



Drivers Of Farmland Conversion Into Non-Agricultural Land: Farmers' Perspectives From Khyber Pakhtunkhwa, Pakistan

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ABSTRACT

Background: Land conversion to non-agriculture uses is a worldwide increasing issue, but especially in developing nations, it poses a threat to food production and rural livelihoods. In Pakistan's Khyber Pakhtunkhwa, swift urbanization and population growth have increased land loss at a fast pace, evoking vital concerns regarding food security and sustainable land management.

Objective: This research examines the area, reasons, and impacts of farmland conversion in KPK (2004–2024), with special emphasis on its effects on agriculture and food security.

Methodology: A cross-sectional survey of 356 farm households was taken from six villages in Mardan, Charsadda, and Nowshera districts that were randomly selected by simple random sampling. Structured questionnaires were used to collect data and SPSS -25 was used to analyze them. Descriptive statistics, binary logistic regression were used to determine drivers of land conversion keeping $p < 0.05$ as significant

Results: A total of 356 respondents participated, with a mean age of 45.5 years. Education levels were generally low, most respondents belonged to extended or joint families with large household sizes, and over 80% reported only 1–2 earning members, indicating high dependency and limited capacity for farm investment. The majority owned small to medium landholdings (average 11 acres), yet rising land values, insecure tenure, restricted market access, and limited non-farm employment created strong pressures for land conversion. Nearly all farmers (96.6%) reported farmland loss over the past two decades, primarily to residential development (84.3%), which severely disrupted farming activities (62.9%). Urbanization (33.1%), infrastructure expansion (36%), economic incentives (30.9%), population growth (70.8%), and high land prices were identified as key drivers, with

	economic motives considered significant by most respondents (79.2%). Logistic Regression analysis revealed that farmland conversion was primarily driven by social attitudes, government incentives, social factors, and access to credit, while real estate showed a negative influence. Conclusion: Farmland conversion in Khyber Pakhtunkhwa is primarily driven by urbanization, infrastructure growth, and economic pressures, with severe impacts on farming sustainability and rural livelihoods. Integrated land-use policies are urgently needed to protect fertile land while balancing development demands.
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1. INTRODUCTION

Land is one of the most essential resources for life, and especially for agricultural production, as it is the main and non-substitutable input (Rondhi et al., 2018). It is also one of the most important assets to accumulate wealth and a most critical engine of economic growth (Sitko et al., 2014; Li et al., 2014; Muyang et al., 2013). Yet, its non-renewability and irreplaceability have created more competition between agricultural and non-agricultural purposes, and the resulting issue of increased land conversion for agriculture has become a growing concern (Gessese, 2018; Msofe et al., 2020). It is an international problem that appears in developing and developed nations alike and is a human-induced environmental phenomenon. As long as industrial revolution, coupled with global economy growth and population expansion, this change not just continued but also accelerated and branched out (Kust et al., 2017).

Conversion of agricultural land decreases land use for crop production, compromising the ability to increase global food supply to meet growing global demand (Baig et al., 2018). The problem is especially serious because cities, even though they cover just ~1% of the Earth's surface, tend to take over the most productive soil (Hossain, 2020; Gupta, 2019). Urban growth not only decreases productive agricultural land but also reorganizes food consumption patterns and way of life, compounding the burden on agricultural systems (Utuk et al., 2015). In highly populated or vulnerable countries, such as Pakistan, China, and India, this trend poses a major risk to food production and price stability (Tengberg & Stocking, 2019)

Food security, ensure that all individuals have access to sufficient, safe, and nutritious food, which is closely related to the agriculture. Addressing the demands of a burgeoning world population, estimated to reach more than nine billion by the year 2050, is that much harder with climate change, urbanization at a breakneck pace, and socio-economic inequality. As of 2023, more than 345 million individuals experienced acute food insecurity, and nearly 2 billion had micronutrient deficiency, further emphasizing the need for quantity and quality in food provision (Hussain et al., 2025). Sustainable farm practices, technological advancements, and focused policy measures are required to meet these problems and the United Nations' target of achieving hunger eradication by 2030 (Shebanina et al., 2024). Urban agriculture, including rooftop gardens, is a potential solution for urban food access, providing social, economic, and environmental benefits (Desiyanti, & Siswanto, 2025). Nonetheless, the success of these efforts hinges on supportive policies, public participation, and region-specific approaches that respond to local environmental and socio-economic circumstances. In the end, food security calls for an integrated effort that balances expanded production with sustainable and equitable food systems.

In developing nations, food insecurity is usually fueled by inadequate economic access as opposed to a lack of supply, and long-term availability will depend significantly on the preservation of agricultural land, increased productivity, and limiting post-harvest loss (Rovshen et al., 2019). Efficient land governance, secure tenure, controlling conversion, and incorporating food policy into urban planning is vital for sustainable agriculture development (Yu & Deng, 2022).

Agricultural land conversion is influenced by interrelated economic, political, technological, environmental, and socio-cultural drivers. Economic drivers include increasing land costs, high input prices, and inelastic agricultural incentives (Farrington et al., 2008; Helming et al., 2008). Politically, poor land-use planning, inconsistent laws, and poor governance enhance conversion. Technological change can lower rural employment demand, triggering migration and urbanization into agricultural lands. Environmental aspects like climate change, pests, and soil loss also affect land-use changes (Feng, 2022).

Rapid urbanization in Asia since the 1970s, along with high population growth rates, has hastened ALC (Baig et al., 2018; Ali et al., 2020). Household composition, farm size, land ownership, and access to markets are also local-level determinants of farmers' land-use decisions (Briassoulis, 2000; Nzunda et al., 2013).

Pakistan experiences extensive loss of farmland in all the provinces but most sharply in Khyber Pakhtunkhwa (KPK) (Peerzade et al., 2018). Within Mardan District, 1,125 hectares were transformed between 1990 and 2010 largely because there were no regulatory policies (Yar, 2013). Since 2007, approximately 41.9% of agricultural land in some areas of the province has been developed into non-agricultural purposes, and Charsadda is one of them most affected (Baig et al., 2018). Built-up land in Mardan rose six times from 1985 to 2015 (Ali et al., 2020), greatly affecting agricultural production and food security. With high rural populations and poverty levels in KPK, the effects of ALC are particularly significant (Miller et al., 2021).

Despite extensive literature on farmland conversion at global and national scales, micro-level evidence capturing farmers' perspectives in Khyber Pakhtunkhwa remains limited. Most studies focus on satellite-based land use assessments or generalized policy analyses, with little emphasis on the socio-economic realities, attitudes, and decision-making processes of farmers at the household level. This study addresses this gap by providing empirical, farmer-based insights into the drivers and impacts of farmland conversion in KPK over the past two decades. By integrating local voices with quantitative analysis, it contributes to the scholarly debate on land-use change and offers evidence-based recommendations for policymakers seeking to balance development needs with food security and sustainable land management.

2. LITERATURE REVIEW

2.1 Global Perspective on Farmland Conversion

The transformation of agricultural land into non-agricultural uses is called farmland conversion. It is a complex global issue shaped by socio-economic and environmental factors, with substantial implications for food security, biodiversity, and ecological balance. Urbanization and economic growth push a good part of this transformation, as observed in the fast-developing world such as China and in nations such as US and Canada, where agricultural land is transformed into housing, industry, and infrastructure (Honghui et al., 2012; Francis et al., 2012). In sub-Saharan Africa, Latin America, and Southeast Asia, demands to increase agricultural production and market access also play a role, whilst globalization and investments create further incentives for land conversion, often driven by technology differences and governance (Valcourt et al., 2024). This change poses a risk to biodiversity, ecosystem function, and soil carbon

cycling, with impacts extending to food production capacity and carbon storage (Francis et al., 2012; Lv et al., 2022). Globally trends differ, with cropland increasing in Africa but decreasing in high-income countries, as well as changes in cultivated areas toward high latitudes and grassland and woodland cover loss (Minghong & Yuanyuan, 2019; Yao et al., 2017).

2.2 Farmland Conversion in South Asia

South Asian farmland conversion is triggered by urbanization, economic growth, and infrastructure development and poses severe threats to food security, rural livelihood, and environment sustainability. For every acre of land converted from agriculture in Tamil Nadu, India, there is a yearly loss of 1.07 tonnes of farm produce, while the conversion of land from agricultural to non-agricultural livelihood sources has pushed agricultural income down from 65% to 25% in Pakistan, leading to the heightening of food insecurity among tenant farmers (Govindaprasad & Manikandan, 2016). This shift usually results in job loss, lowered use of necessities, and increased poverty, as with Pakistan, whereas in Indonesia's Yogyakarta, urbanization imperils the viability of rural economies (Irham & Sudirman, 2017). South Asia has still managed to record productivity increases with conservation tillage, sustainable intensification, and movement towards high-value food products, which fuel economic growth while making agriculture a prime source of employment (Dixon et al., 2020). Yet, urbanization on productive lands exacerbated soil erosion, water scarcity, and loss of biodiversity, requiring sustainable water and soil management systems (Nawaz et al., 2021). Economic development in balance with conservation continues to be important, since the specialization of agricultural landscapes, although economical, threatens ecosystem processes without planned management measures.

While global and South Asian studies have established the drivers and consequences of agricultural land conversion, empirical evidence at the micro level in Khyber Pakhtunkhwa (KPK) is limited, including with regard to farmer-level insights. This research closes the gap by combining two decades (2004–2024) of land conversion data with local knowledge, creating region-specific evidence to inform sustainable land management, enhance food security planning, and secure agricultural livelihoods in one of Pakistan's most vulnerable provinces.

3. METHODOLOGY

This study was conducted at three main districts of Khyber Pakhtunkhwa province, Pakistan, Mardan, Charsadda, and Nowshera. A simple random sampling technique was employed to select the study sites. From the three mentioned districts, two villages from each were randomly chosen, making a total of six villages. Due to time and budget constraints, it was not feasible to collect data from all farmland households. Therefore, using proportional allocation (Cochran, 1977), a 5% sample of farmland households was drawn from each village. The detailed distribution is provided in Table 3.1.

Table 3.1: Detailed distribution of sample respondents in the study area

District	Village Council	Total Households	Sample Size (Households)
Charsadda	Nisatta	1608	80
	Mera Prang	837	42
Nowshera	Manki Sharif	1712	85
	Amangarh	764	38
Mardan	Toru	798	40
	Bakhshali	1431	71
Total		7150	356

Source: Pakistan Bureau of Statistics, 6th Population and Housing Census 2017.

The research employed primary data, where the household (farm household) was used as a unit of observation. The data were obtained from the heads of households (farmers) using face-to-face interviews, employing a pre-formulated questionnaire derived from the particular objectives of the study. The survey had both three-point (Yes = 1, No = 2, Indifferent = 3) and five-point (Strongly Agree = 1 to Strongly Disagree = 5) Likert scales to measure perceptions regarding the causes and effects of farmland conversion and the effects on food security. All research activities were conducted in accordance with established ethical standards for social science research. The purpose of the study, the voluntary nature of participation, and the right to withdraw at any stage were clearly explained to all potential respondents (Riaz et al., 2024a; Riaz et al., 2024b). Informed verbal consent was secured from every participant before the interviews began (Naz et al., 2024a). Confidentiality and anonymity were strictly maintained: personal identifiers were not recorded, and all data were stored securely and used only for academic purposes (Naz et al., 2025; Naz et al., 2024b; Naz et al., 2024c). Respondents who declined to participate were respectfully replaced with other willing participants, ensuring that participation was entirely voluntary and free from coercion (Naz et al., 2023a; Naz et al., 2023b).

Data analysis was performed using SPSS version 25. For quantitative variables, mean $\pm$ standard deviation (SD) or median (IQR) was calculated after testing normality with the Shapiro–Wilk test. Categorical variables were computed in terms of frequencies and percentages. Binary logistic regression was used to determine drivers of land conversion keeping $p < 0.05$ as significant.

4. RESULTS AND DISCUSSION

4.1 Demographic and Household Characteristics

A total of 356 respondents participated, with a mean age of 45.45 years (SD = 13.04), ranging from 24 to 65 years. They were predominantly 41–60 years (40.2%), with 26–40 years (27.5%), >60 years (23.6%), and 15–25 years (8.7%) represented less frequently. The age structure indicates an aging agricultural population, consistent with Ali et al. (2024), which noted that declining youth involvement in agriculture could jeopardize sector sustainability in the long term.

Level of education was low: 36% had reached middle school, 32% matriculation, 23% above matric, and 10% primary level. Low formal education may hinder adoption of modern agricultural practices, consistent with findings by Ullah et al. (2022).

Most (81%) were rural farmers, with smaller proportions in government (6%), private employment (5%), and business (8%). The majority (49%) resided in extended families, 37% in joint, and 15% in nuclear families. Median family size was 11 persons (IQR = 7), with more than half having 8–15 members. Dependency ratios were high: 81% had 1–2 earning members, which could limit farm investment. Our conclusion is consistent with Abbas et al. (2021) rural Punjab study findings that averred that large family size and low earners' households experience financial pressure since most of the income goes towards basic needs, leaving little for investment in agriculture. Combined with the increasing non-farm prospects in peri-urban localities, such economic strain induces farmland sale or leasing for non-farm purposes. The research underscored the fact that high dependency rates limit investment in advanced technologies and enhance land conversion into farmland when urban land prices are higher than anticipated returns on farming (Abbas et al., 2021).

Table 1: Demographic Characteristics of individual (N = 356)

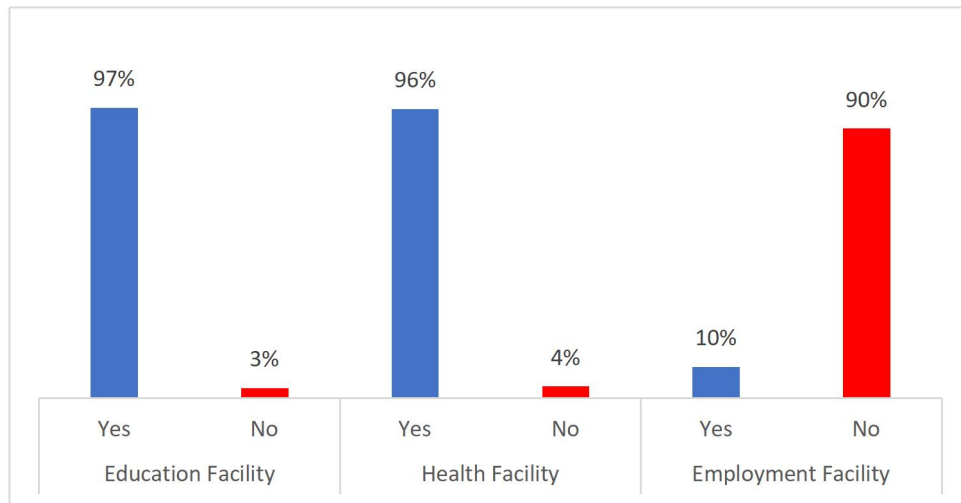
Characteristics	Categories	N (%)
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Age (years)	15–25	31 (8.7%)
	26–40	98 (27.5%)
	41–60	143 (40.2%)
	>60	84 (23.6%)
Education level	Primary	34 (10.0%)
	Middle	127 (36.0%)
	Matric	115 (32.0%)
	Above Matric	80 (23.0%)
Profession	Farmer	288 (81.0%)
	Government	22 (6.0%)
	Private	16 (5.0%)
	Business	30 (8.0%)
Family type	Nuclear	52 (15.0%)
	Joint	131 (37.0%)
	Extended	173 (49.0%)
Family size	1–7 members	94 (26.4%)
	8–15 members	195 (54.8%)
	≥16 members	67 (18.8%)
Number of earners	1–2	287 (81.0%)
	3–4	69 (19.0%)

4.2 Access to Basic Facilities

The following figure-1 identified that although access to educational (96.6%) and healthcare (96.1%) facilities was predominantly sufficient in the study area, employment opportunities were drastically limited and only 10.4% reported local availability. This imbalance underscores a pronounced gap between the provision of basic social services and the economic infrastructure needed for livelihood generation. Comparable findings by Ahmad et al. (2021) in rural Khyber Pakhtunkhwa showed that although public investment expanded education and healthcare, the lack of parallel employment development compelled out-migration, weakened the rural labor base, and encouraged farmland conversion for non-agricultural uses. These results emphasize the importance of integrated rural development policies that not only enhance human capital but also create sustainable employment and agricultural value-chain opportunities to reduce farmland loss.

Figure 1: Basic Life Facilities



4.3 Landholding Patterns and Market Access

The majority of the respondents (85.1%) owned working land, whereas 7.9% rented in and 7% rented out land. The sizes of the land were generally distributed, with most (62.4%) holding 8–10 acres, 20.2% holding 11–15 acres, 11.5% holding more than 15 acres, and 5.9% holding 1–7 acres. The average landholding was 11.12 acres (SD = 3.9), which is within the category of small to medium farms frequently documented in Pakistan. This is in line with national statistics, whereby almost 85% of the farms are below 12.5 acres and are dominated by small and medium farmers (Kousar, 2018).

Rehman et al. (2020) also found similar range in landholding size in northern Khyber Pakhtunkhwa, between less than 5 acres and greater than 30 acres, averaging around 10 acres. This moderate range suggests a semi-concentrated distribution with a predominance of middle-sized farms. Although such holdings can meet household food requirements and leave some for sale in the market, they are still susceptible to fragmentation by inheritance systems, increase in land prices, and pressure for conversion. The organization also influences technology adoption and crop diversification as investment attitudes vary across very small, medium, and large farms. In the context of conversion of farmland, medium farmers usually have conflicting incentives between maintaining farm production and realizing the commercial worth of their land (Rehman et al., 2020).

Land prices were high, with 42.3% of respondents indicating >PKR 5.1 million, average PKR 11.1 million (SD = 3.9 million), indicating firm conversion pressures. Access to irrigation was common (77.2% irrigated). These results also ring true for the overall structural problems in Pakistan's agricultural sector. The tenure system continues to be controlled by absentee landlords, who own large farm holdings, restricting small farmers' access to inputs (Khawaja, 2015). Also, secure land rights are important in promoting long-term agricultural investments, but insecure property arrangements tend to constrain households from undertaking these investments (Kousar, 2018).

Most farms were within 1–4 km of a road (75.5%), and 65.2% were 11–15 km away from market, limiting market access. Distance from roads has well documented consequences for farmers' ability to reach input and output markets, to obtain extension and health services, and to secure timely transport for perishable crops. Research in similar settings demonstrates that bad road access increases transport expense, lowers participation in farmers' markets, and lowers return to production, particularly for high-value and perishable crops (Adugna et al., 2021) Road

upgrading is found to be connected with increased market integration, more use of modern inputs, and greater consumption and welfare in the household, whereas remoteness is found to be connected to decreased output, limited off-farm employment and lower access to services supporting agricultural resilience (Asher and Novosad, 2021)

Farming experience had a mean of 13.3 years (SD = 4.9), with the majority having 11–20 years. Experience farmers tend to have improved knowledge of land degradation problems as well as follow sustainable land management practices. For example, in Ethiopia, experience farmers were found to be more concerned about land degradation issues like soil erosion and fertility reduction, which impacted their investment in land management practices (Saguye, 2022).

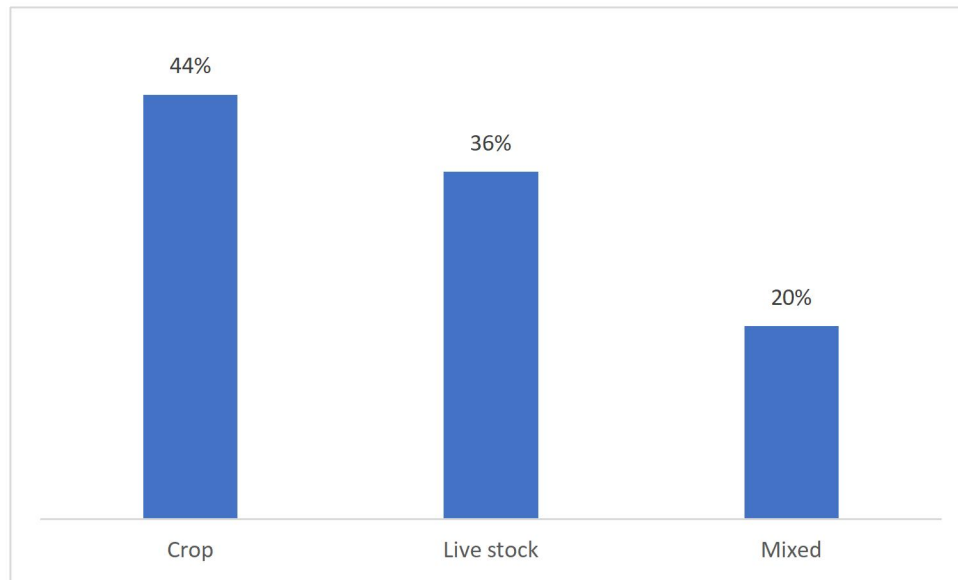
Table 2. Landholding Characteristics and Accessibility (N = 356)

Characteristics	Categories	Frequency (%)
Land tenure	Own operational land	303 (85.1%)
	Rented in	28 (7.9%)
	Rented out	25 (7.0%)
Land size (acres)	1–7	21 (5.9%)
	8–10	222 (62.4%)
	11–15	72 (20.2%)
	>15	41 (11.5%)
Land value (PKR)	3.1–5.0 million	56 (15.7%)
	>5.1 million	300 (42.3%)
Irrigation	Irrigated	275 (77.2%)
	Non-irrigated	81 (22.8%)
Distance to road (km)	1–4	269 (75.5%)
	≥5	87 (24.5%)
Distance to market (km)	6–10	124 (34.8%)
	11–15	232 (65.2%)
Farming experience (yrs)	1–10	92 (26.0%)
	11–20	226 (63.0%)
	>20	38 (11.0%)

4.4 Livelihood Diversification

Figure 2 demonstrate that most of the respondents practiced crop farming (44%), then livestock farming (36%) and mixed farming (20%), indicating not only the prevalence of crop growing but also the increasing importance of rural livelihood diversification. Such diversification improves income stability, nutrition, and exposure to market and climatic shocks. The same trends were indicated by Nabi and Shafi (2021), with a focus that combined crop, livestock systems enhance household food security and minimize exposure to risks (Nabi & Shafi; 2021).

Figure 2: Distribution of the sampled respondents on the basis of types of farming



4.5 Farmers' Perceptions of Farmland Conversion

Nearly all interviewees (96.6%) had experienced conversion of farmland to non-agricultural purposes over the last 20 years. Respondents' perceptions indicated that most assessed the change as relatively small (63.8%) or large-scale (30.3%), with a mere 5.9% assessing it as small, noting a consistent trend of land loss mostly contributed by urban development, infrastructure, and business undertakings. Most of the respondent 84.3% noted residential development to be the leading cause, with a lesser proportion (15.7%) blaming it on industrial growth, which points to demand for housing, migration, and pressures in real estate as the leading drivers transforming rural areas. This trend is also in agreement with GIS-based research in Mardan (Pukhtoon Yar et al., 2021), which revealed built-up areas almost doubling at the cost of fertile agricultural land, highlighting the dominance of residential expansion over industrial growth. The effects of agricultural disruption were felt across the board, with 62.9% of respondents experiencing severe disturbance and the others admitting at least some adverse impact, mirroring general appreciation of land conversion into agriculture as a danger to cropping trends, cultivated lands, irrigation availability, and general farming sustainability. These confirm findings of Naveed Farah et al. (2022) in Punjab, where urban encroachment decreased farm productivity, compelled livelihood changes, and eroded food security. Overall, the evidence suggests that farmland conversion is not only transforming land use but also undermining the agrarian economy, dispersing rural communities, and threatening long-term food sustainability, highlighting the need for strong integrated land-use policies that balance development with the conservation of productive agricultural land.

Table 3. Farmers' Perceptions of Farmland Conversion (N = 356)

Farmland Conversion Reason		Categories	Frequency (%)
Farmland converted (last 20 yrs)			344 (96.6%)
Extent of change	A little		21 (5.9%)
	Somewhat		227 (63.8%)
	A lot		108 (30.3%)

Type of development	Residential	300 (84.3%)
	Industrial	56 (15.7%)
Conversion impact on farming	Severe	224 (62.9%)
	None	0 (0.0%)
	Some	132 (37.1%)

4.6 Drivers of Farmland Conversion

Infrastructure development (36%), urbanization (33.1%), and economic incentives (30.9%) were the main perceived drivers. Economic factors were rated as significant or very significant by 79.2% of farmers, consistent with Farah et al. (2019), who found profit motives and high land prices to be dominant in conversion decisions. Perceptions of government policy influence were divided (45.2% yes, 54.8% no), indicating that market forces may outweigh policy effects. Population growth was seen as a driver by 70.8% of respondents.

Table 4. Drivers of Farmland Conversion (N = 356)

Driver Variable	Frequency (%)
Urbanization	118 (33.1%)
Economic Incent.	110 (30.9%)
Infrastructure	128 (36.0%)
Economic factors importance	282 (79.2%)
Government policy role	161 (45.2%)
Population growth as factor	252 (70.8%)

4.7 Regression Analysis of Determinants

Our results show that farmland conversion is strongly influenced by social attitudes (OR = 20.55), government incentives (OR = 4.64), social factors (OR = 5.05), and access to credit (OR = 2.88), while real estate influence was negatively associated (OR = 0.322). These findings align with broader literature identifying urbanization, population growth, and economic pressures i.e; shift to other source of income (Khan et al., 2023; Kocur-Bera and Pszeny, 2020). Similar to studies highlighting policy gaps and governance failures (Khan et al., 2023), our results underscore the role of incentives and institutional factors in shaping land-use decisions. Moreover, the strong influence of social attitudes in our model reflects how demographic and cultural dynamics reported in the literature, such as youth migration and changing labor patterns, accelerate conversion. While prior studies emphasize environmental stressors like land degradation and climate change (Hissan et al., 2024; Khoso et al., 2024).

Table 5: Binary Logistic Regression Predicting Farmland Conversion

Dependent variable: Conversion to non-agricultural land, (N = 356)				
Predictor	B	P	OR	95% CI (Lower–Upper)
Age	-0.960	.064	0.383	0.139–1.057
Profession	0.105	.661	1.111	0.695–1.775
Health facility	-1.399	.288	0.247	0.019–3.267
Employment status	-0.254	.703	0.775	0.210–2.866
Government incentives	1.534	.000	4.639	2.652–8.116
Real estate influence	-1.132	.043	0.322	0.108–0.963

Access to credit	1.058	.046	2.879	1.018–8.144
Social factors	1.619	.026	5.046	1.217–20.923
Social attitude	3.023	.000	20.546	7.479–56.443

Conclusion

This study demonstrate that farmland conversion is driven by an aging farming population, low education, high dependency ratios, and limited rural employment opportunities. Although most respondents owned small to medium landholdings, high land values, insecure tenure, and restricted market access intensified pressures to sell or lease farmland. Nearly all farmers reported significant land conversion in the past two decades, mainly for residential development, causing disruptions in crop production and threatening agricultural sustainability. Urbanization, infrastructure growth, economic incentives, and population increase were the major drivers.

Policy Recommendations

These findings highlight the need for integrated land-use policies that prioritize the protection of fertile farmland, strengthen rural employment opportunities, and secure land tenure rights.

Future Research

Future studies can adopt longitudinal approaches to capture variations in farmland conversion dynamics across different agro-ecological and socio-economic contexts. Further exploration of environmental drivers such as land degradation and climate change, as well as the effectiveness of land-use governance mechanisms, will be critical to designing more targeted interventions.

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