



OPEN ACCESS

EDITED BY

Marcello De Rosa,
University of Cassino, Italy

REVIEWED BY

Yari Vecchio,
University of Bologna, Italy
Concetta Cardillo,
Council for Agricultural Research and
Agricultural Economy Analysis (CREA), Italy

*CORRESPONDENCE

Farirai Rusere
✉ farirairusere@gmail.com

RECEIVED 11 April 2025

ACCEPTED 23 May 2025

PUBLISHED 10 June 2025

CITATION

Rusere F, Mkuhlani S, Soropa G,
Hunter L, Twine W and Samimi C (2025)
Agrarian transitions in rural Bushbuckridge,
Mpumalanga province, South Africa:
understanding dynamics and determinants.
Front. Sustain. Food Syst. 9:1610323.
doi: 10.3389/fsufs.2025.1610323

COPYRIGHT

© 2025 Rusere, Mkuhlani, Soropa, Hunter,
Twine and Samimi. This is an open-access
article distributed under the terms of the
[Creative Commons Attribution License](#)
(CC BY). The use, distribution or reproduction
in other forums is permitted, provided the
original author(s) and the copyright owner(s)
are credited and that the original publication
in this journal is cited, in accordance with
accepted academic practice. No use,
distribution or reproduction is permitted
which does not comply with these terms.

Agrarian transitions in rural Bushbuckridge, Mpumalanga province, South Africa: understanding dynamics and determinants

Farirai Rusere^{1,2,3,4*}, Siyabusa Mkuhlani⁵, Gabriel Soropa⁶,
Lori Hunter⁷, Wayne Twine¹ and Cyrus Samimi^{2,3,8,9,10}

¹School of Animal, Plant, and Environmental Sciences, Faculty of Science, University of the Witwatersrand, Johannesburg, South Africa, ²Africa Multiple Cluster of Excellence, University of Bayreuth, Bayreuth, Germany, ³Climatology Research Group, University of Bayreuth, Bayreuth, Germany, ⁴Center for Resilient Communities, University of Idaho, Moscow, ID, United States, ⁵International Institute of Tropical Agriculture, Nairobi, Kenya, ⁶Department of Crop Science and Post-Harvest Technology, School of Agricultural Sciences and Technology, Chinhoyi University of Technology, Chinhoyi, Zimbabwe, ⁷Department of Sociology, CU Population Center, Institute of Behavioural Science, University of Colorado Boulder, Boulder, CO, United States, ⁸Department of Geography, Faculty of Biology Chemistry and Earth Sciences, University of Bayreuth, Bayreuth, Germany, ⁹Bayreuth Centre of Ecology and Environmental Research, University of Bayreuth, Bayreuth, Germany, ¹⁰Institute of African Studies, University of Bayreuth, Bayreuth, Germany

In the coming decades, smallholder agriculture in the Global South will experience significant transformations due to environmental challenges, urbanization and demographic shifts. Although current research offers valuable perspectives on agrarian change, few studies have systematically tracked transitions in smallholder agriculture over time. Understanding long-term dynamics and integrating insights from diverse regions and sub-populations are essential for crafting effective and sustainable rural policies. This study employs a mixed-methods approach, combining quantitative longitudinal data from four time points (2010, 2014, 2019, and 2023) with qualitative insights from 10 villages within the Agincourt Health and Demographic Surveillance System site in Bushbuckridge, Mpumalanga Province, South Africa. Through both quantitative modeling and qualitative analysis, we explore agrarian trajectories, revealing trends, determinants, and transitions among various agrarian strategies. The findings emphasize the significant role of migrant and local off-farm employment in influencing the likelihood and level of subsistence farming, highlighting the dynamic nature of agrarian livelihoods. The impact of demographic factors, such as household size and gender, vary across different agrarian strategies. These insights offer valuable guidance for policy and intervention strategies aimed at enhancing rural livelihoods.

KEYWORDS

deagrarianizing, agrarianizing, subsistence farming, agrarian transitions, rural households

Introduction

Approximately 3.4 billion people in low- and middle-income countries of the Global South live in rural areas, with many relying on agriculture for their livelihoods (Giller et al., 2021; Woodhill et al., 2020). These rural populations comprise a significant share of the world's poor and undernourished (Harris, 2019). Transforming smallholder farming through

commercialization has been viewed as a pathway to boosting productivity, improving livelihoods, and reducing poverty (Touch et al., 2024). However, despite these efforts, widespread agricultural transformation, and therefore poverty reduction has not fully materialized (Varga, 2020).

Bryceson (1996) introduced the concept of deagrarianization, highlighting the structural shifts in rural employment patterns in sub-Saharan Africa driven by declining reliance on agriculture and a rise in non-agricultural income sources. This shift continues to resonate in lives, as rural households increasingly diversify their livelihoods, combining on-farm income with off-farm activities such as labor migration (Woodhill et al., 2022). Kelley et al. (2020) and Ragie et al. (2020) document the growing prevalence of labor migration and non-agricultural employment in southeast Asian and South Africa, reflecting this broader trend. Evidence reveals a mix of outcomes: while some households reduce farming activities (Mkhongi and Musakwa, 2022) or abandon land-based activities altogether (Subedi et al., 2022), others persist in smallholder farming, albeit supplemented by off-farm income sources (Giller et al., 2021; Hebinck, 2018). These pathways of agrarian change suggest that shifts are highly context-specific and mediated by factors such as market access, policy interventions, socio-economic conditions, and labor migration dynamics.

Migration, particularly cyclical rural–urban migration, plays a pivotal role in shaping rural livelihoods and agricultural practices. Even so and despite extensive research, the effects of migration on rural agricultural systems remain inconclusive. Migration can simultaneously undermine traditional practices and create opportunities for agricultural modernization. Scholars such as Hebinck et al. (2023) argue that migration-driven labor losses have contributed to deagrarianization, with fewer individuals participating in family farming and more land left uncultivated (Chhetri et al., 2023). Migrants can also leave women and the elderly behind, further altering rural agrarian dynamics including feminization of agriculture (Leder, 2022). These demographic shifts can strain rural labor resources, disrupt sustainable farming practices, and accelerate land abandonment (Maharjan et al., 2020; Suess-Reyes and Fuetsch, 2016).

Conversely, other studies suggest that migration can positively influence agriculture. Remittances enable households to invest in infrastructure, mechanization, and improved inputs, potentially enhancing productivity (Gray and Bilsborrow, 2014; Sugden et al., 2022). For example, in Nepal, remittance-receiving households showed higher agricultural productivity. This is because remittances enabled them to acquire farming equipment and employ advanced techniques, which in turn enhanced agricultural productivity (Kapri and Ghimire, 2020). Bhandari and Ghimire (2016) provide further evidence of a positive association between individual out-migration and agricultural mechanization, particularly tractor use, independent of various community-, household-, and individual-level factors known to influence migration. Similarly, in rural Ecuador and Uganda, migration was associated with more sustainable land use, modern equipment adoption, and consistent agricultural output, though with varying effects on crop diversity (Brewer et al., 2024; Zhao et al., 2021).

Beyond migration, however, a wide array of interconnected determinants shapes rural land use and broader agrarian transitions. Socio-technical transition theories emphasize how changes in technology, infrastructure, institutional frameworks and markets can

foster non-linear and often disruptive shifts in agricultural practices and land use (Geels, 2002; Geels et al., 2023). These transitions often unfold through the co-evolution of technological innovation and policy support, leading to diverse forms of engagement in land-based livelihoods. Crucially, such shifts are mediated by local capacities, political commitment, and cultural contexts, which influence how land use decisions unfold at the household level. Simultaneously, socio-ecological drivers such as climate variability, natural resource availability, and ecological feedback also create complex pathways of land use change (Lambin and Meyfroidt, 2010; Long et al., 2021; Meyfroidt et al., 2010). For instance, prolonged droughts or erratic rainfall patterns can push households to abandon or shift crop types, adopt water-saving technologies (Agamile et al., 2021), or diversify livelihoods away from agriculture altogether (Bansah et al., 2023). Ecological feedback loops, such as those caused by deforestation or overgrazing, may also reduce the resilience of agricultural systems, further influencing land management decisions (Gebeyehu et al., 2023). Critically, the interaction between socio-technical and socio-ecological systems produces path-dependent and place-specific outcomes, where the legacy of past land use decisions, institutional arrangements, and environmental conditions shapes present-day trajectories. These complex interactions highlight the need for integrated analytical frameworks that account for both human agency and biophysical constraints.

These complex and intersecting processes highlight the need for nuanced and context sensitive studies that move beyond singular narratives such as focused on migration alone to explore the multiple, intersecting drivers that shape land use, agricultural productivity, and rural development across different settings (Caulfield et al., 2019). Understanding rural transformation thus requires a holistic, multi-scalar approach that accounts for how structural, institutional, and ecological factors interact over time and space. Such an approach is essential not only to grasp the differentiated outcomes of rural change processes but also to inform the design of equitable and effective poverty-alleviation strategies, climate adaptation policies, and rural development programs that are responsive to local realities and future uncertainties.

In South Africa, rural areas, particularly former apartheid homelands, are home to some of the country's poorest populations, where farming constitutes a primary income source for only a minority of households. Most rely heavily on government social grants (Ragie et al., 2020) which are administered by South Africa's Department of Social Development (DSD), and they target poor individuals from vulnerable demographic groups (Waidler and Devereux, 2019). Furthermore, challenges such as climate change, land access issues, and limited employment opportunities have compounded the struggles of rural dwellers (Cousins et al., 2018). While the National Development Plan 2030 identifies rural agriculture as a potential foundation for economic and social development, achieving this vision requires optimizing land use and addressing labor migration's potential deagrarianizing impacts on farming systems (National Planning Commission, 2012). Yet our understanding of deagrarianization in South Africa is largely drawn from studies in the Eastern Cape (Blair et al., 2018; Hebinck et al., 2018; Shackleton et al., 2019), which predominantly rely on cross-sectional data. While cross-sectional studies are useful for capturing a snapshot of conditions at a specific point in time, they are inherently limited in their ability to trace temporal changes, causality, and household or

community trajectories (Rusere et al., 2024). As a result, these studies often miss the cumulative effects of policy shifts, environmental variability, and socio-economic transitions that unfold over time. They cannot adequately capture how households adapt, intensify, or abandon farming activities across life cycles, generational shifts, or in response to long-term climatic and economic pressures.

To meaningfully understand rural transformation, Barbieri et al. (2021) argue that longitudinal analyses should target distinct cohorts at different stages of development. This approach allows for a more reliable assessment of how life stage and changing household constraints and opportunities shape land use choices. Similarly, Paudel et al. (2019) emphasize the value of mixed-method approaches that further integrate stakeholder perceptions and lived experiences. Such methodologies help unravel the complex dynamics driving change, revealing conditions that foster resilience or vulnerability and exposing the structural constraints that influence land use decisions over time. Importantly, broadening this research beyond the Eastern Cape to other regions of the country characterized by high temporary migration rates (Collinson and Biyase, 2021) can provide new insights into how migration dynamics, socio-economic shifts, and environmental pressures interact to shape present-day trajectories of agricultural land use. This geographic and methodological expansion is crucial for informing more context-sensitive and equitable rural development strategies by recognizing migration as a core livelihood strategy with implications for agrarian change.

This study addresses gaps in understanding by examining rural land use transitions and agricultural transformation in the rural north-east of South Africa. Specifically, we focus on:

- (i) Trajectories of land use
- (ii) Determinants of land use
- (iii) Determinants of land use transitions

By adopting a quantitative longitudinal approach and incorporating the qualitative perceptions and lived experiences of stakeholders, this research offers a comprehensive understanding of the role of migration and other socio-economic factors in shaping land use trajectories and broader rural development processes. These insights will equip policymakers with evidence-based guidance for the development of more targeted and context-sensitive strategies aimed at reducing rural poverty, enhancing food security, and promoting sustainable land use.

Methods

Study site

The study was carried out in the Agincourt Health and Socio-Demographic Surveillance System (AHDSS) site of the Medical Research Council/Wits University Rural Health and Health Transitions Research Unit, in Bushbuckridge Local Municipality, Mpumalanga Province, South Africa. Bushbuckridge is densely populated, encompassing 67 villages ranging in size from 400 to over 2000 households per village (Kahn et al., 2012). This is a legacy of the Apartheid homeland systems in which Black South Africans were uprooted and relocated to these regions between the 1960s and 1980s. These forced removals were part of the broader policy of racial

segregation and aimed at separating Black South Africans from urban areas and economically productive regions, pushing them into under-resourced and overcrowded areas (Aliber and Hall, 2012; Bunce, 2023). Since 1992, the University of the Witwatersrand (Wits) has been conducting an annual census in the study area through the Agincourt Health and Demographic Surveillance System (HDSS) which encompasses 31 villages. Data collection expanded over time, with food security data collection introduced in 2004 and information on farming and natural resource harvesting added in 2010. This long-term data collection framework makes the site well-suited for longitudinal studies on household socio-demographics, livelihoods, and environmental interactions.

Study population livelihood characteristics

Livelihoods in the study area are characterized by diverse formal and informal income sources. These include the small-scale informal sector, trade, home-based micro-enterprises, subsistence farming, and a few individuals engaged in formal employment within social services, nearby private game reserves, and other tourism. A crucial aspect of livelihood strategies is the maintenance of strong rural-urban linkages through temporary migration and remittances (Collinson et al., 2016). A considerable proportion of men, and an increasing number of women, engage in labor migration. In Bushbuckridge, for instance, around 60% of males between the ages of 35–54 years are temporary migrants seeking employment in urban areas or mines while returning periodically to their rural homes during holidays or between contracts (Collinson, 2010). This temporary status is characterized by the migrants' maintenance of strong ties with their home communities, demonstrated through regular remittances, family visits, and an intention to return permanently in later life. These remittances provide a crucial source of income for households which often rely on subsistence agriculture and natural resource harvesting to supplement their income, energy and food requirements (Ragie et al., 2020). Commonly harvested resources include fuelwood, wild foods, medicinal plants, plant fiber, thatching, and construction material (Mbiba et al., 2019). This combination of livelihood activities reflects the diverse strategies employed by rural households to secure their livelihoods and meet essential needs.

Data collection

This research uses data from two studies: (i) the Sustainability in Communal Socio-Ecological Systems (SUCSES) survey and (ii) the socio-ecological drivers of movement into and out of African woodlands study. Both focus on households in 12 villages within the Agincourt Health and Socio-Demographic Surveillance System (HDSS), selected through a stratified random sample to account for spatial variability in rainfall and village sizes.

The SUCSES study aims to understand the dynamic interactions between people, their livelihoods, and the natural environment in rural communities, particularly how these interactions affect household food security. It is a longitudinal research project that collects household data on various livelihood activities, including subsistence agriculture, external field cropping, livestock ownership,

off-farm employment, access to social grants, and household demographics. Data has been gathered through annual interviews with a knowledgeable adult household member for the years 2010–2014, and again in 2019 and 2021. The study began with 590 households in 2010, and by 2021, 493 households remained in the sample.

The woodlands study explores the relationships between human movement, environmental changes, and social values to evaluate socio-ecological sustainability and migration. It uses a mixed-method approach, combining focus group discussions with a quantitative household survey in 2023. We conducted 9 focus group discussions in 2022 and 10 in 2023, focusing on land-based livelihoods, environmental change, and migration and involved 98 and 101 area residents in 2022 and 2023, respectively (Demographic presented in Table 1). More specifically, participants shared their perceptions on (i) the viability of land-based livelihoods, (ii) changes in environmental conditions, focusing on climate, landscape structure, composition, and social values, and (iii) factors prompting temporary migration to urban areas. These discussions were held in villages where the SUCSES study is nested within the Agincourt Health and Socio-Demographic Surveillance System (HDSS). In 2023, we conducted a survey of 250 households that were randomly selected from the participant pool of the SUCSES study. Topics included subsistence crop production, livestock farming, environmental change, migration, and values attached to the environment. To ensure effective communication, experienced field workers from the community conducted surveys and focus group discussions in the local language (XiTsonga). This study draws on data from two sources: the longitudinal SUCSES household surveys conducted in 2010, 2014, and 2019, and the 2023 Woodlands cross-sectional study, which was nested within the same study sites. Together, these four rounds form the longitudinal panel used in our analysis.

Data preparation

From the survey data, we compiled household demographic measures including (i) household size -the total number of household members including temporary migrants, (ii) gender ratio -proportion males to females in a household, (iii) dependency ratio -proportion of non-working age groups (youth and elderly, <16 and ≥65 years) to the working-age group (>15 < 65 years), (iv) gender of the household head - expressed as 0 = female and 1 = male.

We also compiled household economic measures including (i) local off-farm employment ratio- number of self-employed and employed permanent resident members expressed as a proportion of total employed members, (ii) migrant employment ratio - number of self-employed and employed household members who have temporarily migrated expressed as a proportion of total employed members (iii) social grants value - the total monthly financial support received by a household for child support, foster care, disability and old age pension received from government.

The variables related to engagement in subsistence agriculture included whether households were involved in crop production (0 = no, 1 = yes) and where the crops were planted (Y = yard, F = field, B = both yard and field). We then created a new classification

for household agricultural engagement. Households not engaged in any cropping activity were classified as *non-farming* households. Those cropping in the household yard only were classified as *small-scale subsistence* households. Households cropping in the fields outside the homestead or both in the yard and fields outside the homestead were classified as *large-scale subsistence* households.

Analytical approach

This study draws data from two related studies: a longitudinal study with panel survey data collected in 2010, 2014, and 2019, and a cross-sectional study conducted in 2023 that was nested within the longitudinal study design. The 2023 survey revisited a subset of households from the earlier waves, allowing for longitudinal comparison. Descriptive analysis of household demographics and livelihood strategies was conducted for all households surveyed in each wave. However, to ensure consistency in tracking changes over time, the longitudinal analysis focused on a balanced panel of 250 households that were present in all four survey rounds (2010–2023). We examined transitions in household land use across three-time intervals: 2010–2014, 2014–2019, and 2019–2023. While these intervals include overlapping years (i.e., 2014 and 2019), the approach reflects a sequential, wave-to-wave analysis common in longitudinal research, where each time point serves as both an endpoint for one transition and a baseline for the next. This structure allows us to capture changes in land use behavior as they unfold over time and provides a more granular understanding of dynamic livelihood transitions, rather than limiting analysis to non-overlapping, arbitrarily defined intervals. By anchoring transitions to actual survey years, we ensure that observed changes are grounded in empirical data rather than interpolated assumptions. Our approach follows a method introduced by McPeak and Little (2017), which classifies households into three transition types. Deagrarianizing households represent those dropping out of agricultural activities regardless of whether previously engaging in large- or small-scale subsistence agricultural activities. Agrarianizing households are those moving into subsistence agriculture from previously engaging in none, and those moving from small-scale to large-scale subsistence agricultural activities. Persisting households were those that did not transition.

We then used two regression models to estimate the determinants of (i) land use categories and (ii) their transitions to deagrarianizing or agrarianizing. We first perform discrete choice modeling on land use categories, assessing the determinants of households' likelihood of belonging to a specific land use category. In our multinomial logistic regression model (MNL), the probability P_{ij} that a household (i), engages in land use activities (j), can be expressed as a function of the independent variables (xi) as follows in Equation 1:

$$\text{Prob}(LS_i = j / x) = \frac{\exp(x^i \beta_j)}{1 + \sum_{h=1}^3 \exp(x^i \beta_h)} \quad (1)$$

Where β_j is a $K \times 1$ vector with each household having an equal chance to be in category $j = 1, 2, \dots, J$.

TABLE 1 Demographic characteristics of focus group participants in 2022 and 2023.

Year		FGD ¹	FGD ²	FGD ³	FGD ⁴	FGD ⁵	FGD ⁶	FGD ⁷	FGD ⁸	FGD ⁹	FGD ¹⁰	Total
2022	Number of participants	10	10	14	9	13	10	10	11	11		98
	Sex											
	Male	7	5	7	5	6	5	2	5	2		44
	Female	3	5	7	4	7	5	8	6	9		54
	Age group											
	18–29	2	2		2		2		3	2		13
	30–39	3	1	4	2	3		2		1		16
	40–49	1	3	3	3	5	2	5	1	1		24
	50–59	1	1	1		3		2	2	3		13
	60–69	3	3	3	1	1	4		1	3		19
	70–79			3		1	2		3			9
	80+				1			1	1	1		4
	Occupation											
	Unemployed	6	8	8	4	11	2	7	3	8		57
	Employed	2	1	0	4		3	1	2	2		15
	Pensioners		1	5	1	2	5		6	1		21
	Farmers	2		1								3
	Traditional healer							2				2
2023	Number of participants	10	9	13	8	11	6	10	12	10	11	101
	Sex											
	Male	4	4	6	3	5	2	2	5	4	4	39
	Female	6	5	7	5	6	4	8	7	6	7	62
	Age group											
	18–29		3	2	1	2	3		1	1	2	15
	30–39	3	2	1	2	1	1	2	2	1	4	19
	40–49	3		2	2	2		5	1	2	2	19
	50–59	1	1	3	2	4	1	2	4	2	1	21
	60–69	2		3		2			4	3	1	15
	70–79	1	3	1	1		1			1	1	9
	80+			1				1				2
	Occupation											
	Unemployed	8	6	5	4	4	2	7	3	2	4	45
	Employed			2	4	5	3	1	9	3	5	32
	Pensioners	2	3	6	1	2	1			5	2	22
	Farmers											
	Traditional healer							2				2

¹Agincourt, ²Cunningmore, ³Ireagh A, ⁴Ireagh B, ⁵Lilydale, ⁶Justicia A, ⁷Justicia B, ⁸Kildare, ⁹Xanthia ¹⁰Huntington.

The reference category was non-farming with the outcome, LS_i involving two independent land use categories engaged by households: small scale subsistence and large-scale subsistence. A statistical significance level of 5% was used as the basis for discussion and the models included demographic characteristics

(i.e., gender and age of the household head, household size, dependency and gender ratios) as well as the value of social grants, migrant employment and off farm employment ratios in explaining the outcome variables (land use categories) using the model.

$$\ln \left[\frac{P}{1-P} \right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_n$$

Where $\ln \left[\frac{P}{1-P} \right]$ is the odds ratio α is the intercept, $\beta_1, \beta_2, \dots, \beta_n$

represent the coefficient to be estimated while $X_1, X_2, \dots, X_n$ represent the set of explanatory variables.

$$\ln \frac{P}{1-P} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_n$$

The second model represented the transition processes according to three specific periods where the probability P_{ij} that a household (i), is in a transition status (j), can be expressed as a function of the independent variables (x_i) as follows in Equation 2:

$$\text{Prob}(LS_i = j / x) = \frac{\exp(x^i \beta_j)}{1 + \sum_{h=1}^3 \exp(x^i \beta_h)} \quad (2)$$

Where β_j is a $K \times 1$ vector with each household having an equal chance to be in category $j = 1, 2, \dots, J$.

The reference category was “persisting with the outcome, LS_i involving two independent transition state categories namely: to deagrarianizing or agrarianizing (outcome variables). Predictors remained the same as those in the first model.

$$\ln \left[\frac{P}{1-P} \right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_n$$

Where $\ln \left[\frac{P}{1-P} \right]$ is the odds ratio α is the intercept, $\beta_1, \beta_2, \dots, \beta_n$

represent the coefficient to be estimated while $X_1, X_2, \dots, X_n$ represent the set of explanatory variables.

$$\ln \left[\frac{P}{1-P} \right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_n$$

All quantitative analyses were carried out with R within the RStudio environment (R Core Team, 2023).

In terms of the qualitative analyses, focus group discussions were recorded and fully transcribed after participants consented. The transcripts were coded using MAXQDA. First, we coded the transcripts to extract relevant text elements related to farming and grouped them into categories (Creswell, 2009; Flick, 2015). In the second round, we focused on extracting text about the challenges of subsistence agriculture and how these challenges might lead to abandoning it. Thirdly, we extracted text on the drivers of farming in the study area. This process resulted in detailed scripts highlighting different viewpoints on the viability of subsistence agriculture, its importance and challenges in the lives of rural households. The scripts were then summarized into coherent narratives connected to different demographic groups. We triangulated the findings from

regression analysis with participants' perceptions from the focus group discussions, analyzed through MAXQDA, to provide a more comprehensive perspective.

Results

Trends and descriptive statistics

Table 2 presents household descriptive characteristics by land use. There was significant variation across years, with a notable increase in abandonment of agricultural activities in 2019 (62% of households were not involved in agricultural activities (non-farming) compared to 5.3, 4.1 and 10.2% in 2010, 2014 and 2023 respectively). The percentage of households in small-scale subsistence remained relatively stable but peaked in 2023 (61.1%), indicating a resurgence in this category. Households in large-scale subsistence showed a decline over time, with the highest representation in 2010 (40.7%) but dropping to 28.7% by 2023. These patterns are further illustrated in Figure 1, which displays the shifts in agricultural engagement across years and villages. At the village level, non-farming households increased in most areas, small-scale subsistence households rose in select villages like Huntington, Justicia A, Kildare A, Kildare B, and Ireagh A, and large-scale subsistence households declined in all but Xanthia. Households engaged in large-scale subsistence exhibited the most distinctive characteristics as they had the largest average household size, more male and older household heads and the highest dependency ratios. Large-scale subsistence households also received significantly higher mean social grants value (Table 2). Household demographic characteristics at the village level are presented in the Supplementary Tables 1–4.

Determinants of land use

Significant predictors of agricultural engagement included gender and age of the household head, household size, and ratios of household gender, dependency, migrant employment and off farm employment (Table 3). Specifically, male-headed households had 54% greater likelihood of engaging in large scale subsistence agricultural activities ($OR = 1.54, p < 0.01$), while larger households were 24 and 14% more likely to engage in either large- or small-scale subsistence agricultural activities, respectively, compared to not being engaged in agricultural activities. Government grants and the age of the household head had minimal impact, whereas participation in migrant employment and off-farm employment significantly boosted the odds of subsistence farming. These findings suggest that socio-economic factors and access to resources play crucial roles in determining agricultural states among households.

Transition of households in land use categories (2010–2023)

We analyzed the transition of households among three land use categories non-farming, small-scale subsistence, and large-scale subsistence over six different time periods: 2010–2014, 2010–2019, 2010–2023, 2014–2019, 2014–2023, and 2019–2023. The results are

TABLE 2 Descriptive characteristics.

Year	Characteristic	Non-farming	Large scale subsistence	Small scale subsistence	<i>p</i> -value ¹
2010	Percentage of households	5.3%	40.7%	54%	
	Household size	7.31 (4.29)	9.86 (5.65)	7.27 (3.52)	<0.01
	Dependency ratio	0.47 (0.26)	0.52 (0.44)	0.47 (0.37)	0.70
	Gender ratio	1.03 (0.76)	0.98 (0.65)	1.09 (0.79)	0.8
	Gender of household head				0.4
	Female	1.6%	14.4%	23.5%	
	Male	3.7%	26.3%	30.5%	
	Age of household head	42.62 (10.28)	54.15 (13.84)	49.67 (14.31)	<0.01
	Local off-farm employment ratio	0.19 (0.34)	0.15 (0.27)	0.14 (0.20)	0.90
	Migrant employment ratio	0.28 (0.28)	0.18 (0.18)	0.23 (0.24)	0.20
	Social grants value	646.92 (576.60)	1,439.80 (1,133.88)	809.31 (730.77)	<0.01
2014	Percentage of households	4.1%	38.4%	57.5%	
	Household size	5.56 (3.64)	9.63 (5.28)	7.87 (3.94)	<0.01
	Dependency ratio	0.27 (0.43)	0.46 (0.35)	0.40 (0.54)	0.07
	Gender ratio	1.16 (1.34)	0.99 (0.63)	1.09 (0.76)	0.90
	Gender				0.70
	Female	1.4%	15.5%	26.0%	
	Male	2.7%	22.8%	31.5%	
	Age of household head	47.22 (10.59)	58.11 (13.06)	52.52 (13.75)	<0.01
	Local off-farm employment ratio	0.24 (0.38)	0.18 (0.27)	0.16 (0.20)	0.90
	Migrant employment ratio	0.23 (0.17)	0.23 (0.21)	0.23 (0.20)	0.90
	Social grants value	632.22 (1,120.40)	1,945.60 (1,470.75)	1,351.75 (1,136.73)	<0.01
2019	Percentage of households	62.0%	8.3%	29.6%	
	Household size	6.47 (3.66)	8.83 (5.11)	6.78 (3.74)	0.20
	Dependency ratio	0.35 (0.41)	0.49 (0.44)	0.46 (0.58)	0.30
	Gender ratio	1.08 (0.99)	1.09 (0.94)	1.16 (0.97)	0.80
	Gender				0.70
	Female	30.6%	3.2%	14.4%	
	Male	31.5%	5.1%	15.3%	
	Age of household head	55.35 (13.44)	62.39 (14.45)	57.14 (12.55)	0.11
	Local off-farm employment ratio	0.16 (0.23)	0.08 (0.14)	0.20 (0.24)	0.14
	Migrant employment ratio	0.14 (0.20)	0.34 (0.31)	0.18 (0.23)	<0.01
	Social grants value	1,626.12 (1,535.65)	2,825.72 (1,550.63)	1,648.02 (1,457.51)	<0.01
2023	Percentage of households	10.2%	28.7%	61.1%	
	Household size	7.12 (3.46)	9.34 (4.65)	9.01 (4.70)	0.14
	Dependency ratio	0.39 (0.34)	0.37 (0.29)	0.40 (0.30)	0.90
	Gender ratio	1.36 (1.50)	0.97 (0.86)	1.08 (0.83)	0.40
	Gender				0.05
	Female	3.7%	11.1%	34.0%	
	Male	6.6%	17.6%	27.0%	
	Age of household head	55.60 (14.79)	60.76 (11.36)	59.28 (13.89)	0.11
	Local off-farm employment ratio	0.12 (0.22)	0.19 (0.18)	0.15 (0.18)	0.05
	Migrant employment ratio	0.12 (0.25)	0.04 (0.08)	0.06 (0.12)	0.70
	Social grants value	1,973.20 (1,877.72)	2,605.14 (1,973.04)	2,536.17 (2,019.62)	0.30

¹Kruskal-Wallis rank sum test; Pearson's Chi-squared test; Mean (SD) n/(N).

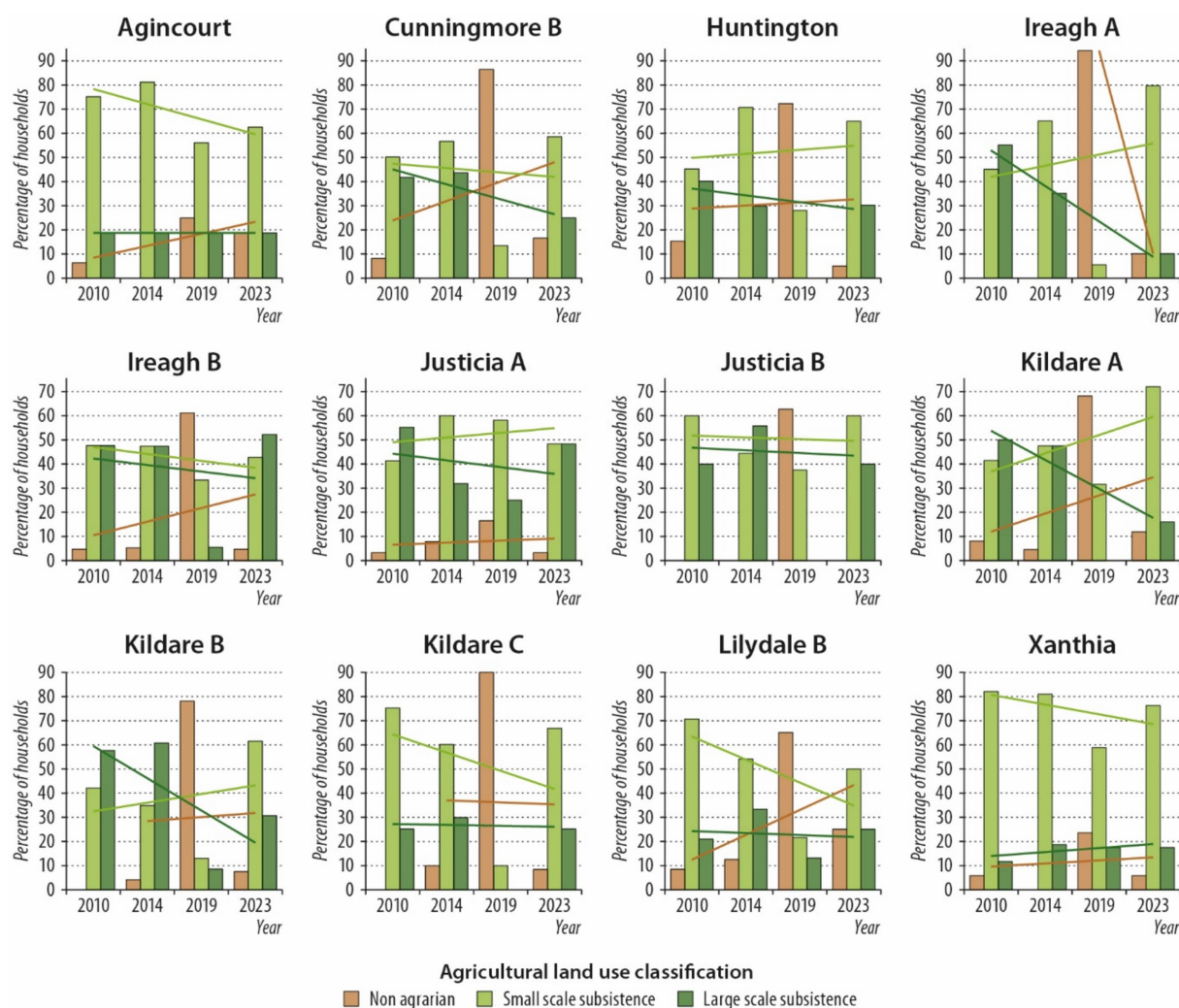


FIGURE 1
Village-level trends in household land use trajectories.

summarized in Figure 2. There has been a consistent movement towards small-scale subsistence farming, with the highest transitions from large-scale subsistence to small-scale observed over the 2014–2023 and 2010–2023 periods. Notably, 19.18% of households transitioned from large-scale subsistence to small-scale farming from 2014 to 2023, and 20.58% from 2010 to 2023. During the period 2019–2023 there was a notable transition from non-farming to small-scale subsistence with 39.35% of non-farming households transitioning into this category. Conversely, there is a slight increase in households transitioning to the non-farming category over time, with notable spikes in transitions to this category between 2010–2019 and 2014–2019. The data indicates a substantial restructuring of agrarian states towards small-scale subsistence farming.

Determinants of land use transitions

Table 4 revealed several significant results for both deagrarianizing and agrarianizing households across the three transition periods (2010–2014, 2014–2019, and 2019–2023). For deagrarianizing, the migrant

employment ratio was notably significant, showing a strong negative association in the earlier periods (2010–2014: OR = 0.89, $p < 0.01$; 2014–2019: OR = 0.29, $p < 0.01$), but a marked positive association in the most recent period (2019–2023: OR = 9.81, $p < 0.01$). The local off-farm employment ratio showed a significant negative association in 2014–2019 (OR = 0.52, 95% CI: 0.51–0.54, $p < 0.05$), and a strong positive association in 2019–2023 (OR = 16.3, 95% CI: 16.2–16.5, $p < 0.05$). Additionally, the dependency ratio was negatively and significantly associated with deagrarianizing in 2010–2014 (OR = 0.26, $p < 0.05$), while in 2019–2023 it showed a weak positive association (OR slightly above 1). The age of the household head was negatively and significantly associated only in 2010–2014 (OR = 0.98, $p < 0.05$). The gender of the household head also played a role, with male-headed households showing a significant negative association with deagrarianizing in 2019–2023 (OR = 0.59, $p < 0.01$). In terms of agrarianizing, significant negative associations were observed for the dependency ratio in 2014–2019 (OR = 0.73, $p < 0.01$) and significant positive associations in 2019–2023 (OR = 1.74, $p < 0.01$). The migrant employment ratio was positively and significantly associated with agrarianizing during the period 2010–2019 (ORs ranging from 1.88 to 13.88, $p < 0.001$), while in 2019–2023 it

TABLE 3 Model summary for multinomial logistic regression predicting land use.

Land use category	Term	Estimate	Std. error	Statistic	P-value
Large-scale subsistence	Intercept	−2.32	0.02	−148.82	<0.001***
	Gender of household head	0.43	0.07	6.52	<0.001***
	Household size	0.21	0.03	7.19	<0.001***
	Gender ratio	−0.26	0.12	−2.20	0.03*
	Age of the household head	0.02	0.00	3.57	<0.001***
	Migrant employment ratio	0.79	0.00	187.81	<0.001***
	Local off-farm employment ratio	0.83	0.01	74.80	<0.001***
	Social grants value	0.00	0.00	−2.48	0.01*
	Dependency ratio	0.59	0.08	7.11	<0.001***
Small-scale subsistence	Intercept	0.09	0.02	5.09	<0.001***
	Gender of household head	−0.13	0.08	−1.62	0.11
	Household size	0.13	0.03	4.74	<0.001***
	Gender ratio	−0.05	0.09	−0.50	0.61
	Age of the household head	0.00	0.00	−0.06	0.95
	Migrant employment ratio	0.51	0.00	160.64	<0.001***
	Local off-farm employment ratio	0.29	0.01	23.77	<0.001***
	Social grants value	0.00	0.00	−2.28	0.02*
	Dependency ratio	0.44	0.10	4.58	<0.001***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

showed a significant negative association (OR = 0.14, $p < 0.05$). Furthermore, the local off-farm employment ratio consistently showed a significant positive association for the periods 2014–2019 and 2019–2023 (ORs ranging from 4.37 to 6.04, $p < 0.01$), while male-headed households were positively and significantly associated with agrarianizing in 2014–2019 (OR = 2.99, $p < 0.01$).

Perceptions revealing drivers of agricultural transitions

Deagrarianization

The focus group participants emphasized that their communities are increasingly transitioning from subsistence-based agricultural livelihoods to non-farm activities due to persistent challenges in agricultural productivity. A recurring theme in the discussions was the adverse impact of climate change and variability, particularly the shortage and unpredictability of rainfall, on farming practices. One community member articulated the following:

Since I became accustomed to farming, I have been encountering a situation of not harvesting anything in my fields, so I have decided to move to Gauteng for hustling. The shortage of rainfall pushes us to migrate, since we depend on our farms.

For many rural households, household hardships arise because subsistence agriculture is no longer able to provide sufficient food nor generate sufficient income. Thus, many have searched for off-farm livelihood opportunities. Others emphasized drought, climate change, and their inability to adapt as a reason for agricultural abandonment. For example, one participant noted:

These changes in climate have negatively impacted us. After planting various crops on our farms, droughts often come and destroy them, making it very challenging. When the rain falls normally, we can harvest, but when it does not, we suffer greatly in terms of our harvest. Hence, we are now going to Johannesburg to look for work.

Another participant echoed the following.

Since the rainy season has changed, we are no longer producing anything on our farms.

Others pointed to crop damage by livestock, particularly cattle, as a major factor in deagrarianisation. One participant pointed out that:

My concern is animals because they are left to enter our farms and eat our crops so in that way it's difficult for us to produce.

Another participant shared similar sentiments:

We have a huge space for farming (ploughing) but I'm concerned about the livestock because they enter in our farms and eat so at the end we cannot produce anything, so we do not know where we are supposed to get help in these matters.

These findings point to weak enforcement of governance structures resulting in crop losses, although others describe land scarcity as influential:

The first challenge that we encounter it's a shortage of space to farm, most people have interest on farming, but we do not have a space, yes, we do have a shortage of rain but if we do have a space for farming, I think we will farm and reap that much.

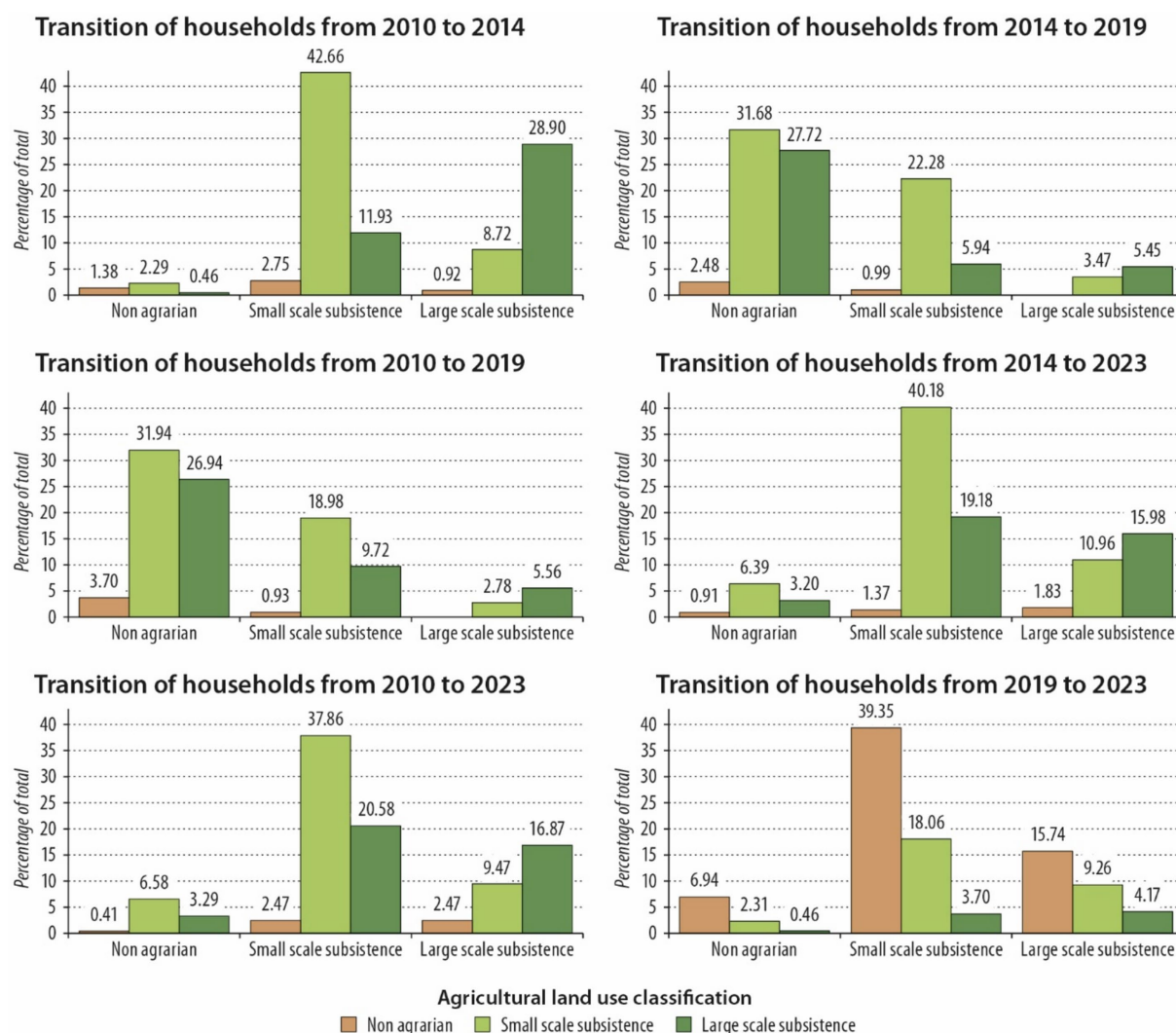


FIGURE 2
Households agricultural transitions (2010–2023).

Others attributed deagrarianization to lack of interest:

We no longer value farming as we did in the past, unlike our parents. I believe there is no future in traditional agricultural activities. Attempts to involve our children in farming have been unsuccessful; they see it as unimportant.

Others echoed:

There is no future for agricultural activities, especially for our young generations because it seems like they are not interested even in learning, they refuse even to eat traditional food.

Finally, others attributed deagrarianization to lack of resources:

We face several challenges in farming, including a lack of resources, materials, and funds. In the past, we used cattle for plowing, but now we need to hire tractors, which we cannot afford due to financial constraints. With no cattle available and no money to hire machinery, it may appear that I'm uninterested or

lazy, but the reality is that we lack the necessary resources and support for farming.

These findings underscore the key drivers behind deagrarianization in the study communities. The shift from subsistence farming to non-farm activities is largely driven by climate change and environmental challenges. Droughts and erratic rainfall have diminished crop yields, while farmlands are increasingly compromised by livestock intrusion and inadequate rangeland governance. This has severely constrained local food production. Moreover, the lack of resources and financial means exacerbates the shift away from traditional agricultural practices. These narratives highlight critical challenges in rural agriculture and underscore the urgent need for targeted support to address these issues and bolster agricultural resilience.

Agrarianization

Perceptions of drivers of agrarianizing indicate that despite numerous challenges, some individuals still choose to move into and continue engaging in agriculture. Many focus group participants indicated that farming is a vital source of food. One said:

TABLE 4 Model summary for multinomial logistic regression predicting land use transitions.

Outcome	Transition period	2010–2014		2014–2019		2019–2023	
	Characteristic	OR	95% CI	OR	95% CI	OR	95% CI
Deagrarianizing	Household size	1.03	0.93, 1.15	1.00	0.91, 1.09	1.02	0.85, 1.22
	Gender ratio	1.23	0.76, 2.01	0.88	0.65, 1.19	1.05	0.61, 1.82
	Dependency ratio	0.26*	0.08, 0.78	1.02	0.52, 2.00	1.02**	1.00, 1.03
	Age of the household head	0.98*	0.95, 1.00	1.00	0.99, 1.01	1.01	0.99, 1.04
	Migrant employment ratio	0.89***	0.86, 0.93	0.29***	0.28, 0.30	9.81***	9.78, 9.84
	Local off-farm employment ratio	1.07	0.65, 1.73	0.52***	0.51, 0.54	16.3***	16.2, 16.5
	Gender of the household head						
	F	—	—	—	—	—	—
	M	0.82	0.38, 1.77	0.88	0.51, 1.50	0.59***	0.51, 0.68
	Social grants value	1.00	1.00, 1.00	1.00	1.00, 1.00	1.00	1.00, 1.00
Agrarianizing	Household size	0.93	0.81, 1.07	0.87	0.67, 1.12	1.06	0.97, 1.16
	Gender ratio	1.03	0.61, 1.74	0.57***	0.56, 0.59	0.88	0.65, 1.21
	Dependency ratio	0.90	0.35, 2.28	0.73***	0.67, 0.79	1.74***	1.69, 1.78
	Age of the household head	1.00	0.98, 1.03	1.06***	1.04, 1.09	1.00	0.98, 1.01
	Migrant employment ratio	1.88***	1.74, 2.02	13.9***	13.5, 14.0	0.14***	0.14, 0.14
	Local off-farm employment ratio	0.36***	0.31, 0.41	4.37***	4.34, 4.41	6.04***	5.87, 6.22
	Gender of the household head						
	F	—	—	—	—	—	—
	M	0.88	0.40, 1.95	2.99***	2.77, 3.22	0.64	0.38, 1.07
	Social grants value	1.00	1.00, 1.00	1.00	1.00, 1.00	1.00	1.00, 1.00

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Good morning, everyone. I'll be straightforward. In the past, we did not rely on supermarket food. We ate what we grew from this soil—mealies, sorghum, peanuts, sweet potatoes, and cassava. We harvested and consumed what we cultivated when we still had good rains.

Even with limited contribution, farming remains an important supplementary income source for some households:

The benefit of farming to these households is financial support. By harvesting crops from their fields and selling them, they can generate income, allowing them to purchase items that are not available on their farms.

In addition to the financial benefits, others highlighted farming's health benefits of farming:

For us older people farming is very important because it benefits us in various ways, such as providing food, exercise, and promoting health. I've noticed that many elderly people now suffer from diabetes and hypertension, which I believe is caused by the food we eat today. When we consumed food from our fields, we were not sick. I remember grinding mealies using a traditional grinder-it was tough, but we stayed healthy. Even our children were strong and fit. Nowadays, our children are overweight due to the food from the supermarkets they eat.

Some noted farming as integral to culture, enabling farmers to grow cultural foods that contribute to their health and wellbeing. As one of the participants stated:

We cultivate pumpkins and produce a dish called “tshopi.” To make “tshopi,” we peel the pumpkins and cook them with ground peanuts. This way, our kids grow up knowing and enjoying “shopi.”

Another echoed:

We plough and cultivate peanuts in our fields, which we use to make “xigugu.” Xigugu is a dish made from ground mealies, sugar, salt, and peanuts. By preparing “xigugu” and adding peanuts to our vegetables, we ensure our children grow up familiar with these traditional foods.

Furthermore, the availability of resources and infrastructure plays a crucial role in driving farming practices. In contrast to areas with access to irrigation, where households successfully grow and sell crops, other areas face severe challenges due to a lack of irrigation infrastructure. As one participant described:

In places like Tsuvulani, people have managed to thrive because they have access to irrigation. They grow mealies, vegetables, and sweet potatoes, which they sell to other villages. In contrast, here in Xanthia we lack irrigation infrastructure, so we depend entirely on rainfall. If it does not rain, we face food shortages.

This disparity illustrates that access to resources and infrastructure, such as irrigation, significantly influences people's ability to engage in successful farming.

Overall, the insights from the focus group discussions reveal a complex interplay of factors driving (de)agrarianizing in rural communities. Despite numerous challenges, including limited resource access, erratic climate conditions, and infrastructural deficiencies, farming remains a cornerstone of rural life. It provides crucial financial support and maintains cultural practices that promote health and wellbeing. The ability to farm effectively is heavily influenced by the availability of resources such as irrigation, which significantly impacts the success of agricultural endeavors.

Discussion

This work has shown the overall levels of engagement as well as changes in subsistence agricultural activities over the years in rural Bushbuckridge, South Africa. The analysis of household transitions among agrarian categories from 2010 to 2023 reveals significant trends including consistent shift from large-scale subsistence towards small-scale subsistence farming, accompanied by a reduction in cropped areas. This reflects a restructuring of agrarian systems, likely driven by household adaptation to socio-economic changes and environmental pressures. Alongside these transitions towards small-scale farming, there is also a marked decrease in large scale subsistence households and a marked increase in non-farming households over time, although notable spikes in transitions to these categories occurred between 2019–2023 and 2014–2019, respectively. Even against the backdrop of general trends, there is important dynamism, with some households abandoning and others resuming or expanding agricultural activities at any given time. Hebinck et al. (2018) and Shackleton et al. (2019) observed similar patterns of disengagement from agriculture by rural households in the Cwebe communities in the Eastern Cape during the periods 2009–2015. They noted that households in the Eastern Cape also exhibited significant shifts towards non-farming activities, driven by socio-economic and environmental pressures.

The marked increase in subsistence farming from 2019 to 2023 could also be attributed to the COVID-19 pandemic. As many people lost jobs and returned to their homes in rural areas, they turned to farming to sustain their livelihoods. This period exemplifies the dynamism of agricultural activity and highlights key drivers and triggers of agrarian trends. It also reveals the importance of land-based activities as safety nets in periods of crises as households adapt to navigate socio-economic and environmental challenges. Given this context, we exercise caution in interpreting post-2019 data and refrain from characterizing it as part of a broader trajectory. Instead, we identify this period as a potential anomaly necessitating further investigation to understand whether these shifts persist or revert to pre-pandemic patterns. This nuanced approach underscores the importance of situating agricultural engagement trends within their broader socio-economic and environmental contexts, particularly during periods of significant disruption. Understanding the impact of unexpected events, such as the COVID-19 pandemic, is crucial in formulating responsive and adaptive strategies to support rural households.

The multinomial logistic regression analysis identifies several key determinants of agricultural engagement: the gender of the household head, household size, migrant employment ratio, and off-farm employment ratio. Male-headed households and larger households are

more likely to engage in large-scale subsistence farming, likely due to gendered disparities in land ownership, access to capital, and labor mobilization. In rural South Africa, women in particular have limited access and ownership to land compared to men (Masuku et al., 2023), hence have a limited capacity for expanding agricultural activities. Additionally, male-headed households have better access to financial resources such as remittances (Posel et al., 2023). Finally, their ability to mobilize labor is also a crucial factor, as men are often positioned to coordinate household and hired labor for farming, particularly for labor-intensive staple crop production (Shackleton et al., 2020). These structural advantages contribute to the higher likelihood of large-scale subsistence farming among male-headed households.

Participation in migrant employment and local off-farm employment also significantly increases the likelihood of subsistence farming. Migrants and local off-farm employment are sources of financial resources that support agricultural activities. This suggests that households with migrant and local off farm labor are more likely to engage in farming because of a strong financial resource base. These results are consistent with Caulfield et al. (2019), who observed that temporary migration and income from off-farm employment boosted the financial resources of sending farming families, leading to investments in cropping and greater use of modern agricultural technologies such as agro-chemicals and mechanized tillage. This aligns with the narrative from the focus group discussions, where participants highlighted the importance of external financial resources in supporting agricultural activities.

The determinants of agrarian transitions, particularly deagrarianization, were examined across three transition periods: 2010–2014, 2014–2019, and 2019–2023. The analysis reveals a shifting role of migrant and local off-farm employment in influencing these transitions. During the earlier periods, the migrant employment ratio was negatively associated with deagrarianization, indicating that higher levels of migrant employment were linked to a reduced likelihood of exiting agriculture. This pattern suggests that remittances from migrant labor may have supported continued agricultural engagement, possibly by easing liquidity constraints, a finding that aligns de Brauw et al. (2014), who argue that rural–urban migration in sub-Saharan Africa can support structural transformation through agricultural investment enabling households to persist or expand agriculturally based activities, rather than abandoning them. However, a major shift occurred in the 2019–2023 period. During this time, both the migrant employment ratio and local off-farm employment became positively and significantly associated with deagrarianization. This reversal implies that in recent years, off-farm economic opportunities, whether local or through migration have begun to pull labor and resources away from agriculture, contributing to the disengagement from farming activities. This shift is consistent with findings by Hajdu et al. (2020) who observed similar trends of rural households moving away from agriculture due to increased dependence on off-farm income sources.

The dependency ratio was a significant factor in agricultural transitions across the observed periods, showing mixed effects on deagrarianization and agrarianization. A high dependency ratio, which indicates a larger proportion of aged individuals and children relative to active adults, can lead to both outcomes. Households with high dependency burdens may experience labor shortages as active adults seek off-farm employment, leading to reduced agricultural labor. Conversely, households may reinvest income from remittances or social grants into farming. In rural South Africa, social grants often make up a substantial share of household income, serving as a crucial

buffer against poverty and economic shocks. These financial inflows can enable households to maintain or even upscale agricultural activities, supporting input purchases, labor hiring, or land expansion. Thus, the impact of the dependency ratio on agricultural transitions is influenced by how households manage labor and financial resources, resulting in the observed mixed outcomes.

The focus group discussions offered valuable qualitative insights into the drivers of deagrarianization and agrarianization, complementing the quantitative findings. Participants identified climate change, resource scarcity, and inadequate rangeland governance as key factors driving deagrarianization. Droughts, erratic rainfall, and livestock intrusion have severely impacted local food production, leading households to shift towards non-farm activities. These concerns align with those found in similar studies conducted in the Eastern Cape, South Africa studies (Connor and Mtwana, 2018; Fischer et al., 2024; Hajdu et al., 2020; Shackleton et al., 2019). In contrast, agrarianizing was driven by the health benefits, cultural importance, and financial support that farming offers, despite the challenges encountered.

This study is subject to several limitations. First, the 2019–2023 period coincides with the COVID-19 pandemic, which introduced exceptional conditions such as job losses, reverse migration, and shifts in household priorities. While this period is analytically rich, we caution against over interpreting patterns as part of a linear agrarian trajectory. Future research should assess whether the pandemic-induced re-engagement in agriculture persists or represents a temporary coping strategy. Second, the study focused on transitions among three livelihood types but did not capture intra-household dynamics, crop choices, or land use intensity. Future studies should explore how gender roles, youth aspirations, and cultural practices mediate agrarian transitions. Additionally, deeper spatial analyses using geospatial data could illuminate the influence of ecological conditions, land tenure regimes, and proximity to infrastructure on agricultural engagement.

Conclusion

This study reveals dynamic changes in the agrarian characteristics of rural households in Bushbuckridge, Mpumalanga Province, South Africa, over recent years. While the overall trend indicates a decline in agricultural engagement, this masks underlying household-level dynamism. The analysis demonstrates how socio-economic pressures, environmental variability, and household-level characteristics such as household size, migrant employment, and dependency ratios interact to influence land use patterns. Some households are shifting away from farming due to resource constraints, limited market access, and the impacts of climate change, whereas others are intensifying their agricultural activities. Importantly, the findings contribute to the broader international literature by providing an empirical case from Africa and the Global South, where rural livelihoods are undergoing similar transformations. This study underscores the unique and shared challenges faced by rural communities in these contexts, such as deagrarianization and adaptation to climate change, while also highlighting potential pathways for resilience. These findings highlight the need for targeted support and policies that address the specific challenges faced by rural households to promote sustainable rural development and agricultural resilience. Programs should prioritize labor-saving technologies and cash transfers to support these vulnerable groups. Additionally, the role

of migration and remittances in sustaining household livelihoods suggests that policies should enable circular migration and incentivize the productive use of remittances. Overall, flexible and adaptive policy frameworks are essential to managing climate and economic shocks while enhancing rural resilience.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

FR: Writing – original draft, Formal analysis, Writing – review & editing, Conceptualization, Methodology, Visualization, Project administration, Investigation. SM: Validation, Visualization, Methodology, Data curation, Formal analysis, Writing – review & editing, Conceptualization. GS: Writing – review & editing, Methodology, Formal analysis, Validation, Conceptualization, Visualization. LH: Formal analysis, Supervision, Writing – review & editing, Project administration, Methodology, Investigation, Visualization, Resources, Validation, Conceptualization. WT: Resources, Methodology, Validation, Project administration, Investigation, Writing – review & editing, Software, Funding acquisition, Supervision, Conceptualization. CS: Investigation, Writing – review & editing, Software, Conceptualization, Funding acquisition, Project administration, Formal analysis, Data curation, Resources, Visualization, Methodology.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This paper is the outcome of research conducted within the Africa Multiple Cluster of Excellence at the University of Bayreuth, funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy-EXC 2052/1-390713894.

Acknowledgments

This paper is the outcome of research conducted within the Africa Multiple Cluster of Excellence at the University of Bayreuth, funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy-EXC 2052/1-390713894. The authors are grateful to the respondents, field staff and management of SAMRC/Wits Rural Public Health and Health Transitions Research Unit, School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, South Africa for their respective contributions towards the collection and production of the data used in this study. This research has also benefited from research, administrative, and computing support provided by the University of Colorado Population Center (Project 2P2CHD066613-06), funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development. The content is solely the responsibility of the authors and does not necessarily represent the official views of the DFG, Wits, CUPC, NIH, or CU Boulder.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated

organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2025.1610323/full#supplementary-material>

References

- Agamile, P., Dimova, R., and Golan, J. (2021). Crop choice, drought and gender: new insights from smallholders' response to weather shocks in rural Uganda. *J. Agric. Econ.* 72, 829–856. doi: 10.1111/1477-9552.12427
- Aliber, M., and Hall, R. (2012). Support for smallholder farmers in South Africa: challenges of scale and strategy. *Dev. South. Afr.* 29, 548–562. doi: 10.1080/0376835X.2012.715441
- Bansah, K. J., Arthur-Holmes, F., and Assan, E. (2023). Climate induced transformation of agriculture to artisanal mining economy in dry regions. *J. Rural. Stud.* 99, 11–19. doi: 10.1016/j.jrurstud.2023.02.005
- Barbieri, A. F., Guedes, G. R., and Onofre dos Santos, R. (2021). Land use systems and livelihoods in demographically heterogeneous frontier stages in the amazon. *Environ. Dev.* 38:100587. doi: 10.1016/j.envdev.2020.100587
- Bhandari, P., and Ghimire, D. (2016). Rural agricultural change and individual out-migration. *Rural. Sociol.* 81, 572–600. doi: 10.1111/ruso.12106
- Blair, D., Shackleton, C. M., and Mograbi, P. J. (2018). Cropland abandonment in south African smallholder communal lands: land cover change (1950–2010) and farmer perceptions of contributing factors. *Land* 7:121. doi: 10.3390/land7040121
- Brewer, J., Larsen, A., and Noack, F. (2024). The land use consequences of rural to urban migration. *Am. J. Agric. Econ.* 106, 177–205. doi: 10.1111/ajae.12369
- Bryceson, D. F. (1996). Deagrarianization and rural employment in sub-Saharan Africa: a sectoral perspective. *World Dev.* 24:97. doi: 10.1016/0305-750X(95)00119-W
- Bunce, B. (2023). A methodology for class analysis: agricultural investments and agrarian change in South Africa. *J. Agrar. Change* 23, 404–432. doi: 10.1111/joac.12505
- Caulfield, M., Bouniol, J., Fonte, S. J., and Kessler, A. (2019). How rural out-migrations drive changes to farm and land management: a case study from the rural Andes. *Land Use Policy* 81, 594–603. doi: 10.1016/j.landusepol.2018.11.030
- Chhetri, R., Yokying, P., Smith, A., Van Den Hoek, J., Hurni, K., Saksena, S., et al. (2023). Forest, agriculture, and migration: contemplating the future of forestry and agriculture in the middle-hills of Nepal. *J. Peasant Stud.* 50, 411–433. doi: 10.1080/03066150.2021.1978983
- Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. (3rd ed.). Sage Publications, Inc.
- Collinson, M. A. (2010). Striving against adversity: the dynamics of migration, health and poverty in rural South Africa. *Glob. Health Action* 3:5080. doi: 10.3402/gha.v3i0.5080
- Collinson, M. A., and Biyase, M. (2021). "Migration and remittances in South Africa" in *The Oxford handbook of the south African economy*. eds. A. Oqubay, F. Tregenna and I. Valodia (Oxford: Oxford Academic).
- Collinson, M. A., White, M. J., Ginsburg, C., Gómez-olivé, F. X., Kahn, K., and Tollman, S. (2016). Youth migration, livelihood prospects and demographic dividend: a comparison of the census 2011 and Agincourt health and demographic Surveillance system in the rural northeast of South Africa. *Afr. Popul. Stud.* 2, 2629–2639. doi: 10.11564/30-2-852
- Connor, T., and Mtwana, N. (2018). Vestige garden production and deagrarianization in three villages in the eastern cape, South Africa. *S. Afr. Geogr. J.* 100, 82–103. doi: 10.1080/03736245.2017.1301268
- Cousins, B., Dubb, A., Hornby, D., and Mtero, F. (2018). Social reproduction of 'classes of labour' in the rural areas of South Africa: contradictions and contestations. *J. Peasant Stud.* 45, 1060–1085. doi: 10.1080/03066150.2018.1482876
- de Brauw, A., Mueller, V., and Lee, H. L. (2014). The role of rural-urban migration in the structural transformation of sub-Saharan Africa. *World Dev.* 63, 33–42. doi: 10.1016/j.worlddev.2013.10.013
- Fischer, K., Johnson, E., Visser, V., and Shackleton, S. (2024). Social drivers and differentiated effects of deagrarianisation: a longitudinal study of smallholder farming in South Africa's eastern cape province. *J. Rural. Stud.* 106:103200. doi: 10.1016/j.jrurstud.2024.103200
- Flick, U. (2015). Qualitative inquiry—2.0 at 20? developments, trends, and challenges for the politics of research. *Qualitative Inquiry* 21, 599–608. doi: 10.1177/1077800415583296
- Gebeyehu, A. K., Snelder, D., and Sonneveld, B. (2023). Land use-land cover dynamics, and local perceptions of change drivers among Nyangatom agro-pastoralists, Southwest Ethiopia. *Land Use Policy* 131:106745. doi: 10.1016/j.landusepol.2023.106745
- Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Res. Policy* 31:62. doi: 10.1016/S0048-7333(02)00062-8
- Geels, F. W., Kern, F., and Clark, W. C. (2023). System transitions research and sustainable development: challenges, progress, and prospects. *Proc. Natl. Acad. Sci. USA* 120:e2206230120. doi: 10.1073/pnas.2206230120
- Giller, K. E., Delaune, T., Silva, J. V., van Wijk, M., Hammond, J., Descheemaeker, K., et al. (2021). Small farms and development in sub-Saharan Africa: farming for food, for income or for lack of better options? *Food Secur.* 13, 1431–1454. doi: 10.1007/s12571-021-01209-0
- Gray, C. L., and Bilsborrow, R. E. (2014). Consequences of out-migration for land use in rural Ecuador. *Land Use Policy* 36, 182–191. doi: 10.1016/j.landusepol.2013.07.006
- Hajdu, F., Neves, D., and Granlund, S. (2020). Changing livelihoods in rural eastern cape, South Africa (2002–2016): diminishing employment and expanding social protection. *J. South. Afr. Stud.* 46, 743–772. doi: 10.1080/03057070.2020.1773721
- Harris, D. (2019). Intensification benefit index: how much can rural households benefit from agricultural intensification? *Exp. Agric.* 55, 273–287. doi: 10.1017/S0014479718000042
- Hebinck, P. (2018). De-/re-agrarianisation: global perspectives. *J. Rural. Stud.* 61:10. doi: 10.1016/j.jrurstud.2018.04.010
- Hebinck, P., Mtati, N., and Shackleton, C. (2018). More than just fields: reframing deagrarianisation in landscapes and livelihoods. *J. Rural. Stud.* 61, 323–334. doi: 10.1016/j.jrurstud.2018.01.004
- Hebinck, P., Smith, L., and Aliber, M. (2023). Beyond technocracy: the role of the state in rural development in the eastern cape, South Africa. *Land Use Policy* 126:106527. doi: 10.1016/j.landusepol.2022.106527
- Kahn, K., Collinson, M. A., Xavier Gómez-olivé, F., Mokoena, O., Twine, R., Mee, P., et al. (2012). Profile: Agincourt health and socio-demographic surveillance system. *Int. J. Epidemiol.* 41, 988–1001. doi: 10.1093/ije/dys115
- Kapri, K., and Ghimire, S. (2020). Migration, remittance, and agricultural productivity: evidence from the Nepal living standard survey. *World Dev. Perspect.* 19:100198. doi: 10.1016/j.wdp.2020.100198
- Kelley, L. C., Peluso, N. L., Carlson, K. M., and Affif, S. (2020). Circular labor migration and land-livelihood dynamics in Southeast Asia's concession landscapes. *J. Rural. Stud.* 73:19. doi: 10.1016/j.jrurstud.2019.11.019
- Lambin, E. F., and Meyfroidt, P. (2010). Land use transitions: socio-ecological feedback versus socio-economic change. *Land Use Policy* 27, 108–118. doi: 10.1016/j.landusepol.2009.09.003
- Leder, S. (2022). Beyond the 'feminization of agriculture': rural out-migration, shifting gender relations and emerging spaces in natural resource management. *J. Rural. Stud.* 91, 157–169. doi: 10.1016/j.jrurstud.2022.02.009
- Long, H., Zhang, Y., Ma, L., and Tu, S. (2021). Land use transitions: Progress, challenges and prospects. *Land* 10:903. doi: 10.3390/land10090903
- Maharjan, A., Kochhar, I., Chitale, V. S., Hussain, A., and Gioli, G. (2020). Understanding rural outmigration and agricultural land use change in the Gandaki basin, Nepal. *Appl. Geogr.* 124:102278. doi: 10.1016/j.apgeog.2020.102278
- Masuku, M. M., Mthembu, Z., and Mlambo, V. H. (2023). Gendered effects of land access and ownership on food security in rural settings in South Africa. *Front. Sustain. Food Syst.* 7:1158946. doi: 10.3389/fsufs.2023.1158946

- Mbiba, M., Collinson, M., Hunter, L., and Twine, W. (2019). Social capital is subordinate to natural capital in buffering rural livelihoods from negative shocks: insights from rural South Africa. *J. Rural. Stud.* 65, 12–21. doi: 10.1016/j.jrurstud.2018.12.012
- McPeak, J. G., and Little, P. D. (2017). Applying the concept of resilience to pastoralist household data. *Pastoralism* 7:82. doi: 10.1186/s13570-017-0082-4
- Meyfroidt, P., Rudel, T. K., and Lambin, E. F. (2010). Forest transitions, trade, and the global displacement of land use. *Proc. Natl. Acad. Sci. USA* 107, 20917–20922. doi: 10.1073/pnas.1014773107
- Mkhong, F. A., and Musakwa, W. (2022). Trajectories of deagrarianization in South Africa—past, current and emerging trends: a bibliometric analysis and systematic review. *Geogr. Sustain.* 3, 1–12. doi: 10.1016/j.geosus.2022.10.003
- National Planning Commission (2012). National development plan 2030: our future—make it work. Pretoria: National Planning Commission.
- Paudel, B., Zhang, Y., Yan, J., Rai, R., and Li, L. (2019). Farmers' perceptions of agricultural land use changes in Nepal and their major drivers. *J. Environ. Manag.* 235, 432–441. doi: 10.1016/j.jenvman.2019.01.091
- Posel, D., Hall, K., and Goagoses, L. (2023). Going beyond female-headed households: household composition and gender differences in poverty. *Dev. South. Afr.* 40, 1117–1134. doi: 10.1080/0376835X.2023.2182760
- R Core Team (2023). R: A language and environment for statistical Computing. Vienna: R Foundation for Statistical Computing.
- Ragie, F. H., Olivier, D. W., Hunter, L. M., Erasmus, B. F., Vogel, C., Collinson, M., et al. (2020). A portfolio perspective of rural livelihoods in Bushbuckridge, South Africa. *South Afr. J. Sci.* 116, 1–8. doi: 10.17159/sajs.2020/7522
- Rusere, F., Hunter, L., Collinson, M., and Twine, W. (2024). Patterns and trends in household food security in rural Mpumalanga Province, South Africa. *Dev. South. Afr.* 41, 164–182. doi: 10.1080/0376835X.2023.2257737
- Shackleton, C. M., Drescher, A., and Schlesinger, J. (2020). Urbanisation reshapes gendered engagement in land-based livelihood activities in mid-sized African towns. *World Dev.* 130:104946. doi: 10.1016/j.worlddev.2020.104946
- Shackleton, C. M., Mograbi, P. J., Drimie, S., Fay, D., Hebinck, P., Hoffman, M. T., et al. (2019). Deactivation of field cultivation in communal areas of South Africa: patterns, drivers and socio-economic and ecological consequences. *Land Use Policy* 82, 686–699. doi: 10.1016/j.landusepol.2019.01.009
- Subedi, Y. R., Kristiansen, P., and Cacho, O. (2022). Drivers and consequences of agricultural land abandonment and its reutilisation pathways: a systematic review. *Environ. Dev.* 42:100681. doi: 10.1016/j.envdev.2021.100681
- Suess-Reyes, J., and Fuetsch, E. (2016). The future of family farming: a literature review on innovative, sustainable and succession-oriented strategies. *J. Rural. Stud.* 47, 117–140. doi: 10.1016/j.jrurstud.2016.07.008
- Sugden, F., Nigussie, L., Debevec, L., and Nijbroek, R. (2022). Migration, environmental change and agrarian transition in upland regions: learning from Ethiopia, Kenya and Nepal. *J. Peasant Stud.* 49, 1101–1131. doi: 10.1080/03066150.2021.1894552
- Touch, V., Tan, D. K. Y., Cook, B. R., Liu, D. L., Cross, R., Tran, T. A., et al. (2024). Smallholder farmers' challenges and opportunities: implications for agricultural production, environment and food security. *J. Environ. Manag.* 370:122536. doi: 10.1016/j.jenvman.2024.122536
- Varga, M. (2020). Poverty reduction through land transfers? The World Bank's titling reforms and the making of “subsistence” agriculture. *World Dev.* 135:105058. doi: 10.1016/j.worlddev.2020.105058
- Waidler, J., and Devereux, S. (2019). Social grants, remittances, and food security: does the source of income matter? *Food Secur.* 11, 679–702. doi: 10.1007/s12571-019-00918-x
- Woodhill, J., Hasnain, S., and Griffith, A. (2020). Farmers and food systems: What future for small-scale agriculture? Oxford: OUP.
- Woodhill, J., Kishore, A., Njuki, J., Jones, K., and Hasnain, S. (2022). Food systems and rural wellbeing: challenges and opportunities. *Food Secur.* 14, 1099–1121. doi: 10.1007/s12571-021-01217-0
- Zhao, Q., Bao, H. X. H., and Zhang, Z. (2021). Off-farm employment and agricultural land use efficiency in China. *Land Use Policy* 101:105097. doi: 10.1016/j.landusepol.2020.105097