

Socioeconomic Institutional and Environmental Factors Influencing Agricultural Land Loss to Non Agricultural Uses

Masala Serah Muobeleni

masalaserah@gmail.com

University of South Africa

Rendani Humphrey Khwidzhili

University of South Africa

Thivhilaheli Richard Netshirovha

University of South Africa

Research Article

Keywords: Agricultural land loss, land use change, socio-economic factors, urbanization, smallholder farmers, CTM, non-agricultural development

Posted Date: September 14th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10606957/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.
[Read Full License](#)

Additional Declarations: No competing interests reported.

Socioeconomic Institutional and Environmental Factors Influencing Agricultural Land Loss to Non Agricultural Uses

Masala Serah Muobeleni[#], Rendani Humphrey Khwidzhili & Thivhilaheli Richard Netshirovha

Department of Agriculture and Animal Health, University of South Africa, College of Agriculture and Environmental Sciences, 28 Pioneer Ave, Florida Park, Roodepoort, 1700, South Africa

[#]*Corresponding author*: E-mail address: 46266097@mylife.unisa.ac.za
/masalaserah@gmail.com (M.S. Muobeleni).

Abstract

Agricultural land loss to non-agricultural uses has become a critical challenge in rapidly urbanizing regions, threatening food security, rural livelihoods, and environmental sustainability. This study aims to investigate the determinants of agricultural land loss within the City of Tshwane Metropolitan Municipality (CTM), focusing on socio-economic, institutional, and environmental perspectives. Using purposive sampling, (n =30) farmers were selected and interviewed using semi-structured, face-to-face interviews. Data were analysed using the Statistical Package for the Social Sciences (SPSS) package for descriptive statistics and Chi-square tests to assess relationships between variables. The findings reveal that development and township development are the primary drivers of land use change, representing 35.3% of responses and 44.4% of cases ($p < 0.01$). Climate change and environmental hazards significantly contributed (17.6%; $p < 0.05$), whereas issues including lack of funds, information, and resources were not statistically significant ($p > 0.05$). Water shortage (70%; $p = 0.03$), municipal urban edges (86.7%; $p < 0.001$), and public participation (PC) (90%; $p < 0.001$) were recognized as significant constraints to agricultural sustainability. The size of the farm and institutional factors exhibited variable effects. The study concludes that agricultural land loss in CTM is primarily driven by structural forces linked to urbanization and environmental pressures rather than individual farm-level characteristics. It recommends strengthening land use planning policies, enforcing urban edge regulations,

improving water resource management, and enhancing stakeholder participation to promote sustainable land management and protect high-potential agricultural land in urbanized regions.

Keywords: Agricultural land loss, land use change, socio-economic factors, urbanization, smallholder farmers, CTM, non-agricultural development

1. Background and introduction

Agricultural land is a finite and vital resource for food production, rural livelihoods, and ecological stability. According to the Food and Agriculture Organization of the United Nations [1], the global availability of productive agricultural land is declining due to urban expansion, industrial development, and socio-economic pressures [9;16]. The conversion of agricultural land to non-agricultural uses poses critical threats to food security, local economies, and ecosystem services, making the protection and sustainable management of farmland a key policy and research priority [15;17]. In South Africa, and specifically within the CTM, agricultural land faces growing pressure from urbanization and non-agricultural development. A rapid increase in population growth, housing demand, and infrastructure expansion has led to the conversion of arable land, reducing the capacity of farmers to sustain productive activities [3]. This is exacerbated by limited access to governmental support and extension services that constrain the ability of farmers to make informed land use decisions. In addition, factors such as an aging farmer population, their reduced level of education, uncertainty regarding land use regulations, and a low awareness of consultation meetings risk further agricultural land loss [9].

Moreover, the subdivision of farmland into smaller unviable parcels is often perceived as a strategy to increase farmable units or access to government subsidies, inadvertently increasing conversion of land from generally economically viable agricultural uses towards residential, commercial, or industrial development [3;13]. Urban sprawl and fragmentation further disrupt agro-ecosystems, reduce biodiversity, and compromise soil and water resources, threatening agricultural productivity [17]. Despite the critical role of agriculture in supporting food security and rural livelihoods, CTM is experiencing significant socio-economic pressure to convert farmland to non-agricultural use, a process often associated with inadequate policy enforcement and insufficient farmer engagement [9]. For smallholders and emerging farmers, this process has broader socio-

economic and environmental implications. Thus, undermining sustainable agricultural development increases dependency on imported food by reducing local food production, raising land prices, and increasing rural inequality [3]. From an environmental perspective, the replacement of agricultural land with urban infrastructure disrupts ecosystem factors vital for long-term sustainability, including water regulation, soil fertility and carbon sequestration [17].

Despite existing studies on CLU at national and regional scales, there is limited research focused specifically on CTM land use, creating a knowledge gap in understanding the localized drivers of agricultural land loss and the effectiveness of policy interventions [12]. Addressing this gap is critical to inform evidence-based land management strategies aimed at balancing urban development with the preservation of productive farmland [8]. Moreover, this study seeks to identify and analyze the factors driving agricultural land loss within CTM. Understanding the socio-economic, institutional, and environmental determinants will enable policymakers, land use planners, and farmers to implement strategies that mitigate land conversion, enhance sustainable land management, and support food security in urbanizing regions. Therefore, this study aims to investigate the key determinants associated with agricultural land loss and non-agricultural use within CTM and to provide recommendations for sustainable land management.

2. Research methodology

2.1. The study area

The study area is located about 25 kilometers from the center of the City of Tshwane within the Gauteng Province, Republic of South Africa (Figure 1).

STUDY AREA MAP WITHIN CITY OF TSHWANE MUNICIPALITY, GAUTENG PROVINCE, SOUTH AFRICA

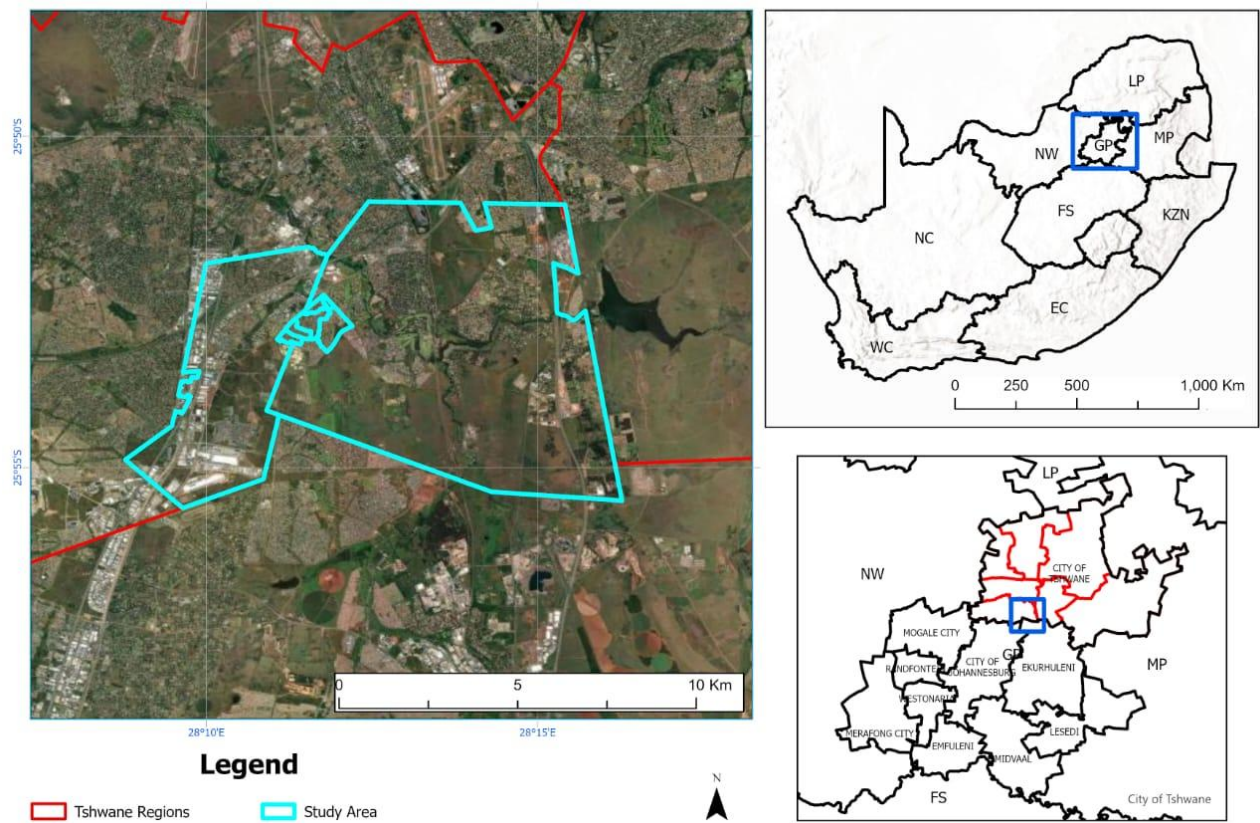


Figure 1: Location of the study area in South Africa. The map was created using South African administrative boundary shapefiles obtained from IGISMAP.

The study area, as shown in Figure 1, illustrates the farms affected by changes in land use within the region and the extent to which alternative land use activities have encroached upon agricultural land, so much so that there is little to no visible evidence of previous farming activities. Land ownership in the study area remained mixed between municipal, government, and predominantly private (individual) farmers, with agriculture continuing to focus on crops and livestock despite increasing pressure from urban expansion, particularly near O.R. Tambo International Airport and along the R21 towards Tshwane. Should current trends persist, agricultural land will likely be progressively converted to non-agricultural uses, however, existing irrigation infrastructure indicates strong potential for continued productivity and food security. To address this, a blended land use approach was adopted, where farms were integrated into urban development as green belts, preserving agriculture while providing additional socio-economic benefits. This involves

introducing agri-tourism initiatives such as controlled access, improved fencing, and simple recreational facilities, allowing farmers to diversify income while maintaining core farming activities. Overall, this multifunctional approach was enhancing land sustainability, strengthening rural-urban linkages, and improving the resilience of farming systems against urban encroachment.

The literature revealed that the soils of the study area are predominantly high-potential agricultural soils that could support sustainable crop production under proper management practices. Land capability assessments conducted in Gauteng Province have shown that there are extensive areas with moderate to high agricultural potential, owing to suitable soil, terrain and climatic conditions for crop production [6]. Most of the land capability within the study area is in classes 5 to 10, suggesting low to moderately high agricultural potential. Consequently, these areas are considered suitable for producing different crops, which can contribute to the annual farm productivity. Natural physical constraints such as steep slopes, shallow soils, and rock outcrops generally characterize low-potential agricultural areas. These may constrain cropping and increase vulnerability to soil erosion. The surrounding areas are characterized by large areas of moderate-to-high potential agricultural land and further support the idea of this region being an important agricultural production area in Gauteng Province [7].

2.2. Data collection

The study area was selected based on the tremendous changes that were observed in the area through different types of land uses that affected agricultural production. A qualitative study was therefore conducted with farmers, where the list of farmers was obtained from the provincial Gauteng Department of Agriculture and Rural Development (GDARD) in the Tshwane regional offices. A total sample size of 30 farmers was selected purposively to participate in the study.

The primary data was collected through an interview guide designed for the collection of data, where the farmers were interviewed, and the responses were recorded manually in the interview guide. In instances where farmers were interviewed in groups, the responses were recorded in groups as per a particular question for all the farmers. The interview guides were further scanned and saved electronically as soft copies for record purposes.

2.3. Selection

The study area was selected based on significant and observable CLU patterns, which had a noticeable impact on agricultural production within the region. These changes, particularly the conversion of agricultural land into non-agricultural uses, warranted an in-depth investigation to understand their implications for farming activities and livelihoods. As a result, a qualitative research approach was adopted to gain detailed insights into the experiences, perceptions, and challenges faced by farmers in the area. A list of active farmers within the study area was obtained from the GDARD, specifically through the Tshwane regional offices, with the assistance of agricultural extension officers. These officials played a key role in identifying farmers who were directly affected by land use changes and who could provide relevant and reliable information for the study. From this list, a total of 30 farmers were selected using purposive sampling. This sampling technique was considered appropriate as it allowed the researcher to deliberately select participants with firsthand experience and knowledge of the phenomenon under investigation [11].

2.2.1. Sample Size

The sample size for this study was figured out using a proportion-based formula to make sure the chosen participants truly reflected the targeted population. The formula used was:

$$n = N / (1 + N(e^2))$$

where n represents the sample size, N represents the total number of farmers in the study area, and e represents the margin of error (usually set at 5%) [2]. This method is commonly used in social science research to derive an appropriate sample size when the population is known. Based on this calculation, a sample size of 30 farmers was considered adequate for the study. Assuming a population of 34 farmers in the study area, the sample size was calculated as follows:

$$n = \frac{N}{1 + N(e^2)}$$

Substituting the values:

$$n = \frac{34}{1 + 34(0.05^2)}$$

$$n = \frac{34}{1 + 34(0.0025)}$$

$$n = \frac{34}{1 + 0.085}$$

$$n = \frac{34}{1.085}$$

$$n = 30$$

A total of 30 farmers were selected from this list of farmers through purposive sampling. This method was considered appropriate because it enabled the researcher to purposively select participants with firsthand experience and knowledge of the phenomenon under investigation.

2.2.2. Sampling and processing

Data was collected using a semi-structured interview guide designed to explore key themes related to land-use change and its effects on agricultural production. The semi-structured interview guide was developed based on existing literature, such as FAO reports or other relevant studies. Open-ended questions were used to allow participants to share their views freely, which ensured impartiality. The questionnaires were then pre-tested through a pilot study by involving a few farmers with the same characteristics as those in the study area, and improved before the main data collection. The sections of the questionnaires were divided into socio-demographic data, factors affecting land use change, and farming characteristics. The total number of questions was thirty (30), including open-ended questions. An informed consent form was administered to all participants after explaining the purpose of the study. Questions were asked during the interview session, and responses were recorded manually in the interview guide to ensure that all relevant information was captured systematically. In addition, with the consent of the participants, interviews were also recorded using a cellphone to enhance the accuracy and reliability of the data.

collected. This dual recording approach allowed for cross-verification of information during the data analysis phase. The responses were organized accordingly, grouping all participants' answers under each study theme to facilitate easier comparison and analysis. Following the data collection process, all completed interview guides were carefully scanned and stored electronically as soft copies to ensure proper record-keeping. Data security involves locking the data on a password-protected laptop. This process also enhanced accessibility and enabled efficient data management during subsequent stages of analysis. Overall, the data collection process was designed to ensure credibility, reliability, and depth of information, thereby strengthening the quality of the study findings.

2.3 Statistical analysis

The collected data were captured, coded, and analyzed using the SPSS package for descriptive and inferential statistical techniques and Chi-square (χ^2) tests. Qualitative responses from the semi-structured interviews were transcribed, organized, and coded as themes. Microsoft Excel was used for data management, including coding and classification into categorical variables. Descriptive statistics were computed using frequencies (n) and percentages (%),

where the percentage was calculated as $\% = \frac{n}{N} \times 100$,

with N representing the total sample size.

To assess relationships between categorical variables,

the Chi-square (χ^2) test of independence was applied using the formula:

$$\chi^2 = \sum \frac{(O-E)^2}{E},$$

is the Chi-square (χ^2) test statistic, used to determine whether there is a significant difference between observed (O) and expected (E) frequencies.

The significance level of $p < 0.05$ was used to determine statistical significance. Multiple response analysis was conducted for variables with more than one response option, and a goodness-of-fit Chi-square test was used to evaluate differences between observed and expected distributions. Cross-tabulation was further applied to compare variables such as farming activities and drivers of change in land use (CLU). These analytical methods improved the reliability, validity, and depth of the study findings. The factors collected from respondents, such as farming system and socio-economic status, are shown in Table 1. These factors were identified from the questions administered to participants, and Microsoft Excel was used to code the factors into categorical variables. The variables were grouped accordingly into themes such as production factors, which included the type of farming activities and socio-economic characteristics like farm size and land ownership.

3. Results

The socio-demographic characteristics of participants in the City of Tshwane

The socio-demographic profile of participants indicates a gender distribution of 53.3% male and 46.7% female. Educational achievement showed variability, with 16.7% lacking formal education, 26.7% completing Grades 9–11, 10% achieving Grade 12, and a significant percentage possessing advanced qualifications at NQF levels 6–7 (30%) and 8–9 (16.7%). The marital status was similarly spread, with 50% married, 46.7% single, and only 3.3% divorced farmers. The social status assessments revealed that 50% of participants classified their status as good, 43.3% as low, and 6.7% as moderate. Ownership status indicated that 56.7% owned their farms, and 43.3% managed leased land, as shown in Table 1. 70% of participants reported family assistance as good, 3.3% as moderate, and 26.7% as poor. Regarding other income sources, 60% possessed alternative income sources, whereas 40% did not. Yet 70% indicated the absence of additional business activities, while 73.3% claimed no alternative activities were being conducted, indicating significant reliance on agriculture as the primary source of employment.

Table 1 Frequency and percentage distribution of the socio-demographic characteristics of participants in the City of Tshwane (n=30)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	16	53.3
	Female	14	46.7
Educational qualification	No schooling	5	16.7
	Grade 9 – 11	8	26.7
	Passed grade 12	3	10.0
	NQF level 6 – 7	9	30.0
	NQF level 8 – 9	5	16.7
Marital status	Single	14	46.7
	Married	15	50.0
	Divorced	1	3.3
Social status	Poor	13	43.3
	Moderate	2	6.7
	Good	15	50
Ownership status	Owner	17	56.7
	Leased	13	43.3
Assistance by family	Poor	8	26.7
	Moderate	1	3.3
	Good	21	70
Other income	No	12	40
	Yes	18	60
Other business activities	No	21	70
	Yes	9	30
Alternative activities	No	22	73.3
	Yes	8	26.7

NQF -National Qualifications Framework.

3.2. The socio-economic and farming characteristics of the participants

The participants showed a broad age range from 24–79 years, with a mean age of 48.5 years, indicating that most farmers are middle-aged, with a significant standard deviation (SD) of 15.4, as shown in Table 2. The farming experience ranged significantly, from 3 months to 360 months, with a mean of 132 months (about 11 years). Household income showed significant variability, ranging from zero to R150,000, with a mean of R14,916 and a significantly high standard deviation (SD = 32,293). Farm sizes varied from minimal holdings (1 hectare) to extensive farms (630 hectares), with a mean of 73.8 hectares and significant variability (SD = 167.8), indicating that while most farmers manage small to medium plots, a minority possess significantly large farms that influence the average higher, as shown in Table 2.

Table 2: Descriptive statistics of socio-economic and farming characteristics of participants (n =30)

	N	Min	Max	Mean	STD. Deviation
Age of the farmer	30	24	79	48,53	15,391
Experience in farming	30	3	360	131,97	114,509
Household income	25	0	150000	14916,00	32293,249
Farm size	29	1	630	73,76	167,819

Note: Household income in Rands (R), farm size in hectares, experience in farming in months, age of the farmer in years. Min – minimum. Max – maximum. Std – standard deviation

3.3. Factors contributing to the loss of agricultural land

The findings of this study indicate that farm size limitation was reported by 53.3% of farmers, although this factor was not statistically significant ($p = 0.79$), suggesting variability in its impact. In contrast, water source availability showed a statistically significant difference (70% lacking access; $p = 0.03$), highlighting water scarcity as a critical constraint to sustainable farming. The PC involvement was extremely low, with 90% of farmers not involved, however, the ($p < 0.001$) was highly significant. Similarly, municipal urban edge (MUE) impact was identified by 86.7% of

respondents and was highly significant ($p < 0.001$), confirming urban expansion as a major driver of agricultural land loss, as shown in Table 3. Additionally, 66.7% of farmers indicated being affected by CLU, which was statistically significant ($p = 0.04$), demonstrating the widespread influence of land use changes in the study area.

Pressure factors were evenly distributed (50%; $p = 1.00$), indicating no clear dominance in their influence. The Department of Agriculture (DoA) consultation was reported by 60% of farmers; however, the result was statistically insignificant ($p = 0.28$), suggesting moderately inconsistent institutional support. Cultural factors and other contributing factors to CLU were each reported by 26.7% of respondents and were statistically significant ($p = 0.02$), indicating they are not dominant drivers but still affect a minority of farmers, particularly in relation to issues such as graves on farmland. Lastly, the presence of CLU in the area was reported to be 46.7%, and it was not statistically significant ($p = 0.79$), suggesting that land use change is not uniformly experienced across all farms.

Table 3. Factors contributing to the loss of agricultural land among farmers in CTM (n=30)

Variable	Category	(n)	(%)	Variable	Category	(n)	(%)
Ze limitation	No	14	46.7	Cultural factors	No	22	73.3
	Yes	16	53.3		Yes	8	26.7
Water source	No	21	70	Pressures	No	15	50.0
	Yes	9	30		Yes	15	50.0
PC Involvement	No	27	90	MUE impact	No	4	13.3
	Yes	3	10		Yes	26	86.7
	No	10	33.3		No	12	40.0

Affected by CLU	Yes	20	66.7	DoA consultation	Yes	18	60.0
Other factors contributing to CLU	No	22	73.3	CLU in the area	No	16	53.3
	Yes	8	26.7		Yes	14	46.7

Note: CLU - change of land use; Ze - size; PC - public participation; MUE - municipality urban edge; DoA -Department of Agriculture; n - frequency or number; % - percentage. These variables represent the coded categories obtained from questionnaire responses.

3.4 Association between farming activities and perceived drivers of CLU

A Chi-square test of independence was applied to determine whether there is a statistically significant association between farming activities and perceived drivers of CLU, and it suggests that regardless of whether farmers are engaged in livestock, mono-gastric production, grain, vegetables, or other activities, their responses to CLU drivers are relatively similar, and the differences observed are likely due to chance. However, descriptive patterns show variation across farming systems. Large and small livestock farmers most frequently identified development and township establishment (42.9%) and other contributing factors (42.9%) as key drivers of CLU, while monogastric farmers showed a broader spread of perceived causes, including development (44.4%) and climate change (33.3%). Vegetable farmers also identified multiple drivers, particularly development and township establishment (35.0%), climate change and environmental hazards (30.0%), and other contributing factors to CLU (30.0%), reflecting their higher exposure to environmental and urban pressures. Grain farmers reported development and township establishment (40.0%) and others contributing to CLU (40.0%) as the main contributors, as shown in Table 4. In contrast, farmers engaged in “other activities” universally identified climate change and environmental hazards (100%) as key drivers of CLU, while development and township establishment, settlement and land invasion, and other contributing factors were each reported by 50% of respondents.

300 **Table 4** Cross tabulation of farming activities and factors contributing to the change of land use (n=30)

			Contributing to CLU ^a					
			Development and township establishment	Climate change and environmental hazards	Lack of funds and information	Lack of resources	Settlement and land invasion	Other contributing to CLU
Farming activities ^a	Large and small livestock	Count	6	0	2	1	0	6
		%	42.9	0.0	14.3	7.1	0.0	42.9
	Monogastric	Count	4	3	1	1	2	1
		%	44.4	33.3	11.1	11.1	22.2	11.1
	Grain	Count	2	0	1	0	1	2
		%	40.0	0,0	20.0	0.0	20.0	40.0
	Vegetables	Count	7	6	3	2	2	6
		%	35.0	30.0	15.0	10.0	10.0	30.0
	Other activities	Count	1	2	0	0	1	1
		%	50.0	100.0	0,0	0.0	50.0	50.0

301 Percentages and totals are based on responses.

302 ^aDichotomy group tabulated at value.

303 ¹CLU- change of land use, other factors contributing to CLU is theft, unutilised land, political influence, commodity change, over-
 304 population, poor government performance and construction. Other activities are grazing, beekeeping and CTMton production.

305

3.5. Factors contributing to CLU using multiple response analysis

The results indicate that development and township establishment are the most frequently reported factors, accounting for 35.3% of responses and 44.4% of the cases. Followed by other factors contributing to CLU (23.5%; 29.6%) and climate change and environmental hazards (17.6%; 22.2%). The lack of funds and information, settlement and land invasion, and lack of resources were less reported (8.8%; 11.1%), (8.8%; 11.1%), and (5.9%; 7.4%), respectively are shown in Table 5.

Table 5. Change in land use in the area: multiple response frequencies distribution (n=30)

Change in land use in the area ^a	Responses		
	N	Percent (%)	Percent of cases (%)
Development and township establishment	12	35.3	44.4
Climate change and environmental hazards	6	17.6	22.2
Lack of funds and information	3	8.8	11.1
Lack of resources	2	5.9	7.4
Settlement and land invasion	3	8.8	11.1
Other contributors to CLU	8	23.5	29.6

^a Dichotomy group is tabulated at a value.

N - number of farmers, CLU - change in land use.

3.6. Relationship between land ownership status and experience of CLU

The findings indicate variations in the significance of land ownership status on perceptions of the drivers of land use change (CLU). Among the landowners, the most reported factors were development and township establishment (46.7%) and settlement/land invasion (33.3%), as well as climate change and environmental hazards (20%). On the other hand, leased respondents indicated a broader range of related issues, with development and township establishment (41.7%)

and climate change (25%) being the most common, in addition to others contributing to CLU (25%) and insufficient funds/information (16.7%), as shown in Figure 2.

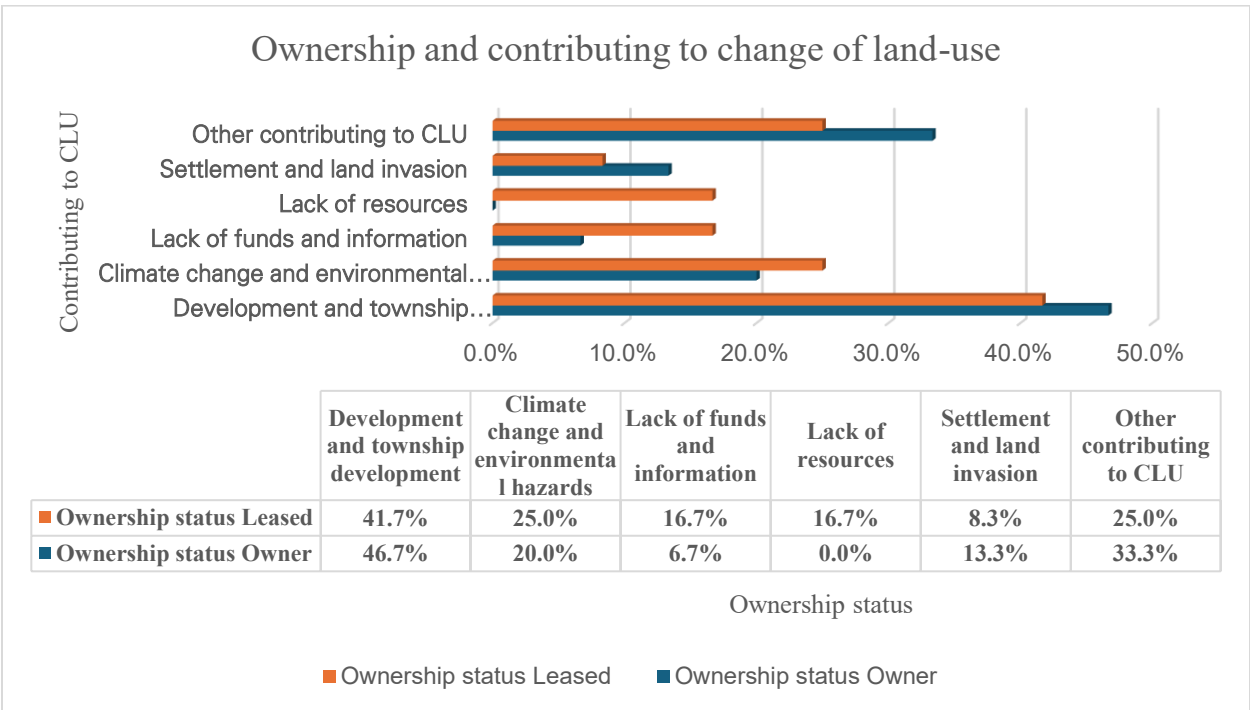


Figure 2: Association between ownership status and contributing factors to CLU

4. Discussion

The findings of this study indicate that agricultural land loss in the study area is primarily driven by development, structural, environmental, and institutional factors, particularly water scarcity, municipal urban expansion (MUE), and limited PC in land use planning processes. These results suggest that farm size limitation and pressure-related factors play a less consistent role in shaping land use outcomes, while water shortages and urban expansion pressures remain the most influential drivers. These findings are consistent with Seto et al. [17;1], one interpretation of these findings is that rapid urban growth, combined with weak stakeholder engagement, accelerates the conversion of agricultural land to non-agricultural uses, thereby undermining agricultural sustainability in peri-urban areas. Similar studies have shown that urban expansion is a major driver of farmland loss, especially in rapidly growing metropolitan regions [12;17]. In addition, water scarcity has been widely recognised as a key constraint affecting agricultural productivity

and long-term sustainability in semi-arid regions [1]. These findings are consistent with published global literature indicating that urbanisation and resource constraints are major determinants of agricultural land conversion [20;4]. However, the study further highlights that institutional factors, particularly limited PC in land use decision-making, play a significant role in shaping land use outcomes in the study area. This suggests that governance failures may be as important as environmental pressures in influencing agricultural land loss [8;21]. The results, therefore, imply that strengthening participatory planning processes and improving water resource governance could help reduce the vulnerability of agricultural land [19]. Practically, this highlights the need for policies that integrate farmers into municipal land use planning and improve access to essential resources. Therefore, future research should explore land use dynamics using larger datasets and spatial-temporal approaches to better understand how urban expansion and policy frameworks interact to influence agricultural sustainability.

The findings are consistent with published literature, which indicates that land use change in peri-urban and agricultural interface zones is largely driven by external structural forces rather than farm-specific characteristics, including urban expansion, environmental variability, and policy-driven land transformation processes [12;17]. These studies emphasise that agricultural systems, regardless of type, are often exposed to similar external pressures that shape land use dynamics. Although patterns may differ across farming systems in how drivers are perceived, existing research suggests that such variation is common in mixed agricultural landscapes where farmers interpret land use change through the lens of their production systems and local experiences [20]. Furthermore, rapid urban growth and land-system transitions have been widely documented as key drivers of agricultural land conversion across multiple farming contexts [4]. The literature supports the interpretation that land use change pressures are broadly distributed across farming systems rather than being unique to specific agricultural activities.

The results strongly imply that urban development and township expansion are the most dominant drivers of CLU in the study area. This finding is consistent with global and regional evidence showing that rapid urbanization is a primary force behind the conversion of agricultural and rural land into residential, commercial, and infrastructural uses [12;17]. One interpretation of these

findings is that land use change in the study area is largely driven by planned spatial development processes and population growth pressures rather than individual household decisions. According to the Intergovernmental Panel on Climate Change (IPCC), environmental factors such as climate change and hazards also play a role, but they appear to function as secondary drivers that intensify existing vulnerabilities rather than independently triggering large-scale land conversion [12]. In contrast, Verburg et al. [20] reported that socio-economic constraints, including limited financial resources, inadequate access to information, and shortages of essential resources, were less consistently identified as drivers of land-use change, suggesting that these factors are context-specific rather than universally significant determinants across different study populations. This finding is supported by Lambin et al. [12] & Verburg et al. [20], who emphasized that the relative importance of socio-economic drivers varies depending on local institutional, environmental, and economic conditions. This contrasts with studies that emphasize poverty and limited access to capital as major drivers of land use decisions in rural contexts [22]. The findings highlight a context-specific dynamic where formal urban expansion and planning processes outweigh household and farm-level constraints. Moreover, the study suggested that managing urban growth through effective spatial planning and integrating climate adaptation strategies is essential for sustainable land use management in the area [18].

This result explores how land ownership status affects farmers' perceptions of the drivers behind cropland land-use change. However, the findings indicate clear differences between landowners and leased farmers, with landowners focusing primarily on direct land pressures such as development and climate-related hazards, reflecting concerns about land loss and tenure security. In contrast, Verburg et al. [20] reported that leased farmers identify a broader range of factors, including climate change and financial limitations, suggesting that they perceive land-use change as a socio-economic challenge linked to weaker institutional and resource support. In addition, these results highlight the importance of tenure security in shaping farmers' interpretations and responses to environmental change, as tenure insecurity has been shown to reduce incentives for long-term investment in sustainable land management [14]. Moreover, the findings therefore emphasize the need for policy interventions tailored to different tenure groups, while also acknowledging that the relatively small sample size limits generalizability and points to the need for further research across broader contexts.

5. Conclusions

The study concludes that agricultural land loss in CTM is mainly driven by urban expansion and developments, water scarcity, weak stakeholder participation, and exposure to CLU. Municipal urban edge development and township expansion emerged as the most dominant pressures, showing that urbanization is the key force transforming agricultural land in the area. Water availability was also identified as a critical constraint affecting farming sustainability and productivity, while limited PC reflects weak inclusion of farmers in land use planning processes. Although socio-economic and cultural factors were reported, they were less dominant, indicating that land use change is largely influenced by broader structural and environmental forces rather than individual farm-level conditions. Therefore, CLU affects all farming systems and land tenure groups, showing that agricultural land loss is a widespread and systemic issue in the study area. Additionally, this is motivated by rapid population growth, urbanization, infrastructure expansion, and household demand, along with the continuous influx of individuals from countries outside South Africa, which is close to the City of Tshwane, and which intensifies pressure on urban land expansion.

6. Recommendations

The study recommends that the CTM strengthen urban planning and land use control measures, particularly through stricter enforcement of urban edge policies and protection of high-value agricultural land from encroachment. Improved water resource management, including investment in irrigation infrastructure systems and sustainable water allocation systems, is also essential to support agricultural productivity under increasing scarcity. In addition, farmer participation in land use planning should be enhanced through inclusive consultation platforms and stronger engagement between municipalities and agricultural stakeholders. Extension services from the Department of Agriculture should be intensified to improve farmer awareness and adaptive capacity to land use pressures. Finally, policies aimed at improving land tenure security, especially for leasing farmers, should be prioritised to reduce vulnerability to unplanned land conversion and promote long-term agricultural sustainability.

Acknowledgment (s)

The authors wish to thank the farmers for their patience and the invaluable information provided. We also wish to thank GDARD for allowing us to conduct the project through their officials, for their time, and for the information they provided. Finally, we thank our field officers, all researchers, development professionals, government officials, and farmers who voluntarily contributed to and participated in this study.

Authors' contributions

This work was carried out in collaboration among all authors. Masala Serah Muobeleni, Rendani Humphrey Khwidzhili, and Thivhilaheli Richard Netshirovha designed the study, wrote the protocol, and wrote the first draft of the manuscript. At the same time, Masala Serah Muobeleni managed the analysis of the data. All authors read and approved the final paper.

Funding

The authors wish to thank the University of South Africa for funding this research.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Clinical trial number

Not applicable

Ethics approval and consent to participate

The study protocol was approved by the College of Agriculture and Environmental Sciences Health Research Ethics Committee (CAESHREC) of the University of South Africa (Ethics Ref. No. 2025/CAES_HREC/7087) in accordance with the University of South Africa's ethical guidelines. The study was classified as low-risk research and adhered to fundamental ethical principles. Written informed consent was obtained from all participants prior to data collection. Participants were informed of the study's purpose, potential benefits, their right to withdraw at any

time without providing a reason, and the measures taken to ensure confidentiality and anonymity of their information.

Consent to Publish

Not Applicable.

Competing interests

The authors declare no competing interests.

References

1. Food and Agriculture Organization of the United Nations (FAO), 2021. The State of Food and Agriculture: Making agrifood systems more resilient to shocks and stresses. Rome: Food and Agriculture Organization of the United Nations. <https://doi.org/10.4060/cb4476en>
2. Ahmad, A. (2024). *Sample size determination in survey research: A practical guide for researchers. International Journal of Research Methodology*, 7(1), 15–28.
3. Ayejugbagbe, I. O., Gxumisa, N., & Mnguni, P. (2026). *Determinants of agricultural land conversion and sustainable land management in South African metropolitan municipalities. Land Use Policy*, 143, 107230.
4. D'Amour, C., Reitsma, F., Baiocchi, G., Barthel, S., Güneralp, B., Erb, K.-H., Haberl, H. & Creutzig, F., 2017. Future urban land expansion and implications for global croplands. *Proceedings of the National Academy of Sciences*, 114(34), pp.8939–8944. <https://doi.org/10.1073/pnas.1606036114>
5. Department of Agriculture, Forestry and Fisheries (DAFF). (2015). *Land capability classification for agricultural land in South Africa: A land capability classification system for South Africa*. Pretoria, South Africa: Department of Agriculture, Forestry and Fisheries.
6. Department of Agriculture, Forestry and Fisheries (DAFF). 2012. A Framework for the Protection and Development of High Potential Agricultural Land in South Africa. Pretoria, South Africa.
7. Department of Environmental Affairs (DEA). (2018). *National land use and land cover dataset for South Africa*. Pretoria, South Africa: Department of Environmental Affairs.

8. Food and Agriculture Organization (FAO). 2023. *The Status of Land and Water Resources for Food and Agriculture Systems (SOLAW) – System at Breaking Point*. Rome, Italy: FAO.
9. Food and Agriculture Organization of the United Nations (FAO). 2022. *The State of Food and Agriculture 2022: Land Use and Sustainability*. Rome: Food and Agriculture Organization of the United Nations. <https://www.fao.org/publications/sofa/2022/en/>
10. Geist, H. J., & Lambin, E. F. (2002). Proximate causes and underlying driving forces of tropical deforestation. *BioScience*, 52(2), 143–150. [https://doi.org/10.1641/0006-3568\(2002\)052\[0143:PCAUDF\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2002)052[0143:PCAUDF]2.0.CO;2)
11. Etikan, I., Musa, S.A. and Alkassim, R.S., 2016. Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics*, 5(1), pp.1-4. Doi:10.11648/j.ajtas.20160501.11
12. Lambin, E.F. & Meyfroidt, P., 2011. Global land use change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences*, 108(9), pp.3465–3472. <https://doi.org/10.1073/pnas.1100480108>
13. Minghong, T., Peijun, S., & Xiubin, L. (2004). Farmland conversion and land-use change in rapidly urbanizing regions of China. *Journal of Geographical Sciences*, 14(3), 273–282.
14. Nkonya, E., Pender, J., & Kato, E. 2011. Who knows, who cares? Determinants of enactment, awareness, and compliance with community natural resource management regulations in Uganda. *Environment and Development Economics*, 16(1), 79–109.
15. Ranjithkumar, A., 2025. Assessing the impact of agricultural land reduction on future global food security: challenges and sustainable solutions. *Indian Journal of Natural Sciences*, 15, pp.89066-89083.
16. Rötter, R. P., Carter, T. R., Olesen, J. E., & Porter, J. R. (2024). Agricultural land-use change, climate change, and global food security: Challenges and opportunities for sustainable development. *Global Food Security*, 40, 100760.
17. Seto, K.C., Güneralp, B., & Hutyra, L.R., 2012. Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences*, 109(40), 16083–16088.
18. UN-Habitat. 2020. *World Cities Report 2020: The Value of Sustainable Urbanization*. United Nations Human Settlements Programme. www.unhabitat.org

19. United Nations. 2024. *Sustainable Development Goals Report 2024*. New York, NY: United Nations.
20. Verburg, P., Crossman, N., Ellis, E., Heinimann, A., Hostert, P., Mertz, O., Nagendra, H., Sikor, T. & Erb, K.-H., 2013. Land system science and sustainable development of the Earth system. *Land Use Policy*, 33, pp.1–8.
<https://doi.org/10.1016/j.landusepol.2012.04.015>
21. United Nations Human Settlements Programme (UN-Habitat). 2024. *World Cities Report 2024: Cities and Climate Action*. Nairobi, Kenya: UN-Habitat.
22. Pierri, F.M., Anseeuw, W. and Campolina, A., 2025. Land tenure for resilient and inclusive rural transformation. *Global Food Security*, 44, p.100835.