0.25)
Credit	-0.002	(0.16)	-0.011	(0.11)	0.142	(0.14)	0.050	(0.17)	0.083	(0.18)	0.5***	(0.17)	0.145	(0.26)
Farm income	0.066	(0.05)	-0.040	(0.03)	0.039	(0.04)	-0.050	(0.05)	0.088	(0.06)	-0.057	(0.05)	-0.25**	(0.07)
Off-farm activity	0.000	(0.12)	-0.251***	(0.08)	-0.163	(0.11)	-0.20**	(0.13)	0.118	(0.14)	-0.29**	(0.14)	-0.269	(0.20)
Land tenure security	0.482***	(0.13)	-0.330***	(0.08)	0.430***	(0.12)	0.005	(0.14)	0.950***	(0.17)	0.123	(0.15)	0.615**	(0.24)
Cultivated area	-0.244***	(0.09)	0.550***	(0.06)	-0.40**	(0.08)	-0.010	(0.09)	-0.4***	(0.11)	0.27**	(0.10)	-0.41**	(0.16)
Sahelian zone	-0.094	(0.15)	0.112	(0.10)	-0.013	(0.14)	-0.024	(0.16)	-0.113	(0.18)	0.283	(0.17)	-0.408	(0.28)
Sudano-Sahelian zone	0.095	(0.14)	0.076	(0.10)	-0.125	(0.13)	-0.050	(0.15)	-0.008	(0.16)	-0.074	(0.17)	0.157	(0.23)
Farmer's organisation	0.250*	(0.13)	0.151	(0.09)	0.270**	(0.12)	0.122	(0.14)	0.359**	(0.15)	-0.012	(0.16)	-0.188	(0.25)
Extension services	0.114	(0.12)	0.183**	(0.09)	0.028	(0.12)	0.002	(0.14)	0.109	(0.15)	0.4***	(0.14)	0.391*	(0.21)
Constant	-2.787***	(0.77)	0.192	(0.52)	-2.02**	(0.72)	-0.410	(0.80)	-2.70**	(0.91)	-1.90**	(0.88)	-0.235	(1.24)
Wald $\chi^2(147)$	732.96 ***													

Notes: A = intercropping; F = organic fertiliser; SWCT = soil and water conservation techniques; 1 = adoption; 0 = non-adoption; $A_0F_0SWCT_0$ = non-adoption of all three practices and reference category; *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Standard errors are shown in parentheses.
Source: Survey data (2021)

Maré *et al*. (2022) emphasise that intensifying sustainable agriculture through the adoption of several sustainable agricultural practices could thus be an essential solution to counter declining per capita production and combat food insecurity in sub-Saharan Africa. These findings are consistent with those of Manda *et al*. (2018) in Zambia and Kone and Uzmay (2024) and Sawadogo *et al*. (2025) in Burkina Faso.

Table 4: Effects of SAP adoption on food security

Assumptions	SAPs adoption	Food security	
		Coefficients	SE
Exogenous	$A_1F_0SWCT_0$	0.018	0.026
	$A_0F_1SWCT_0$	0.085***	0.017
	$A_0F_0SWCT_1$	0.010	.0248
	$A_1F_1SWCT_0$	0.040	0.029
	$A_1F_0SWCT_1$	0.049	0.032
	$A_0F_1SWCT_1$	0.080**	0.0325
	$A_1F_1SWCT_1$	0.080	0.047
Endogenous	$A_1F_0SWCT_0$	0.008	0.047
	$A_0F_1SWCT_0$	0.019	0.041
	$A_0F_0SWCT_1$	0.137**	0.055
	$A_1F_1SWCT_0$	0.005	0.050
	$A_1F_0SWCT_1$	0.341***	0.048
	$A_0F_1SWCT_1$	0.209***	0.050
	$A_1F_1SWCT_1$	0.282***	0.065
Selection correction terms	$A_1F_0SWCT_0$	0.013	0.042
	$A_0F_1SWCT_0$	0.090**	0.043
	$A_0F_0SWCT_1$	-0.139**	0.054
	$A_1F_1SWCT_0$	0.040	0.044
	$A_1F_0SWCT_1$	-0.316***	0.038
	$A_0F_1SWCT_1$	-0.132***	0.040
	$A_1F_1SWCT_1$	-0.206***	0.050

Notes: A = intercropping; F = organic fertiliser; SWCT = soil and water conservation techniques; 1 = adoption; 0 = non-adoption; $A_0F_0SWCT_0$ = reference category. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Selection correction term: terms for correcting selection bias.
Source: Survey data (2021)

4. Conclusion

This research aimed to examine the determinants of households' decisions to adopt a combination of SAPs and the effect of this adoption on food security in Burkina Faso. To achieve our objectives, data from the Permanent Agricultural Survey (EPA), covering the 2020–2021 agricultural season, were used. A multinomial regression model with an endogenous treatment effect (METE) was adopted to account for selection bias due to observable and unobservable factors. The results show, on the one hand, that farmers' decisions to adopt a combination of SAPs are influenced by several socioeconomic and demographic factors within households. On the other hand, the results show that the adoption of one or more SAPs improves food security. In addition, the adoption of a combination has greater effects than the isolated adoption of SAPs.

This research therefore suggests an integrated approach to the promotion of SAPs. In particular, strengthening rural vocational training programmes through farmer organisations and agricultural extension services is essential. In addition, the reduction in constraints to adoption and the introduction of incentive measures should encourage wider dissemination of SAPs, thereby helping to improve food security for farm households. Beyond the efforts already made by the government, our results suggest the importance of the combined adoption of SAPs to maximise productivity gains and reduce food insecurity.

This study uses cross-sectional data, limiting causal interpretations despite controlling for endogeneity. Dichotomising the CARI also leads to a loss of information on the severity of food insecurity. Future research could use panel data and exploit the ordinal nature of the CARI to better capture SAP adoption dynamics and varying levels of food insecurity.

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