



Research Article

The Nexus of Land use Changes and Livelihood Transformation of Farmers at Rural-Urban Interface of Pakistan

Naveed Farah^{1*}, Izhar Ahmad Khan¹, Asif Ali Abro², Jehanzeb Masood Cheema³ and Muhammad Luqman^{4*}

¹Department of Rural Sociology, University of Agriculture, Faisalabad, Pakistan; ²Newports Institute of Communications and Economics, Karachi, Pakistan; ³Department of Land and Water Conservation Engineering, PMAS-Arid Agriculture University, Rawalpindi, Pakistan; ⁴Department of Agricultural Extension, College of Agriculture, University of Sargodha, Sargodha, Pakistan.

Abstract | In Pakistan, rapid urban expansion is changing the landscape at rural-urban interface through agricultural land conversion into urban infrastructures. The present study compares the patterns of land use changes and the resulting livelihood transformation of farmers at urban fringes in two contrasting cities of Punjab province of Pakistan. A mixed method approach was employed for data collection and at first, a longitudinal analysis of Landsat imagery of land use was done through GIS and Remote Sensing for a time period of 2001-2016. The results of GIS analysis revealed that during the period 2001 to 2016, Faisalabad showed 24% increase in urban area and 23 % of this expansion consumed agricultural land. In Sahiwal, urban land has increased by 21 %, which encroached 13 % of agricultural land and 8 % bare land. Qualitative and quantitative data show that most of the farmers (82.4 % in Faisalabad & 78.5 % in Sahiwal) have relocated toward more intensive farming from traditional extensive agriculture in response to declining agricultural land and, the 65.2 % (Faisalabad) and 71.8 % (Sahiwal) of respondents rely on farming plus non-farming activities as alternate livelihood strategies. The results of independent T-test reveals that the human and social assets index show an improved livelihood in Faisalabad. However, Sahiwal has a better Physical assets index ($p=.008$), natural assets index ($p=.000$) and Financial assets index ($p=.000$) as compared to Faisalabad. The overall livelihood index shows an improvement in the livelihood assets indicator in Sahiwal as compared to Faisalabad. The research findings will be helpful to understand the ways in which people construct their livelihoods in the milieu of agricultural land use changes at urban fringes which is crucial for formulating the strategies for the well-being of the farming households.

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***Correspondence** | Naveed Farah, University of Agriculture, Faisalabad, Pakistan; **Email:** n.farah@uaf.edu.pk and Muhammad Luqman, University of Sargodha, Sargodha, Pakistan; **Email:** muhammad.luqman@uos.edu.pk

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Introduction

Throughout the history, land use changes have occurred due to human induced interventions for their social, economic and environmental purposes. However, the changes in the composition and utilization of land have direct or indirect affects the

livelihood of rural communities across the globe. In recent years, peri-urban development occurred mainly due to competition between different land uses *i.e.* the traditional land use (rural/agriculture) and new (urban) land uses. Hence, the Rural-Urban Interface (RUI) in low and middle-income countries are facing extensive land use changes resulting in loss of

agricultural land due to rapid urban expansion. Human competition for land and urban expansion has driven to profound fundamental modifications in the dynamics and composition of the landscape, and affecting the fragile rural/urban balance (Alberti, 2010; Barrico and Castro, 2016). Land use change in urban peripheries due to urban expansion is considered as a proof of development (Hegazy and Kaloop, 2015) however, it is a widely expressed concern that expanding cities will come up with substantial loss of farmlands (Francis *et al.*, 2012; Haregeweyn *et al.*, 2012; Zhen *et al.*, 2014).

Throughout the urban history, the rural and peri-urban resources have been depleted and degraded for urban purposes. However, it has never been such a problematic issue as it is in recent times due to the augmented rate of urban growth which leads to resource scarcity. Urban expansion is contributing towards a range of environmental and social problems in urban areas and the adjoining country sides. The land use changes from agricultural to urban purposes may considerably affects the sustainability of the soil and water resources, ecosystem functioning and biodiversity, climate change, as well as social and economic well-being (Bossio *et al.*, 2010; Vliet *et al.*, 2015).

In the villages situated at the rural-urban interface, the process of agricultural land conversion to built-up areas comes up with livelihoods transformations of the people who rely on natural resources (Kamwi *et al.*, 2015). Conversely, urban development is not presenting constraints for them but also generates opportunities by enhancing the access to basic facilities and diversifying livelihood strategies (Cobbinah *et al.*, 2015). This explains the potential of urban expansion to either improve or deteriorate the livelihood prospect of people living in the urban fringes who are not only vulnerable to the urban encroachment of their agricultural lands; but simultaneously, there are several options for land uses, access to markets, water supply, housing or non-farm income generating activities. However, the development plans often ignored such opportunities by undermining the positive impacts of the variety of opportunities for the livelihoods and vulnerability of people living at rural-urban interface (Seto and Ramankutty, 2016; Ricci, 2019).

In an agricultural economy like; Pakistan, land use serves as the backbone and Pakistan has long been a nation defined by its countryside, however, today this

tradition is imperiled. Population growth combined with massive rural to urban migration has forced cities to find solution to accommodate this large influx of people through their expansion. Urbanization in Pakistan has changed the landscape and the demography of the country. Agriculture is the main stay of Pakistan economy and it remains crucial for the social and economic development of the country since its inception. It nourishes a rapidly growing population, employs more than half of the labor force, add a substantial share in exports, and provides raw material for manufacturing industries (Malik *et al.*, 2016; GoP, 2016). The current estimates of FAO show that in Pakistan, agriculture is the most dominating land use that covers 47 % of the total land area of the country. Currently, Pakistan is experiencing an augmented urbanization rate with an urban growth rate of 3% that is highest among the South Asian countries and it is estimated that by 2025, the urban settlements will accommodate approximately half of the country's population (UN, 2018).

Historically, land remains a major source of earnings in the rural areas of Pakistan. In the context of agricultural economy of Pakistan, farmer's livelihood is greatly influenced by the patterns of land use. However, farming households are unable to sustain their livelihoods through agriculture as a primary source of income. This is because the agricultural sector is facing a steep reduction in farm sizes, low farm output, backward production technologies, land degradation, increasing soil erosion, rising subsistence farming and changes in climatic conditions (GoP, 2010; Malik *et al.*, 2016; Spielman *et al.*, 2016). Their agricultural activities are further depreciated by the current trends of land use changes at rural-urban interface. The rapid urban expansion along with industrial development and swift population growth have transformed the traditional uses of agricultural land in the villages situated at the fringes of all major cities of Pakistan (Farah *et al.*, 2019).

Farmers respond to the pressure on land and meager agricultural output by adopting multiple livelihood strategies including diversified non-farm livelihood strategies, yet, these options are not permanently accessible or available for them. Hence, understanding the ways in which people construct their livelihoods in the milieu of agricultural land use changes at urban fringes is crucial for formulating the strategies for the well-being of the farming households. While, this

phenomenon has captured the attention of researcher during last few years, but most of the research on land conversion and impact on farmer's livelihood in highly urbanized cities of different regions. But, little attention was paid to the cities that are at initial stage of urbanization as the push and pull dynamics of LULC changes and livelihood options may be different in both the cases. The present study is envisioned to portray a comparative picture on the land use changes in two contrasting cities *i.e.* a city at advanced stage and a city at initial stage of urban expansion in Punjab province of Pakistan, in order to observe whether there is any difference in the rate of LULC changes and livelihood transformation depending upon the stage of urban expansion. Under this scenario, the present study is designed to investigate the most profound question related to LULC changes that:

1. What are the comparative patterns of urban expansion and agricultural land use changes in both case studies and which factors derive these changes?
2. Which alternate livelihood strategies are adopted by the farmers and what are the livelihood outcomes resulting from transformed livelihood strategies?

Materials and Methods

The study was conducted in the year 2017-18 and the case study research approach was employed by using mixed method research paradigm. Many researchers agreed that for a comprehensive investigation of land use changes and its causes and consequences, a sole research approach is insufficient, rather, a combination of multiple approaches is suggested (Lambin *et al.*, 2000; Kalnay and Cai, 2001; Long, 2007).

Study area

Punjab province of Pakistan was selected for the research due to its rich climatic variations, fertile agricultural land and strong agrarian background. (GoP, 2016). During the last several decades, considerable land use changes have been occurred in the province as a result of rapid demographic changes coupled with economic development (Zaman, 2012; Nazir, 2015).

On the basis of current trends of urban expansion in Punjab (Urban Unit, 2018), two cities were selected purposively as case studies representing the contrasting settings, such as;

Case study-I: A large city *i.e.* Faisalabad at an advanced urbanisation stage, driven by urban "pull"-dynamics, **Case study- II:** A smaller city *i.e.* Sahiwal at an early stage of urbanisation and characterised by rural "push"-factors.

Among 36 districts of Punjab Province, Faisalabad is the 2nd most urbanized city while Sahiwal is ranked 20th and showing a fast trend towards urbanization (GoP, 2016). For analysis purpose, 18-20 and 10-12 km radii were selected for Faisalabad and Sahiwal cities respectively that encompass most of the urban area with the spatial coverage of approximately 553 km² and 29 km² respectively.

Initially, the land use changes in both cities were analysed by using Satellite images (Landsat) for the period 2001-2016. The maps show that most of the expansion has occurred along the North- West -South belt in both of the case studies. These satellite maps were used to select 3 communities at rural-urban interface of each city purposively considering the following criteria for further investigation of land use changes and livelihood assessment:

1. Distance from city centre *i.e.* 18-20 km in Faisalabad and 8-10 km in Sahiwal
2. At least 50% area had undergone land use changes.

Sampling

The sample households were selected by following a two-stage sampling design and at first stage, 12 villages were selected purposively from selected Peri-urban communities (2 villages from each community) in Faisalabad and Sahiwal.

The unit of analysis in this study was farming household, so, at second stage, proportionate sampling technique was applied to decide about the size of sampled household from each village. Out of 2,082 farming household, 416 farming households from the selected villages were selected proportionately depending upon the number of farming households in the villages whether full-time or part-time. In this way, 221 respondents from Faisalabad and 195 respondents from Sahiwal were selected for survey. The head of the household was considered as respondent.

Data collection

The present research employed the mixed method approach, so quantitative and qualitative methods were

used to gather household data through different tools and techniques. Land use change analysis was done by using GIS and Remote Sensing.

Land use data: The data regarding urban expansion and conversion of agricultural land during the period 2001-2016 was collected by employing Remote Sensing and GIS techniques which is frequently used by many researches to measure urban expansion and land use changes (Weng, 2001; Long *et al.*, 2007; Ghaffar, 2015; Osman *et al.*, 2016).

Household data: For quantitative data collection face to face survey was conducted by using a structured interview schedule encompassing both open and close ended questions for capturing the information regarding the implications of urban expansion for agricultural land use, non-farm income generating opportunities and subsequent livelihood transformation.

Qualitative data: For qualitative data 06 (FGD's) were conducted to validate the data. From each community, one (1) FGD was conducted with the farmers who have sold their agricultural land and adopted some alternate livelihood strategies. Key informants include the real estate agents and local political leaders in both case studies.

Data analysis

1. The ERDAS and GIS were used to calculate area under cropping for the LULC maps of both cities. In ERDAS the area was calculated by the number of pixel in the map. The number of pixel was further converted into the area units. The boundary shape file of the area of defined classes was created in the ArcGIS area was calculated using statistically.
2. The quantitative data was analyzed through Statistical Package for Social Sciences (SPSS) and the indicators of livelihood outcomes were scored and analyzed by comparing their means for two case studies using independent T-test.
3. Thematic analysis of qualitative data produced through focus group discussions, and key informant interviews, was carried out through translation of field notes and audio recordings, coding and triangulation with research questions.

Results and Discussion

The integrated data obtained through remote sensing

and GIS, quantitative and qualitative methods identified the spatial changes and transformation in the livelihoods of farmers residing at the rural-urban interface in Punjab province of Pakistan. The following sub-sections describe the results of the study:

Agricultural land conversion resulting from urban expansion

At the urban fringes of both case study areas, the horizontal urban expansion was observed with residential development as the dominant expression of this expansion. In order to detect the range of urban intrusion on agricultural lands, Land use and Land Cover (LULC) maps of Faisalabad and Sahiwal were generated for years 2001, 2009 and 2016. Supervised and unsupervised classification was performed for mapping of land use land cover using ERDAS Imagine 2014. Landsat tile was classified into 25 classes that were merged into three major classes (*i.e.* urban, bare and vegetation) bases on signature and training samples of these land features. Further verification of maps was carried out using Google Earth from historical images. For 2016, supervised classification was done using training of 3 major classes. Classification was performed using these training areas to classify other pixels based on the likelihood of these training classes. Figure 1 provides land use map of selected area within city Faisalabad.

It is evident from the Figure 1 that the urban area of Faisalabad city (within the radius of 18 km) has shown spatial increase during the time span of 15 years. Table 1 illustrates that the shift in area (ha) of each class with percent change shows an overall increase of 24% in urban area of Faisalabad from the year 2001 to 2016 while most of the agricultural area (23% decrease) has been converted into urban settlements.

The World Bank (2015) also reported 19 % decrease in the agricultural land, 1 % decrease in barren land and 14 % increase in the built-up area of Faisalabad city during the period 2000-2013. The report also mentioned that fast expansion and haphazard growth in city area of Faisalabad during this time period with residential development as a key feature. Various other researchers (Bahlli *et al.*, 2012; Peerzado *et al.*, 2019; Nazir, 2015; Zaman, 2012) also supported the findings of the study that all the major cities in Pakistan are expanding at a faster pace and consuming the fertile agricultural land at the rural-urban interface.

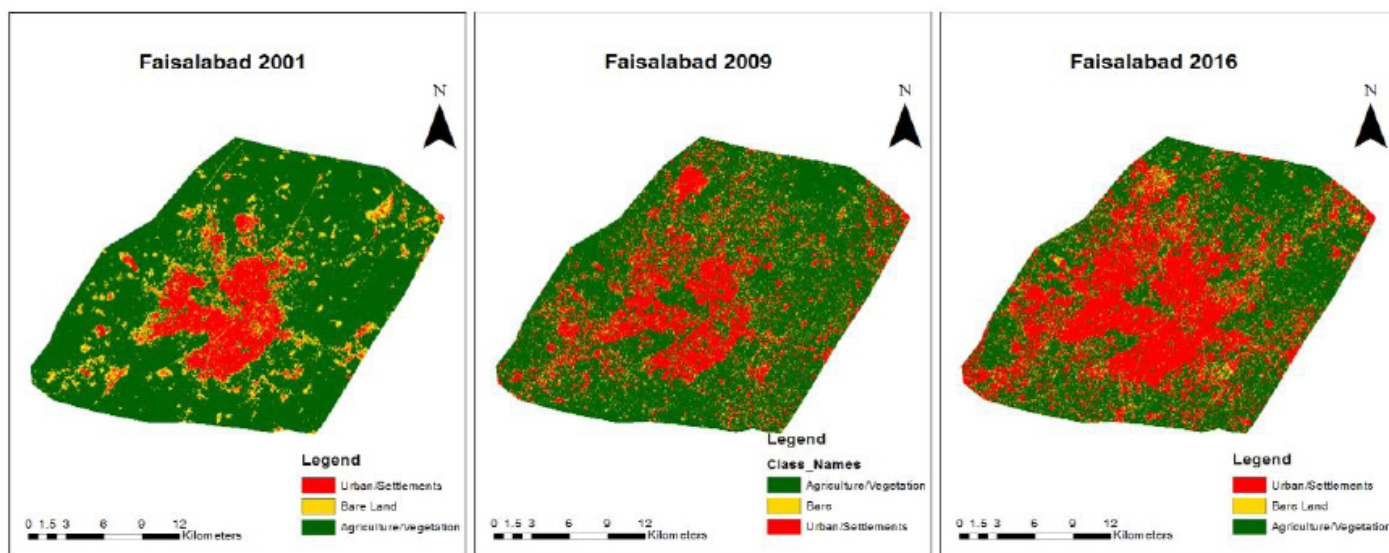


Figure 1: Spatial maps of Faisalabad for year 2001, 2009 and 2016.

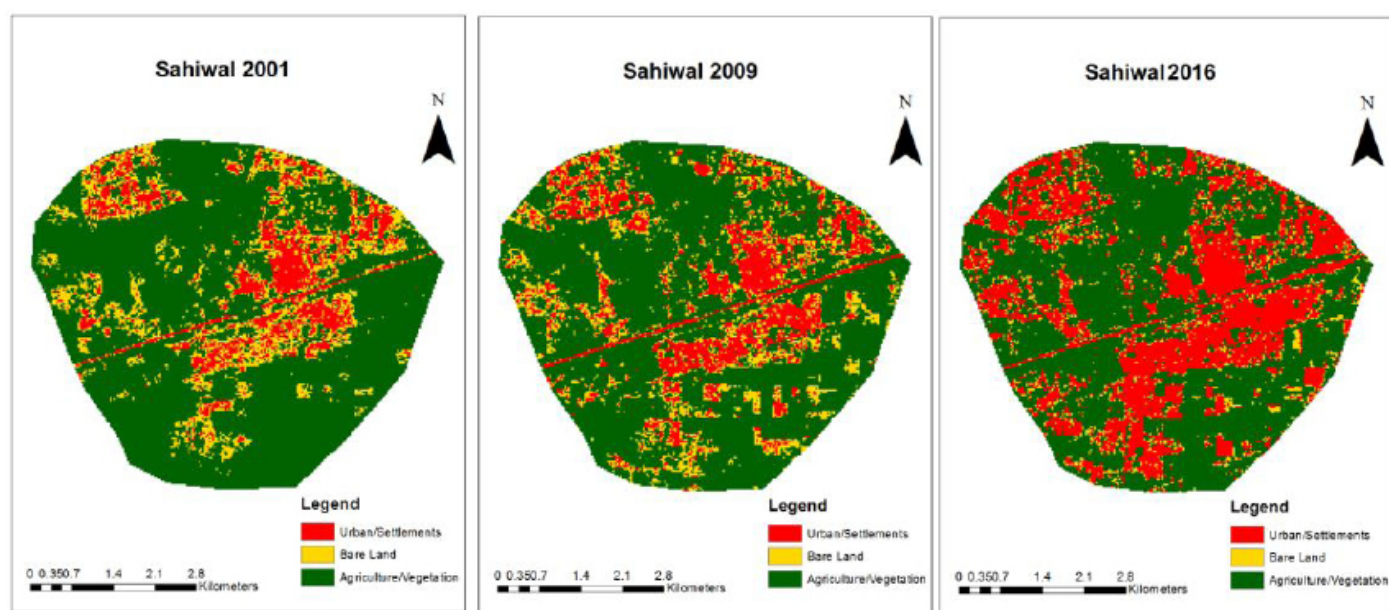


Figure 2: Spatial maps of Sahiwal for the year 2001, 2009 and 2016.

Table 1: Land use change analysis of Faisalabad from 2001 to 2016 (Area in hectares).

Class	2001	2009	2016	Percent Change
Urban/ Settlements	6968 (12.6 %)	12344 (22.3 %)	20162 (36.4 %)	24
Bare land	6391 (11.4 %)	5517 (10.0 %)	5852 (10.6 %)	-1
Vegetation/ Agriculture	41998 (76.0 %)	37495 (67.7 %)	29343 (53.0 %)	-23
Total	55357	55357	55357	

In Sahiwal, on the other hand, city area within the radius of 10 km, was selected and LULC satellite maps were generated for years 2001, 2009 and 2016 (Figure 2) which demonstrate the extent of city expansion during the observed period.

Table 2 provides change in area (ha) of each class with percent change which shows overall 21% increase in urban area of Sahiwal from 2001 to 2016. Major portion of this encroachment is on agricultural land as agricultural land has been decreased by 13 %, whereas, 8 % barren land was also consumed for urban infrastructure. The maps also showed an outward expansion of the city in North-Eastern, South-Eastern and North-Western sides.

It is clear from the results that in Faisalabad, although there is 23 % reduction in the farmland, the change in land use/land cover occurred at somewhat constant pace, while in Sahiwal from 2001–2009 no significant change was observed in the land use/land cover but from 2009 to 2016 the urban land increased in double figures as compared to the reduction in the vegetation

and bare land inversely. Various other studies (Mohsin and Khan, 2017; Yar *et al.*, 2016; Younes *et al.*, 2017) also found similar trends of urban encroachment of agricultural land in small cities of Pakistan. This analysis show that urban expansion is consuming agricultural land in all the cities of Pakistan irrespective of the fact that whether the city is at highly urbanized stage or at initial stage of urbanization.

Table 2: Land use change analysis of Sahiwal from 2001 to 2016 (Area in hectares).

Class	2001	2009	2016	Percent Change
Urban/Settlements	341 (11.4 %)	482 (16.2 %)	968 (32.4 %)	21
Bare land	472 (15.7 %)	449 (14.9 %)	232 (7.7 %)	-8
Vegetation/Agriculture	2185 (72.9 %)	2066 (68.9 %)	1797 (59.9 %)	-13
Total Area (ha)	2997	2997	2997	

Livelihood Transformation of farmers

Land and people are interrelated and interdependent natural resources that rely on each other for their sustainable development. Therefore, agricultural-based livelihoods are closely associated with land and are dependent on physical environment (Dhas, 2008). Rapid urban expansion adversely alters the use of farmlands in the areas at urban fringes. In many developing countries, however, these negative impact is getting worsen due to the absence of any sound policy on planning and managing urban expansion. In the study area, the process of land use change from agriculture to urban development has not only change the agronomic activities but the livelihood patterns of the farmers were also transformed considerably.

Change in agricultural activities

The research findings revealed that in both case studies, one of the major implication of urban expansion on farmer's livelihood is gradual displacement of farming activities. It was observed that although, agriculture is still one of the main livelihoods activity but it has lost its economic value due to decreasing number of households which are full-time engaged in farming. The conversion of land of adjoining countryside into built-up areas or settlements decreases the extent of land accessible for agricultural activities. The study found that the average farm size in both case study cities is 1-2 acres (48.3 %). The percentage of landholders having 3-5 acres of land is 35.3 % and

the number of large farm size is very low *i.e.* only 1.2 % possessed above 5 acres of land.

Before 10 years, majority of the household heads (80.5%) were involved in agriculture as their primary source of income, whereas only 7.9 % were non-farmers and 11.5 % had farming + non-farming occupation. However, currently, situation is quite different as now only 10.1% of the respondents have farming as their sole livelihood activity, 16.6 % are engaged in non-farming while majority (73.3 %) of the household heads are involved into farming + non-farming income generating activities. Mandere *et al.* (2010) reported the reduction in the percentage of full time farmers at the urban fringes of Kenya from 90 % to 49 % during the period of 1960-2010 and 51 % households are only part-time farmers. John *et al.* (2020), also observed the shifting of economic activities in Tanzania from a predominately agrarian economy to one based on industry and services.

Due to reduction in land available for farming, large scale cultivation is not possible in the urban fringes, so as either a survival strategy or accumulation strategy, a general trend is the adoption of intensive agricultural practices from the traditional extensive agriculture and grow the crops with shorter gestation period and having high demand in local market (Mandere *et al.*, 2010, Thuo, 2010). It was found that wheat is the most cultivated crop in both case studies however, 89.4 % of the respondents told that they mostly grow wheat but it is used only to sustain the household food requirements. Afriyie *et al.* (2014) highlighted the cultivation of vegetables in peri-urban areas, as vegetables give quick returns of investment among all crops. Due to the rising demand in the city and the short gestation period, farmers are diverting to cultivating the vegetables in peri-urban areas. Besides vegetable cultivation, livestock keeping was equally adopted by the farmers in selected communities.

The fallow system which embodies extensive cultivation can no longer be practiced in these areas due to unavailability of extensive agricultural lands; hence to enhance the household food security crop intensification is adopted. It was the key finding of the study that most of the farmers (82.4 % in Faisalabad & 78.5 % in Sahiwal) have relocated toward more intensive farming from traditional extensive agriculture in response to declining agricultural land.

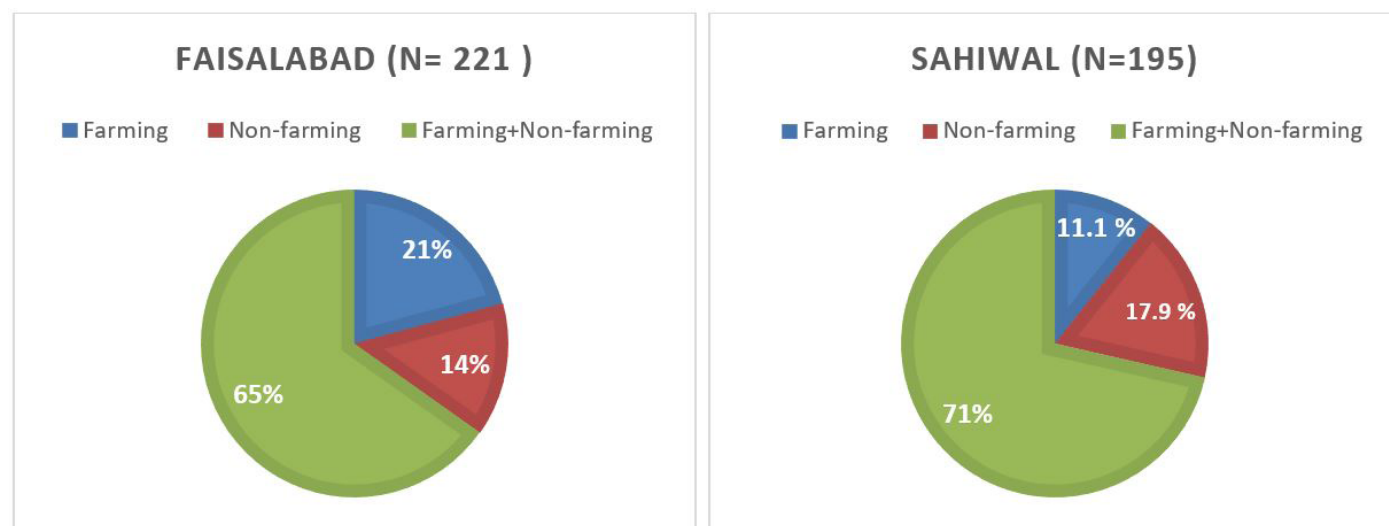


Figure 3: Percentage distribution of alternate livelihood strategies.

Table 3: Types of alternate livelihood strategies.

Alternate strategies	Percentage		Aggregated percentage (N=416)
	Faisalabad (N= 221)	Sahiwal (N=195)	
Job	14.0	12.8	13.5
Business	12.6	5.2	9.1
Agric. Labor	15.4	5.1	10.6
Construction laborer	5.9	12.8	9.1
Migration/Continue agri. somewhere else	10.9	3.1	7.2
Domestic workers	19.5	15.4	17.5
Dairy farming	21.7	45.6	32.9

In a similar study, [Korah et al. \(2018\)](#) also found that most of the farmers had modernized their farming practices in response to the land loss due to urbanization.

Alternate livelihood strategies

The non-profitable farming compared with the high land value by altering the use for building infrastructure force most of the farmers to sell their agricultural land to urban developers or convert it to some commercial purposes. Selling of agricultural land is an important alternate livelihood strategy and the results revealed that in Faisalabad 61.1. % respondents have been sold their agricultural land while in Sahiwal only 38.9 % respondents had sold their farmland. The high land values and selling price of agricultural land offered by the urban developers is the most powerful motive in the farmer's decision of agricultural land use change in the villages at rural-urban interface ([Farah et al., 2019](#); [Coulibaly and Li, 2020](#)). After selling their agricultural land, majority of the households simultaneously followed both farming and

non-farming income generating activities in order to sustain their livelihoods. The results clearly indicate that majority of the sampled households depend on a blend of livelihood strategies rather depending on single one ([Figure 3](#)). In Faisalabad, the 65.2 % and in Sahiwal 71.8 % of respondents rely on farming plus non-farming livelihood strategy. In another similar study, [Seraje \(2007\)](#) owed the adoption of non-farm income generating activities by majority of the farmers (50.5 %) due to shortage of land as major reason (47. 6 %) for this income diversification. However, his findings are in contrast in the sense that due to limited labour or business absorptive capacities in the nearby town, most of the people adopted non-farm activities as an additional income source whereas our study found the adoption of these activities as a regular income source due to lack of land available for farming.

[Table 3](#) shows various livelihoods strategies adopted by the respondents and it is clear that majority (32.9 %) respondents choose dairy farming as the alternate livelihood strategy. The trend of dairy farming is more prominent in Sahiwal (45.6 %) than in Faisalabad (21.7 %).

This is due to the fact that many international and national dairy companies had set up their production units in the villages at rural-urban boundary of Sahiwal and purchased milk from the farmers. Livestock keeping is a common supplementary source of income in the urban fringes due to the presence of milk market in the City ([Tariq, 2013](#)). Second important alternate strategy was the working as domestic or home workers (17.5 %); like house maids, gardeners, drivers

or security guards and this trend is more prevalent in Faisalabad. Ricci (2019) emphasized that due to development of peri-urban communities, high-middle class families arrived there with a desire of more living space or cheaper housing and, in turn, create work opportunities for domestic workers.

Among other non-farm occupations private or govt. jobs (13.5 %) and business (9.1 %) were adopted by the respondents. The remaining respondents were attached with agriculture in the form of tenants, agric. labor, or migrate and settled in some other rural communities and continue agriculture somewhere there. They sold their agri. land in these 2 cities at very high price and buy the more land area somewhere else at cheap rates. In turn, they are getting more production from large landholding at somewhere else. The findings are consistent with Cobbinah *et al.* (2015) who found migration or adoption of urban based employment by small farmers due to increasing trends of land use changes in the urban fringes of Ghana.

Among the emerging livelihood opportunities, different types of jobs are in access of these villages. In Sahiwal, mostly Petrol pumps, seed factories, dairy processing units, pesticide companies, shopping complex are providing jobs. In Faisalabad, domestic workers (House-maids, gardeners, security guards *etc.*), dairy farming, construction labor and jobs in textile units are the dominant alternate livelihood options for farmers. It was found that majority of the respondents have very low education and also lack of skills other than agronomic skills, due to which they are not capable of getting jobs in formal sector and are involved in unskilled informal activities like domestic workers, construction laborers, factory workers *etc.* as a major source of income. Cobbinah *et al.* (2015) and Nguyen *et al.* (2016) recognized that due to huge loss of farmland, agricultural labors have predominantly shifted towards informal-paid works, services or trade in the city. However, age and education play significant role in getting new livelihood opportunities. The above discussion made it clear that although opportunities for alternate livelihood strategies are available, especially in unskilled and informal sectors but they are largely unreliable and unsustainable in the long term. Our study also exhibits that majority (53.8 %) of the respondents were not satisfied with their current livelihood strategies. However, the findings are contradictory with Nguyen and Kim (2020) who established that urbanization is not pushing the

farmers but also creating opportunities for the betterment of peri-urban inhabitants. The participants of focus group discussion had varying viewpoints about the implications of this trend for the livelihoods of the farmers.

"Farmers are badly affected as they sell their agricultural lands and migrated from here. But now, they returned back after wasting their money in different businesses but now they have no land to cultivate" (A participant of FGD at Gattwala village, Faisalabad).

Another participant of FGD at Naymona village (Faisalabad) said that change of livelihood activities is partially sustainable for the farmers and only for those who started their business, he said:

"Small farmers are negatively affected as they owned only 1-2 acres of land or even less than an acre. But the large farmers got much benefit by selling their lands and they established factories or their own housing colonies by this amount".

In Village 94/9-L (Sahiwal) a participant added that: *"Only 30 % of farmers used the money to sustain their livelihood but almost 70 % of them spend the amount received after selling their lands on marriages and house construction or buying vehicles"*.

The urban developers were agreed that this trend of land use changes is adversely affecting the agricultural land, but they argued that it is benefiting the farmers economically.

"The farmers are purchasing more acres of agricultural land somewhere else, and they are cultivating those lands there, which were not being cultivated before" (urban developer at 94/9-L, Sahiwal)

An urban developer in Kamal pur, Faisalabad added that:

"Yes, we are consuming the agricultural land for housing construction, but it is the need of the time to accommodate the growing population. I think it will not affect the agricultural system in future, rather, farmer's livelihood is improving after selling their agricultural lands".

This qualitative data indicates that land use changes due to urban expansion significantly influenced the people who rely on natural resources for their livelihoods. Alternate livelihood opportunities are present

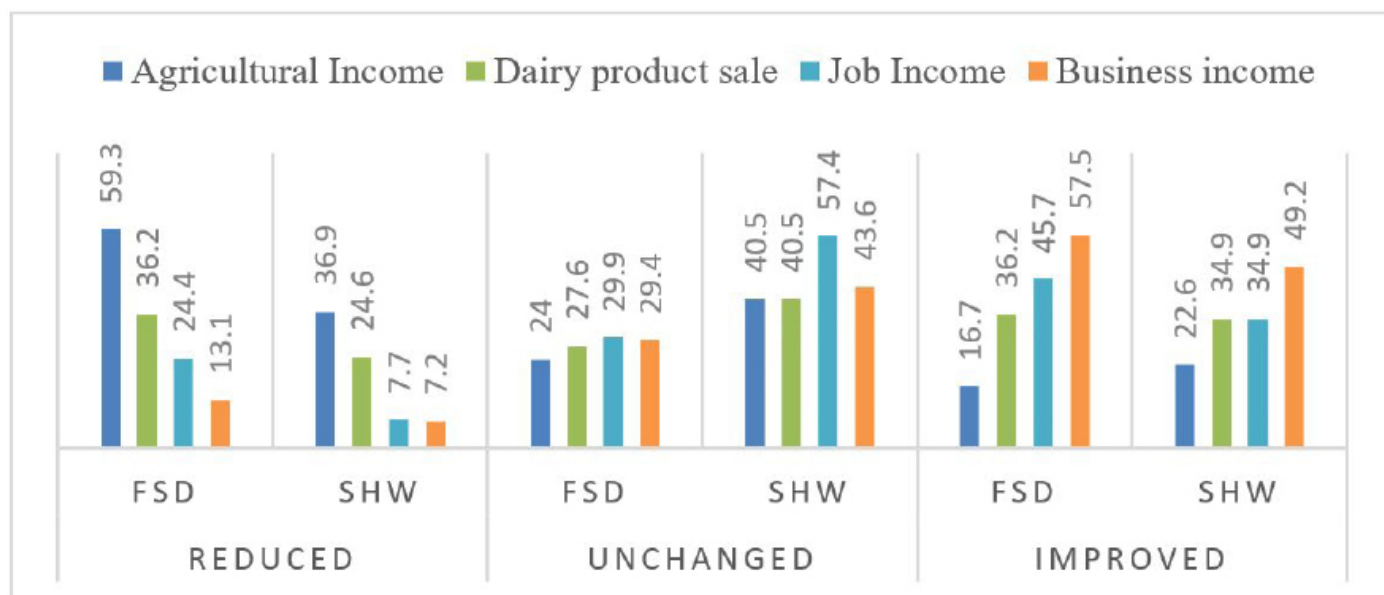


Figure 4: Effects of alternate livelihoods strategies on income of the respondents.

but not sustainable and also only available for those who possess the required assets and have a capability to utilize the opportunities emerged by urbanization.

Livelihoods outcomes

In the study area, the land use change results in considerable livelihood changes because farmers have shifted to new livelihood activities and change their primary means of living. [Toku et al. \(2021\)](#) also argued that agrarian communities at the urban fringes largely affected by the effects of urbanization which led towards major land use changes and livelihood transformations for farmers. We used more income and increased well-being (access to livelihood assets) as livelihood outcomes and findings of the research illustrate that the agricultural land conversion in both case studies brought both positive and negative impacts for the income and access to assets for the farmers in the villages located at rural-urban interface.

Effect on income: The [Figure 4](#) demonstrates the change in income from different sources as a result of multiple income generating strategies adopted by the farmers after selling their agricultural land. The outcome of the interviews revealed that in the study areas, the abandoning of agricultural activities has brought adversities for the farmers for whom the agriculture served as primary source of income. About half of the respondents (48.8 %) faced a reduction in income from agriculture, however, in Faisalabad, most of the respondents (59.3 %) faced a decline but in Sahiwal, majority (40.5 %) had no change in their income from farming. ([Haller, 2014](#) and [Afriyie, 2020](#))

also considered the reduction in size of farm area due to urban development as a threat for food and income security for the smallholders. The livestock keeping was recorded as the major alternate livelihood strategy in both case studies and overall a mixed trend was observed in income from sale of dairy products as almost equal percentage of respondent's majority (35.6 %) earned more from dairy product sale. Rapid urbanization in Pakistan is escalating the demand for foods in the urban centers and the rising demand for animal origin food urged the farmers in adjoin rural areas to establish dairy farms in fringe areas of all big cities including Faisalabad ([Tariq, 2013](#)).

Comparison of livelihood outcomes for the two case studies: Five types of assets/capital identified by [Dhas \(2008\)](#) in Sustainable Livelihoods Framework, including; human assets, social assets, natural assets, physical assets and financial asset were studied for the purpose of livelihood transformation. [Filmer and Pritchett \(2001\)](#) states that household's structural income status and underlying welfare can be assessed by the information about the access to assets and not based on short term variations in income. In Faisalabad, human, social, physical and financial capitals were either improved or remained unchanged while the changing livelihood strategies brought negative implications for natural capital of the respondents as 64.7 % of respondents faced a reduction in their farm size and 52.9 % of them had lost their occupancy status and shifted from ownership to tenants, share croppers or laborers. Source of irrigation water was also not improved and the majority (65.6 %) of

respondents complained that they did not get enough share of canal water, due to which they are compelled to depend on tube well or waste water (Figure 5).

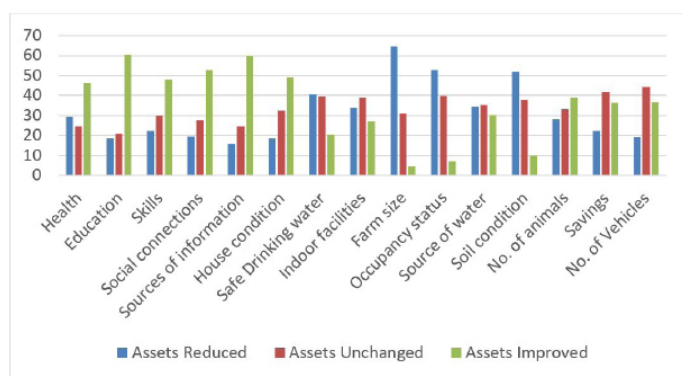


Figure 5: Livelihood Outcomes of farmers in Faisalabad (City at advanced stage of urban expansion).

In Sahiwal, again improvement or no change is observed in human, social, physical and financial assets. But on the contrary, the natural capital bear negative consequences like Faisalabad as 42.1 % of respondents faced a reduction in their farm size and 46.2 % of them had lost their occupancy status (Figure 6) However, the extent of reduction in farm size and occupancy status is comparatively less than the Faisalabad.

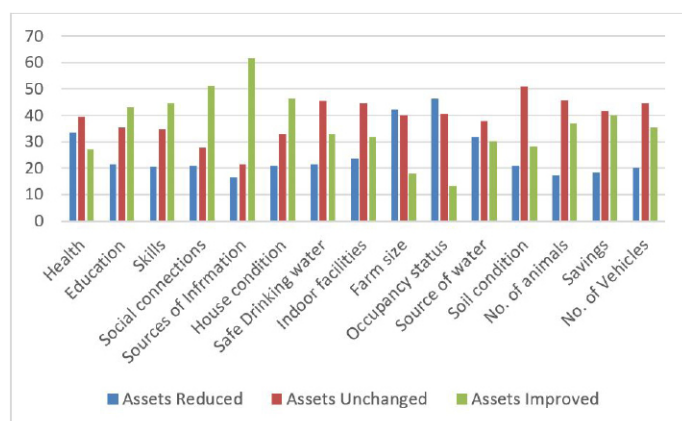


Figure 6: Livelihood Outcomes for Farmers in Sahiwal (City initial stage of urban expansion).

The indicators of livelihood outcomes were scored and analyzed by comparing their means for two case studies using independent T-test. A three-point rating scale with discrete value of 0 (Reduced), 0.5 (unchanged) and 1 (improved) was used for measuring the impact of alternate livelihood strategies for livelihood outcomes (Table 4).

The results of independent T-test (Table 4) reveals that the human capital *i.e.* health, education and skills, has improved in Faisalabad as compared to Sahiwal with T-value (2.536) and showing a significant

relation with a p-value (.012). Other studies (Har-egweyn *et al.*, 2012; Cobbinah *et al.*, 2015; Afriyie *et al.*, 2020) also found that urban development improves the people's access to water, electricity, schools, health and roads and contribute towards improved well-being in the areas at urban fringes. Social assets index also shows an improved livelihood in Faisalabad with t-value (.185) but having a non-significant relationship. Physical assets index is better in Sahiwal as compared to Faisalabad (T-Value= -2.673) and a highly significant relation at $p=.008$. Natural assets index is also better in Sahiwal with t-value (-5.799) and highly significant ($p=.000$). Financial assets index is again better in Sahiwal with T-value -2.246 and highly significant ($p=.000$). Pensuk and Shrestha (2007) also used independent T-test to compare the livelihood of 2 diverse groups of household and found that both groups of households have a low index in natural asset. Some recent studies (John *et al.*, 2020; Afriyie, 2020) also claim that in the process of livelihood transformation, the smallholders in the fringe areas are facing depletion of natural assets specially land as a new challenge. The overall livelihood index shows an improvement in the livelihood assets indicator in Sahiwal as compared to Faisalabad which shows that the urban expansion has adverse impacts for livelihoods of farmers in highly urbanized cities while the livelihoods of farmers is better in the city that is at the initial stage of urban expansion.

Conclusions and Recommendations

It is concluded that in both cities, agricultural land has undergone considerable changes and encroached by urban expansion particularly housing development, however, the rate of agricultural land conversion is higher in Faisalabad as compared to Sahiwal. As a result of these land use changes, the agricultural activities and livelihood patterns of farmers have been greatly changed in the communities at rural-urban interface of both case studies. Most of the agricultural land has been sold by the farmers to urban developers. Those who are still linked with farming have shifted towards more intensive and subsistence farming from traditional extensive agriculture in response to declining agricultural land. In both cities, majority of farmers adopted farming plus non-farming income generating activities as alternate livelihood strategies but there is variation in the types of non -farming activities. In Faisalabad, farmers were inclined towards business, dairy farming and domestic worker's jobs,

Table 4: *Livelihood assets indicators assessment for livelihood outcomes.*

Livelihood asset indicator	Faisalabad		Sahiwal		T-value	P-value
	Mean	S.D.	Mean	S.D.		
Human capital						
Health	.5837	.42747	.4538	.39705	3.197	.001**
Education	.7104	.39293	.6077	.38822	2.676	.008**
Skills	.6290	.39929	.6205	.38608	.219	.827 ^{NS}
Human capital index	1.9231	.99588	1.6821	.93414	2.536	.012*
Social assets						
Source of information	.7195	.37602	.7231	.38359	-.097	.923 ^{NS}
Social connections	.6674	.39200	.6513	.39837	.416	.678 ^{NS}
Social assets index	1.3869	.67814	1.3744	.69857	.185	.853 ^{NS}
Physical assets						
House condition	.6516	.38241	.6256	.39108	.683	.495 ^{NS}
Safe drinking water	.4005	.37725	.5872	.38003	-5.020	.000**
Indoor facilities	.4661	.39020	.5410	.37079	-2.001	.046*
Physical assets index	1.5181	.84726	1.7538	.95163	-2.673	.008**
Natural assets						
Farm size	.1991	.28794	.3897	.36524	-5.944	.000**
Occupancy status	.2715	.31414	.3359	.34988	-1.978	.049*
Sources of water	.4796	.40260	.4923	.39480	-.323	.747 ^{NS}
Soil conditions	.2896	.33348	.5359	.34988	-7.346	.000**
Natural assets index	1.2398	.83337	1.7538	.97437	-5.799	.000**
Financial assets						
No. of animals	.5543	.40647	.5974	.35645	-1.144	.253 ^{NS}
Savings	.5701	.37636	.6077	.36776	-1.027	.305 ^{NS}
No. of vehicles	.5882	.36325	.5769	.36500	.316	.752 ^{NS}
Income from all sources	.2873	.38141	.4282	.37987	-3.766	.000**
Financial assets index	2.0000	.95108	2.2103	.95486	-2.246	.025*
Overall livelihood index	8.0679	2.07582	8.7744	2.51703	-3.136	.002**

Scale: 0 = (Reduced), 0.5 = (unchanged), 1 = (improved)

****:** Highly-Significant; *****: Significant; **NS:** Non-significant.

whereas in Sahiwal, private jobs, dairy farming and transport were adopted as alternate ways. The livelihood outcomes were almost similar as human, physical and financial capitals were improved, social capital remained unchanged while the natural capital faced reduction in both cities, however, overall livelihood index shows an improvement in the livelihood assets indicator in Sahiwal as compared to Faisalabad .

Based on the research findings, firstly, it is suggested to manage urban expansion in a desirable and sustainable way while preserving the fertile agricultural lands at the fringes and implement a sound land use policy in the country. Development of intermediate cities and vertical infrastructure can be adopted to tackle the housing needs of growing population.

Secondly, steps should be taken to improve the livelihood options for the farmers at rural-urban interface. No doubt, urban development has offered new livelihood opportunities but most of such options are unsustainable, thus not adding much to the well-being of farmers. The results suggest that through better participation of small-scale farmers into gainful non/off-farm activities, the livelihoods of farmers can be improved in the areas located at urban fringes. There is a need to focus on the dairy sector development as livestock keeping was found as an important alternate strategy and results show stability in income from dairy farming in both case studies. Value addition of livestock production must be prioritized for the improvement of livelihood conditions in peri-urban areas. For peri-urban areas development, the significance

of rural-urban linkages is not fully recognized by the government and thus overlooked in national development plans. So, it is recommended to strengthen the rural-urban linkages through supportive non-farm and informal income generating activities in nearby towns/cities, supporting agricultural intensification, strengthening market infrastructure and supporting the development of agro-processing industries.

Novelty Statement

The land use changes at the rural-urban interface exerts multiple social, economic and environmental impacts for both the natural landscape and for the residents of these areas. The conversion of agricultural land into urban infrastructure creates direct implications for the livelihoods of agriculture associated people, however, not much attention was given towards the study of livelihood implication resulting from urban expansion and land use changes. Hence, the present study aims to analyze how spatial and agronomic transition processes affects the social and economic well-being and livelihood of the farmers along the rural-urban interface.

Author's Contribution

Naveed Farah: Conceived the idea, conducted field research and wrote the manuscript.

Izhar Ahmad Khan: Performed quantitative data analysis.

Asif Ali Abro: Literature reviewed and final editing.

Jahan Zeb Masood Cheema: Generated the LULC maps for both cities and analyzed the land use changes.

Muhammad Luqman: Helped in proofreading and finalized the manuscript.

Conflict of interest

The authors declared that there is no conflict of interest.

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