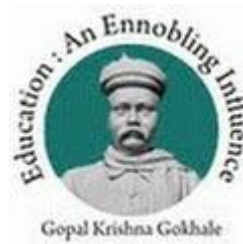


**IMPACT OF URBANIZATION ON SEMI-ARID AGRICULTURE
IN THE VICINITY OF HYDERABAD CITY, INDIA**

A THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ECONOMICS

AT



GOKHALE INSTITUTE OF POLITICS AND ECONOMICS

By

Ms. Kanchan Ghugre

Under Guidance of

Dr. Dilip Kajale

GOKHALE INSTITUTE OF POLITICS AND ECONOMICS

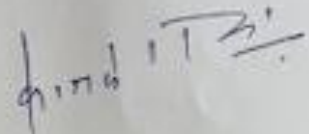
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**IMPACT OF URBANIZATION ON SEMI-ARID AGRICULTURE
IN THE VICINITY OF HYDERABAD CITY, INDIA**

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It is certified that the work incorporated in this thesis entitled "*Impact of Urbanization on Semi-Arid Agriculture in the Vicinity of Hyderabad City, India*" submitted by Ms. *Kanchan Ghugre* was carried out by candidate under my supervision. It is an original contribution and has not been submitted elsewhere for the award of any other degree. Such material as has been obtained from other source has been duly acknowledged in this thesis. I recommend that the thesis should be considered for the award of the degree of "Doctor of Philosophy".



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DECLARATION

I, Kanchan Ghugre, hereby declare that this thesis on the topic entitled, "*Impact of Urbanization on Semi-Arid Agriculture in the Vicinity of Hyderabad City, India*" is submitted for the award of Degree of Doctor of Philosophy in Economics to the Gokhale Institute of Politics and Economics, Pune 411004.

It is an original contribution and has been completed during my tenure as a research scholar at Gokhale Institute of Politics and Economics, Pune.

This thesis has not been submitted by me elsewhere for the award of any degree or diploma-part or full. The information gathered by me elsewhere for the thesis is original, true and factual. Such material as has been obtained from other source has been duly acknowledged in the thesis. I hereby request, to consider the thesis for the award of the degree of 'Doctor of Philosophy'.

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ABSTRACT

Urbanization is a dynamic phenomenon with multi-faceted impact on agriculture. While it is directly responsible for the land use changes, it is also influencing market access, technical efficiency of farming, land prices, agricultural inputs (labour and water) and regulatory frameworks. Urbanization-induced agricultural land use change is an important policy concern to ensure food and nutritional security and sustainability of farming systems. Urbanization-related pressures and opportunities influence farm households' decisions on the allocation of resources and produce diverse farming systems. This study aims to understand the effects of urbanization on the agriculture in the vicinity of Hyderabad, India, with a farming system approach.

The study relies upon the qualitative and quantitative data collected through the primary data collection by means of focus group discussions and a household survey (consisting of 400 farm households across 10 villages) to identify 5 dominant farming systems in the study area. In the first stage, the role of urbanization in the emergence of these farming systems is explored through the perspective of land use theories. Further, these farming systems are characterized on the basis of their components such as the crop and livestock production systems, the inputs used (labour, machinery and irrigation), marketing channels and value addition, and the socio-economic profile of the farmers. In the next stage, the impact of urbanization on the resilience of the identified farming systems is explored. The resilience of the farming systems is characterized by the three capacities of resilience i.e. robustness, adaptability, and transformability. Indicators were identified for the attributes that contribute to the capacities of resilience of the farming systems. In the last stage, the study attempts to understand the effects of urbanization on the farm labour participation through a gendered lens. It aims to understand the effect of urbanization on the participation of male and female members of land-owning farm households in farm and non-farm activities by identifying the factors affecting the participation of farm labor in full-time farming, full-time non-farm activities, and part-time farming activities. For data analysis, econometric and statistical tools were used with the help of STATA.

The study has identified the following dominant farming systems: 1) Monocropping without livestock, 2) Diverse cropping without livestock, 3) Monocropping with dairy, 4) Diverse cropping with dairy, 5) Cropping with small ruminants. The farming systems in

the study area are dynamic and evolving under the influence of a variety of urban pressures and mediating factors. Spatial structural changes, growing demand for food, and shifting diets are the urban pressures along with the mediating factors i.e., neighborhood effect, biophysical and socio-economic characteristics of the farm household, location of the farm, and distance to the market are influencing the farming systems in the vicinity of Hyderabad. Farmers are facing several constraints such as a shortage of farm labor, high input costs, shortage of farmland, high land prices, and low farm incomes. Diversification, intensification, agglomeration, land use expansion, and farm exits are the identified responses by the farm households. Urbanization has a mixed impact on the resilience of the farming systems. The indirect effects of urbanization i.e. market effect and the technical efficiency effect contribute positively to the adaptability and transformability of the farming systems by facilitating market access, demand for high-value crops, access to infrastructure, and agricultural services. It directly affects the robustness of the farming systems negatively by constraining access to natural resources i.e. land and water. while age, household size, and participation in the MGNREG scheme affect female participation, age, land size, and participation in livestock rearing affect male participation across activities. High-value crop cultivation promotes male and female participation in full-time farming. Urbanization affects the participation of household members by creating market access, access to non-farm jobs, and access to farmland.

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ACRONYMS

FAO: Food and Agriculture Organization

FS: Farming System

GHMC: Greater Hyderabad Municipal Corporation

HH: Household

HVC: High value Crops

ICRISAT: International Crop Research Institute for Semi-Arid Tropics

IFPRI: International Food Policy Research Institute

KMO: Kaiser-Meyer-Olkin

MGNREGS: Mahatma Gandhi National Rural Employment Guarantee Scheme

PMKSN: Pradhan Mantri Kisan Samman Nidhi

SLU: Sveriges lantbruksuniversitet (Swedish University of Agricultural Sciences)

TANGO: Technical Assistance to Non-Governmental Organizations

TLU: Tropical Livestock Unit

UPA: Urban and Peri-Urban Agriculture

EXECUTIVE SUMMARY

Introduction

The rapid expansion of urban areas has gone beyond the management capacities of the urban administrators in developing countries. The present standards and regulations stand insufficient to meet the challenges presented by urban sprawl. Informal urbanization is by-passing the guidelines and regulations laid down by urban planners to solve the present issues (Naab et al., 2013). This leads to a land-use shift in the fringe areas from agriculture to high-value urban uses such as urban dwellings, and development projects to compensate for the high land prices/rents. The conversion of farmland to high-value uses is a part of the process of economic growth and development which usually yields economic benefits. However, in this process, agriculture becomes secondary with priority given to urban development by policymakers as a tool of rapid economic growth. Land fragmentation, changes in land supply, rapid increase in land prices, and the subsequent inaccessibility of land are the results of urbanization.

The growing population and rapid urbanization, particularly in developing countries are making food and nutrition security more challenging (IFPRI, 2017). By 2050, Nigeria, China and India are expected to account for 35% of the growth in the world's urban population during 2018-2050 (United Nations, 2019). India alone is expected to add a population of 416 million to its cities. 60% of the megacities defined as metropolitans with a population of 10 million or more are in Asia, particularly in East, South-East, and South Asia (Pribadi et al., 2015). India has five megacities today (Mumbai, Delhi, Chennai, Kolkata, Bengaluru) and will add two more by 2030 (Hyderabad and Ahmedabad) (United Nations, 2019).

“Urban sprawl is described as the spatial expansion of urban areas as a result of insufficient regional governance and planning and certain externalities” (Cobbinah and Amoako, 2012). With the growing population of the cities, the existing infrastructure and amenities such as sanitation, housing, drinking water, and transportation prove inadequate for the residents. To cope with such congestion, the cities sprawl which results in the loss of traditional agricultural lands to unplanned urban outgrowth, both within the city and periphery. Further, it also contributes to the loss of biodiversity (IFPRI, 2017).

The farming system approach facilitates the understanding of the interconnections between multiple components in the agricultural sector as a result of a variety of internal and external influences (Gilbert et al., 1980). It allows us to recognize the problems and solutions which could be faced by multiple stakeholders in the agricultural community. According to Kebede et al. (2019), “farming systems are dynamic, complex socio-ecological systems that provide food, feed, and cash and result from past farmers’ livelihood strategies and land-use decisions.” Meuwissen et al. (2019) describe a farming system as a local network of farms and other actors/stakeholders, associated with a variety of economic processes and social systems, interacting in a particular agro-ecological context. A peri-urban farming system is “defined from a geographical perspective as the farming system performs in a defined space close to urban area” (FAO,1999). As a farming system operates in an open, agroecological environment, it adjusts to the changing environmental, ecological, and social circumstances (Meuwissen et al., 2019). Access to farmland and markets are major factors influencing the farmers’ decisions with respect to non-farm diversification, crop choices, land use and livestock rearing (Kebede et al., 2019). The present farming systems face a variety of social, economic, institutional, and environmental challenges. Recognizing and appreciating the various aspects of farming systems, factors influencing changes within them, and the direction of their evolution is a necessity in order to build resilient farming systems (Kebede et al., 2019). Appreciating farmers’ choices in terms of livelihood and adaptation strategies in the context of their socio-ecological environment is necessary to recognize the issues and policy interventions that influence socio-economic changes and encourage innovations toward sustainable agriculture (Feola et al., 2015).

Rapid expansion of the cities is changing the agricultural value chains in terms of diets transformation, supply of commercial agricultural goods, and the markets catering to the urban food demand (IFPRI, 2017). The value chains for high-value crops and for staple food crops are experiencing a renovation in the developing parts of the world due to their megacities (IFPRI, 2017). Rapid urbanization and increasing incomes are resulting in diverse diets which include fruits, vegetables, and animal protein products (Rao and Joshi, 2009; Kumar, 2013 Hazell, 2019). With the increasing participation of women in the labor force, the demand for processed foods is increasing in urban areas (IFPRI, 2017). These transformations are accompanied by the vertical integration of the traditional staple food value chains as a result of the increasing scale of the middle and retail sections such as transportation, wholesaling, warehousing, cold storage, primary and secondary

processing, and supermarket chains (IFPRI, 2017; Hazell, 2019). Technology adoption by the farmers is also influenced by the cities as high input prices are compensated by the high output prices in the urban markets (IFPRI, 2017). Keeping this trend in mind, private dealers invest in the marketing of agricultural inputs near the cities (Hazell, 2019). This offers an opportunity to the farmers who can link themselves to the modern value chains.

Problem Focus

The Food and Agriculture Organization of the United Nations (FAO) defines “food security as a situation that exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preference for a healthy lifestyle.” A direct effect of rapid urbanization is the loss of peri-urban agriculture, which plays an important role in supplying fresh food to the cities (IFPRI, 2017; Filippini et al., 2018). Urbanization presents the farmers in the peri-urban region with several constraints and opportunities (Hazell, 2019). Proximity to the urban market, a high-income consumer base, rising demand for high-value food crops, and non-farm job opportunities are the opportunities emerging for farmers as an outcome of the urban expansion (Rao et al., 2006; IFPRI, 2017; Gumma et al., 2017; Hazell, 2019). However, urbanization also enforces several constraints such as scarcity of farmland and irrigation, high land prices, land fragmentation high farm wage rates, shrinking grazing lands, and pollution (Cobbinah and Amoako, 2012; Swaine, 2013; Gumma et al. 2017) It also affects the interdependence between crop and livestock systems (Swaine, 2013). As a result of the measures taken by the farm households to adapt to these changing circumstances, dynamic farming systems emerge in response. Identifying these peri-urban farming systems in the context of urbanization is an important step toward building resilient farming systems.

Farming systems around the world face accumulating societal, ecological, and economic trials raising concerns about their resilience to stresses and shocks. These issues need to be identified and addressed in their regional context as farms, supply chain actors and farmers act in their local environment and agricultural functions. “A farming system is characterized by constant and complex interactions between social and natural systems” (Cabell and Oelofse, 2012). The interlinkages between the social and ecological systems are the focus of the resilience approach (Adger, 2000; Folke et al., 2003; Darnhofer et al.,

2010; Jacobi et al., 2015). According to (Darnhofer et al., 2010); “a farming system can be sustainable only through adaptability and change.” This entails a dynamic insight into resilience which is not restricted to robustness or the buffer capacity to withstand shocks and the subsequent return to the initial state. Thus, as a dynamic system attribute, resilience appears to be apt for appreciating farming systems with respect to a dynamic phenomenon (Jacobi et al., 2015) e.g. urbanization. Thus, it is necessary to assess the resilience of peri-urban farming systems to understand and address the issues faced by farm households in a region peri-urban region in the face of rapid urban expansion.

Another dimension of the effect of urban sprawl is the time allocation of the farm household. Empirical studies in semi-arid villages of India have shown that non-farm livelihood sources may account for 45-55% of average household income and seem to be of raising significance (Nedumaran, 2013). A rise in urban consumption is accompanied by an increase in agricultural income and non-farm employment (Chand et al., 2009). With the rapid urban expansion, rural labor is attracted to the urban areas for non-farm work opportunities due to a variety of reasons such as shrinking farmland, higher wage rate, and sluggish expansion of the rural non-farm sector (Rao and Joshi, 2009). Farmers around Hyderabad are facing a shortage of farm labor due to the preference for non-farm livelihood activities. One of the major factors facilitating this shift is the MGNREGA scheme implemented by the Govt. of India (Narsimha et al., 2014). Additionally, to support the high cost of farm inputs and relieve the credit stress, farm households diversify into non-farm livelihood activities (Matshe and Young, 2004). To identify and understand the pattern of the shift of farm labor in the peri-urban regions across the farm and non-farm activities, understanding the time allocation of farm households for their livelihood activities with a gender lens is necessary. This exercise is necessary to identify policy interventions to facilitate an adequate supply of labor for both farm and non-farm activities.

Research Questions

With this backdrop, we arrive at the following research questions:

1. What are the different crop-livestock production systems around Hyderabad and their resilience to the changing resource constraints and urbanization?

2. What are the key drivers of the changing cropping pattern by the farmers over the years due to urbanization?
3. What are the adaptation strategies adopted by the farmers to the resource use challenges and market opportunities imposed by urbanization?
4. What are the changes made by farmers in their marketing strategies as a result of the changing marketing environment created by urban sprawl?
5. How are the farm households allocating time across farm and non-farm sectors in order to meet the challenges and opportunities presented by urbanization?

Methodology

Identification of the Farming Systems

The current study aims to contribute to the growing literature on understanding the effects of urban sprawl on land use, agriculture, and farming systems in the context of rapidly developing cities. We identify the farming systems in the study area in the context of Hyderabad city. The aim is to understand the influence of urbanization and a variety of mediating factors on the development of farming systems from the lens of land rent theories. We observed five components of a farming system for this purpose.

1. Agro-Climatic Conditions
2. The Crop and Livestock Production System
3. The inputs: Labour, Machinery, Irrigation
4. Marketing Channels and Value Addition
5. Socio-Economic Profile of the Farmers

Assessment of Resilience of the Farming Systems Identified

The resilience perspective emerged from ecology in the 1960s and early 1970s. Hollings (1973) introduced resilience as “the capacity to persist within such a domain in the face of change” and proposed that “resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state

variables, driving variables, and parameters and persist.” Resilience is the ability of a system to withstand shocks and to continue to transform simultaneously in order to largely maintain the same services, configuration, identity, and responses (Walker et al., 2004). It also incorporates the prospects that disruptions open for stakeholders with respect to the realignment of transformed configurations and processes, the opening of new paths, and the regeneration of the system (Carpenter and Gunderson, 2001).

The concept of resilience is a holistic one making it challenging to measure it. But its bifurcation into subcomponents makes it possible to identify proxy indicators for its measurement. (Jacobi et al., 2015; Cabell and Oelofse, 2012; Darnhofer et al; 2010). We take inspiration from the framework developed by Meuwissen et al. (2019) to assess the resilience of farming systems. Each farming system performs some desirable functions. These functions can be divided into the provision of private goods and public goods. Private goods include delivery of healthy and affordable food, delivery of raw material to industry, ensuring reasonable livelihood to farming system actors, and improving life quality by providing employment. The public goods include maintaining natural resources, protecting biodiversity, ensuring that rural areas are attractive for tourism, and ensuring animal welfare. We limit the scope of our study to functions that provide private goods. Meuwissen et al. (2019) argue that a farming system should have three individual capacities to be resilient. 1. Robustness is the ability of farming to withstand shocks and stresses and continue its functions. 2. Adaptability is the ability of a farming system to continue its functions in the face of stresses and shocks by changing its input configurations. 3. Transformability is the ability of the farming system to transform itself in reaction to severe shock or disruption which makes continuity of functions as normal impossible. Such transformation may result in a lasting shift in the functions of the farming system.

Taking inspiration from the USAID/TANGO method (TANGO International, 2018) of computing resilience capacity indexes, we calculate indexes for robustness, adaptability, and transformability for each farming system identified. Each index is made up of a combination of indicators computed from household-level data.

We use factor analysis to combine these indicators of resilience into indexes (TANGO International, 2018). Factor analysis is a multivariate statistical method that uses the relationship among variables to identify one or more underlying factors. A “factor” is an unobservable or latent variable that can be understood through its relationship with other

variables that can be observed and measured. Resilience measurement is not possible using a single variable as the concept is multidimensional. Thus, a scale is developed based on various indicators that capture various traits associated with resilience capacity. Factor analysis allows the researcher to calculate the relative weights of the respective index components based on their inter-relations and create a single variable i.e., the index.

We applied factor analysis to calculate index weights which are further used in the calculation of the resilience capacity index. A Kaiser-Meyer-Olkin (KMO) test is used to confirm that the index components have enough in common to warrant factor analysis. In the next step, the index is calculated for the resilience capacities using the weights derived from factor analysis. For reporting purposes, the index is standardized and placed on a scale of 0 to 100 using minimum and maximum values. Further, average values of each resilience capacity for each of the farming systems are calculated to help understand the contribution of each capacity and for comparison of resilience capacities across farming systems.

Time Allocation of the Farm Households

The option of full-time working off the farm is generally neglected in farmers' time allocation studies (Kimhi, 1994). Many farmers divide their time between farming and off-farm work. Part-time farming is becoming a common phenomenon in India with the growing importance of non-farm income sources to the farm household (Binswanger-Mkhize, 2013). This prompts the question if part-time farming is a stable phenomenon or a move in the direction of exit from farming (Kimhi, 1994). The urban expansion offers access to non-farm jobs to the farmers located in the peri-urban areas. It influences access to farm production factors such as land, water, and labour while also providing access to an urban market. This prompts a production and consumption decision dilemma for the farm household. A production decision at the farm household level affects food security, sustainability, and poverty alleviation as the majority of the poor population is located in the rural areas of developing countries (Kuiper et al., 2007). Urbanization influences the decision to participate in non-farm activities, the choice of crops, investment in agricultural inputs, and assets (Mathijs et al., 2012; Pribadi and Pauleit, 2015; Delbecq and Florax, 2010). Thus, it is important to understand if urbanization as a stimulus is affecting the choice of farm households with respect to labour time allocation across farm and non-farm, activities. We investigate the time allocation of farm owners in the study area across four types of choices of time allocation. Most studies of time allocation deal

with the choice between full-time and part-time farming. However, we incorporate farm households who do not work on-farm at all, while retaining the choice to do in the form of ownership of farmland.

We estimate a multinomial logit model which involves four choices of time allocation for the farm households: Part-time farming, full-time farming, full-time non-farm, and idle. We estimate the model separately for the pooled sample, peri-urban sample and rural sample. This process is done separately for the male and female members of the farm household.

Study Area

Hyderabad, the capital city of the southern Indian state of Telangana, is the sixth-largest metropolis in the country. Hyderabad is in the Musi sub-basin which is a part of the Krishna River basin. It consists of twelve municipalities including the Greater Hyderabad Municipal Corporation. Rapid development, increasing job opportunities, and economic growth have attracted skilled and unskilled labor from across the country pushing the city's population to 10.3 million (Gumma et al., 2017; WPR, 2021). The public services are stressed with the inflow of migrants in search of livelihood opportunities. Efforts by the state government of the erstwhile Andhra Pradesh to develop Hyderabad as the hub of the IT sector in the country led to many changes in the policies regarding the development of infrastructure and facilities along with the concerned public sectors (Kennedy, 2007).

During 2005-2016, the built-up area in Hyderabad constituting housing and other buildings has increased from 38,863 ha to 80,111 ha; unfavorably affecting the water bodies and rainfed cropland (Gumma et al., 2017). The land under agriculture within the city limits has decreased with the ongoing infrastructure development with seasonal waterbodies being abused the most for building purposes. The expansion of built-up areas in the peri-urban region is attributed to the expansion of the IT sector (Kennedy, 2007). In 2005-2011, the Outer Ring Road was constructed from the eastern to the southern part of Hyderabad (HMDA, CICI). Along with the expansion of the IT sector, new pharmaceutical, food, and manufacturing companies were established and the real estate business in Hyderabad began to take off. This has resulted in a shift in land use, mainly

from farmland to built-up area (Gumma et al., 2017). As a result of these developments, the Musi River which flows through the city has become very polluted. Nevertheless, there is also a rise in wastewater-irrigated agriculture on the banks of the Musi River for vegetables and paddy cultivation to cater to the increasing urban demand (Gumma et al., 2011; Gumma et al.,2017).

Based on the findings of Gumma et al. (2017), field explorations were conducted. Semi-formal interviews were conducted with local experts and officials of the Department of Agriculture to identify the study area.

Data Collection

The study employed semi-formal interviews, focus group discussions and household survey. Semi-formal interviews were conducted with local experts, government officials, and local progressive farmers to identify the issues faced by the local farming community and upcoming trends and opportunities due to the proximity of an urban center. Based on these discussions, six villages were identified around Hyderabad to conduct focus group discussions with farmers. Discussions were conducted in Telugu with the help of enumerators using a predesigned instrument. The discussions were recorded and further translated into English. The predesigned instrument focused on various aspects of a farming system i.e., crop and livestock production, use of labor and machinery in agricultural practices, marketing channels employed, the impact of urbanization observed by the farmers on the agricultural activities.

In the next stage, Haveli Ghanpur, Mulugu and Yacharam mandals (blocks) were selected for the farm household survey based on the understandings derived from the focus group discussions. A sample of 400 respondents was selected randomly from 10 villages within these mandals. The farm households were selected at random subject to the consent of an adult male and female household member to participate in an interview. The interviews were conducted in Telugu and responses were recorded in English. Field enumerators fluent in Telugu and English were hired for the survey.

Findings

Farming Systems Identified:

Based on the data collected through the focus group discussions and household survey, five farming systems were identified in the study area:

1. Monocropping without livestock (FS1)
2. Diverse cropping without livestock (FS2)
3. Monocropping with dairy (FS3)
4. Diverse cropping with dairy (FS4)
5. Cropping with small ruminants (FS5)

Assessment of the Resilience of the Farming Systems Identified:

The results of the factor analysis conducted for the assessment of the resilience of the farming systems identified present a mixed picture. Agricultural income, landholding, irrigation, food production and income from the government's direct benefit transfer schemes are the major factors contributing to the robustness of the farming systems in the study area. The farming system Diverse cropping with Dairy ranks the highest on the robustness scale. Crop diversity and the area under high-value crops cultivations are significant components in building the capacity of adaptability for the farming systems identified. The farming system Diversified cropping without Livestock is ranking the highest on the adaptability scale. Access to agricultural services (agricultural inputs, hired labor, and veterinary services), access to supporting infrastructure (health, education, and transport facilities), and proximity to the city are the components making up the capacity of transformability for the farming systems identified in the study area.

Time Allocation of the Farm Households:

In the case of male members, the size of the landholding increases the probability of the choice of full-time farming and decreases the probability of the choice of part-time farming. The distance to the city decreases the probability of the choice of part-time farming. In the case of females, high-value crop cultivation and participation in NREGA increase the probability of the choice of full-time farming. In the case of full-time non-

farm activities, participation in NREGA decreases the probability of that choice by females. On the other hand, age and HH size increase the probability of opting for full-time non-farm occupations by females. In the peri-urban region, in the case of male members, age, landholding and high-value crop cultivation decrease the probability of the choice of part-time farming. In the peri-urban region, the size of the household decreases the probability of the female choice of not participating in any type of activity. In rural areas, livestock rearing decreases the probability of the choice of part-time farming and full-time non-farm activities. Consequently, it increases the probability of the choice of farming full-time for the male members. In the case of female members in the rural area, participation in NREGA and the distance to the city increase the probability of the females working full time on the farm. A larger size of household increases the probability of the female choice of working full time in non-farm activities.

Conclusion and Policy Implications

The farming systems in the study area are dynamic and evolving under the influence of a variety of factors. Monocropping without livestock, diverse cropping without livestock, monocrop with dairy, diverse cropping with dairy, and cropping with small ruminants are the five farming systems identified in the study area. While spatial structural changes, increasing demand for food, and shifts in the consumption pattern along with urbanization-induced socio-economic changes are urban pressures; neighborhood effect, biophysical and farm household characteristics, location of the farm, and distance to the market are the mediating factors that contribute to the responses of the farming systems identified near Hyderabad. Diversification, intensification, agglomeration, land use expansion are the farming system responses identified. Monocropping without livestock and diverse cropping without livestock are the two dominant farming systems in the rural and peri-urban areas respectively while the farming systems monocropping with dairy, diverse cropping with dairy, and cropping with small ruminants are on the decline. Farm HHs are shifting towards farming systems without livestock activities. Some farm HHs are exiting farming due to the high cost of inputs and access to alternate non-farm livelihood opportunities.

Urbanization has a mixed impact on the resilience of the farming systems identified. Agricultural income, income from government schemes, irrigation, farmland, food

production, crop diversity, high-value crop cultivation, access to agricultural services, access to infrastructure, and distance to the city affect the resilience of the farming systems. Urbanization has a positive impact on farming systems in terms of crop diversity, and the cultivation of high-value crops by providing better market access. Urbanization also enables the farmers to access supporting infrastructures such as health and education facilities, and transport facilities. However, urban expansion negatively affects access to irrigation and farmland by the means of land-use changes and increased demand for water which leads to land fragmentation, loss of land under water bodies, and strain on the available water resources.

Proximity to urban centers has provided the opportunity for farm households to connect to modern value chains through improved and easier access to modern markets (IFPRI, 2017; Hazell, 2019). This has encouraged farm households to undertake demand-driven diverse high-value crop cultivation in addition to cereals and cash crops such as paddy, maize, and cotton. As a result, we observe intensive farm activities undertaken by farm households in the peri-urban region of the study area. This has encouraged farmers to opt for full-time farming despite having access to non-farm job opportunities in the urban vicinity. On the other hand, in rural areas, we observe farm households practicing part-time farming to support the household income in addition to the farm income. Additionally, we observe a dependence of the farm households in rural areas on the MGNREGA scheme, as a permanent source of non-farm income. This is particularly evident in the case of the female members of the household.

Policy responses in a multi-level hierarchy are needed to address the issues identified. It is vital to recognize the contribution of peri-urban agriculture in providing ecosystem services to the urban areas and urban food security while designing policies for urban planning and development.

Connecting and communicating with the youth to understand their issues, expectations, and perception of farming is necessary to engage them in agriculture (Farooq and Ullah, 2021). Training and workshops should be conducted at the village level to spread awareness about modern techniques of farming. Farming techniques that reduce the dependency on hired labor should be promoted. To enhance production, preservation of biodiversity, soil fertility, and water quality, incentives should be provided for the adoption of crop diversification strategies such as intercropping, and crop rotation. This can be achieved by making the direct benefit transfers (e.g. Rythu Bandhu Scheme by the

State Government of Telangana) to farm households conditional to the adoption of crop diversification strategies. Such measures can be used to ensure the cultivation of crops significant to local diets which would contribute to local food and nutritional security. This would further result in the benefits of agglomeration to the farmers and other stakeholders. While diminishing common property grazing land and insufficient family labor appear to be the reasons for declining livestock activity, further investigation is required for a better understanding of the issues faced by dairy farmers and shepherds.

Custom hiring centers can make farm machinery accessible to farmers at reasonable rates (Sarkar, 2020). Innovative platforms should be developed to match the demand and supply of farm machinery and equipment to improve the efficiency of rental services. Such centers can also be developed as demonstration spaces for modern farming technologies and techniques such as ICT and AI in agriculture to facilitate knowledge transfer. Further, steps should be taken to create awareness about the benefits of integrated farming practices. Expert consultation and guidance should be ensured to farmers who aspire to transform and modernize their farming activities.

INTRODUCTION

Urbanization is a global phenomenon having multi-layered consequences in terms of sustainability and resilience of socio-ecological systems. With almost seven out of every ten people projected to live in urban areas by 2050, 57% of the global population is already living in urban areas by 2021 (FAO et al., 2023). While growing urbanization is a trend worldwide, Africa and Asia are projected to account for 88% of the new urban dwellers from 2018 to 2050. Particularly, India, China, and Nigeria are to account for a 35% increase in the world urban population by 2050 (United Nations, 2019). With almost half (47%) of the world's population living in peri-urban areas due to increasing urban-rural connectivity, peri-urban regions are going to influence the urban-rural continuum (FAO et., 2023). From 1975 to 2020, the urban population in low-income countries grew to 300 million, which is expected to reach 700 million by 2070 (UN-Habitat, 2022).

Overview

Urbanization is a complex socio-economic process that involves the transformation of the settlements from rural to urban while spatially shifting the population from rural to urban areas (United Nations, 2019). Urbanization is directly linked to social, economic, and environmentally sustainable development. While well-planned cities accounting for long-term trends of urban population can contribute to economic development with minimal environmental degradation, unplanned and mismanaged urban expansion can have adverse impacts such as urban sprawl, and pollution. Urban sprawl is the informal, fragmented expansion of urban areas on the fringe of the cities because of a variety of factors such as urban planning failure, lower land prices, increasing population, migration, pollution, low cost of transport, and increasing income levels (Cobbinah & Amoako, 2012; Brody, 2013; Youssef et al., 2020). As a result of the urban sprawl, the peripheries of the cities are transformed into peri-urban areas. It is the interface between the urban and rural areas.

Farming systems are complex and dynamic socio-ecological systems resulting from the decisions made by farm households with respect to land use and their livelihood strategies. These farming systems provide food, feed, and cash to the farm and non-farm actors involved at various levels. Farming systems and urbanization compete for land as urbanization takes place mostly in peri-urban and/or ex-urban areas. While urbanization

influences agriculture in general in a variety of aspects, its most profound impact is felt in the regional farming systems in the urban hinterland. The influences present both opportunities and challenges to the local communities. While urbanization-driven land use change resulting in farmland loss is the most obvious and almost irreversible impact, urbanization also influences the livelihood of farmers in the vicinity by changing consumer behavior, employment opportunities, rising income levels, and lifestyle changes. Urban expansion results in land use changes for the expansion of built-up areas for urban infrastructure such as housing for the growing urban population, road connectivity, and other amenities. This results in loss of farmland and water bodies which curtails the access to land and water for farming. Urbanization is generally accompanied by rising income levels and employment creation leading to a shift in consumer behavior beyond the traditional crops. This is reflected in the rising demand for dairy, meat, fish, fruits, and vegetables from urban areas. Furthermore, formal, complex regional food value chains are created that provide employment to women and youth (FAO et al., 2023). Urbanization also provides non-farm job opportunities that attract workforce from rural areas to urban areas. This affects the availability of farm labor for farm activities.

Problem Focus

Urbanization increases the demand for food in urban areas where farm produce is limited as most urban dwellers work in the non-farm sector. As most urban poor have low, irregular incomes, their access to farm produce is constrained making them more susceptible to food insecurity than the rural poor. Urban and peri-urban agriculture (UPA) is increasingly being promoted as a strategy for enhancing urban food security and overall urban resilience. While contributing to urban food security, UPA provides vital ecosystem services such as dampening stormwater runoff, conservation of biodiversity, aesthetic enhancement, and use of urban organic waste in food production. It also has the potential to shorten the value chains thus reducing the food cost in the informal economy, sourcing diverse nutrient-loaded food, and reducing the greenhouse emissions associated with food transport. Understanding and managing the effects of urbanization on regional farming systems is vital for their sustainability and resilience, particularly in developing countries which are projected to account for most addition to the world's urban population. The interlinkages in the urban and farming systems can be leveraged to achieve economic development and provide access to healthy diets. For this purpose, governance mechanisms beyond the scope of sectoral and administrative limits and coordinated investments in infrastructure for urban-rural connectivity are the need of the hour.

Adger (2000) established a definite link between social and ecological resilience, mainly for communities that depend on environmental and ecological resources for their living. Hence, the resilience of the farming systems is affected by the influence that urbanization has on the affected farming systems. There is no perfect remedy to all agricultural problems as the solution would vary based on the agroecological and the socio-economic context of the problem. According to Panpakdee and Limnirankul, (2018), integrating resilience into farmers' activities would provide a possible, effective solution. The ability of a farming system to deal with a challenge can be described as resilience. The concept of resilience provides a cohesive framework for appraising farming systems from an agroecological and socio-economic perspective. Managing resilience is a way to design strategies that curtail the socio-economic effects without compromising the system's ability to cope with future shocks (Marshall and Marshall, 2007).

Scope of the Study

This study is a step forward in understanding the interlinkages between the emergence of regional farming systems and urbanization in low and middle-income countries in semi-arid conditions. With a strong conceptual and theoretical framework, it brings out the intricacies of the farming systems in the periphery of a major urban center. While highlighting the issues distressing the local farming systems in the face of urban expansion, it also underlines the role of urbanization in their evolution. The impact of urbanization on agriculture in the vicinity of Hyderabad city has been explored through the holistic approach of resilience perspective. By exploring the resilience of the farming system while identifying urbanization as the stress, this study makes a unique contribution to the growing literature on the resilience of socio-ecological systems.

Keeping in mind that UPA plays a key role in achieving urban food security, the understanding of the emergence of farming systems contributes positively to the discourse of designing policies towards urban sustainability. As resilience is implicit in the concept of sustainability, insights into the resilience of peri-urban farming systems provide significant inputs towards designing policies aimed at bringing sustainability to urban and peri-urban agriculture which further enhances urban resilience.

This study attempts to understand the effects of urbanization on the farming systems in the vicinity of Hyderabad, India. Recognizing the importance of context in farming system research, this study is divided into three parts. In the first part, farming systems in

the study area are characterized by studying their various components. A particular farming system stems from the decisions taken by several farm households pertaining to the resource allocation such as land, labor, capital, management of crop and livestock activities, and non-farm livelihood activities. Farm household strategies are in response to the pressures and opportunities posed to them. Urbanization creates a variety of pressures on the farming systems in the vicinity such as shifts in consumer behavior, socio-economic changes, structural spatial changes, rural land institutes, and migration transition. A variety of factors mediate in the decisions made by the farm households such as historical farming systems, bio-physical characteristics of the farm, socio-economic characteristics of the household, proximity to the urban center, and neighborhood effect. Such farm household decisions generate responses at the farming system level such as land use expansion (peri-urban agriculture), intensification, diversification, agglomeration, and decline. To understand this evolution of the farming systems in the context of urbanization in the surroundings, a land use theory perspective is adopted.

In the second part of the study, the resilience of the farming systems to the pressures of urban expansion is assessed. For this purpose, the framework for the assessment of resilience of farming systems developed by Meuwissen et al., (2019) is adopted. Resilience is a holistic concept which makes it challenging to measure comprehensively. Hence, it is subdivided into three capacities namely, robustness, adaptability, and transformability. This subdivision makes it viable to identify proxy indicators to assess the levels of resilience capacities in the farming systems (Jacobi et al., 2015). The resilience approach makes it possible to identify the factors contributing positively and negatively to the resilience of the farming systems. Further, by linking such factors with urbanization, the effect of urbanization on the resilience of the farming systems is highlighted.

The third part of the study focuses on farm labor participation against the backdrop of urban influences on the livelihood of farmers. With urban expansion, farm households may pivot their strategies in terms of the crop (e.g. switching from traditional to high-value crops) and livestock activities (e.g. shift from local to high-yield breeds). Furthermore, urbanization creates new non-farm jobs which attract labor from rural to urban areas. Farmers are faced with the tradeoff of farm and non-farm jobs. They may also choose to work part-time in farm and non-farm jobs to diversify their income sources. Additionally, farm owners may choose to work full-time in the non-farm sector and give up farming as a profession. The factors determining the participation of farm labor in the

face of such choices are explored and analyzed with a gender lens. As labor is a key input in agriculture, understanding the factors mediating the workforce participation decisions by both men and women makes a significant contribution to understanding the trends of labor force participation on the fringe of the cities.

Urbanization is an inevitable part of the future of the world. It is entwined with various economic, social, and environmental challenges globally. Planning for urban growth and developing the governance mechanism to manage urban expansion is a must for a sustainable future. Coping with rapid urban expansion is one of the key challenges in low and middle-income countries, where urban expansion without effective planning might make urban sprawl a low-income country phenomenon. While doing so, appreciating the contribution of UPA in achieving a sustainable urban future, particularly urban food security is crucial. Augmenting governance capacities across sectoral and administrative limits and building multilayered policy frameworks whilst integrating stakeholders in the urban and agricultural spheres is the need of the hour globally, particularly in low and middle-income countries.

IMPACT OF URBANIZATION ON EMERGING FARMING SYSTEMS

Abstract: Agricultural land use changes driven by urbanization present a significant policy challenge for maintaining food and nutritional security and the sustainability of farming systems. Pressures and opportunities associated with urban expansion shape farm households' resource allocation decisions, leading to the emergence of diverse farming systems. Based on focus group discussions with farmers from six villages surrounding Hyderabad, combined with empirical data from 400 households, this study identifies five predominant farming systems. The findings indicate that agricultural intensification and diversification into non-farm activities are the dominant strategies adopted at the urban-rural interface. The study derives perspective from land use theories and establishes a benchmark and baseline for examining the drivers of farming system transformation and for informing integrated urban spatial planning and rural development policies.

Introduction

One of the major processes responsible for socioeconomic and ecological changes globally is urbanization. Urbanization or the spatial expansion of urban areas is the result of multiple social, demographic, economic, and cultural factors such as rising income levels, demographic changes, rural-urban migration, etc. The role of urbanization in fragmentation and loss of farmland worldwide is well recognized in the literature. Urbanization also influences access to organic fertilizers and water resources. An urban area serves as a large market for food and agricultural produce because of the growing urban population with higher income. Urban and peri-urban agriculture (UPA) is vital for urban food security. It also provides ecological and aesthetic services.

India currently has five megacities (Mumbai, Delhi, Chennai Kolkata, Bangalore) with Hyderabad and Ahmedabad expected to become megacities by 2030. The urban population in India has steadily increased at a growth rate of 31.8% which is higher than the average population growth rate of 17.64%. (Shekhar, 2021). Such accelerated urban expansion presents many ecosystem and social challenges (Sultana & Satyanarayana, 2018; Wakode et al., 2018; Gumma et al., 2017). Against this backdrop, it is important to investigate the impact of urbanization on the farming systems in the Indian context.

Literature Review

Urbanization is the conversion of past rural settlements into urban ones, while simultaneously shifting the spatial distribution of the population in favor of the urban areas (UN, 2019). A major consequence of urbanization is urban sprawl, which is the spatial expansion of urban areas due to the intersection of multiple factors such as social, cultural, economic, institutional, and demographic (Brody, 2013; Cobbinah & Amoako, 2012; Naab et al., 2013; Cobbinah et al., 2015). Urban sprawl is the informal, fragmented expansion of urban areas on the fringe of the cities because of a variety of factors such as urban planning failure, lower land prices, increasing population, migration, pollution, low cost of transport, and increasing income levels (Cobbinah & Amoako, 2012; Brody, 2013; Youssef et al., 2020).

Peri-urbanization is linked to urban sprawl by Nechyba & Walsh (2004) and Gilham & Maclean (2002) as they characterize urban sprawl as the low-density development accompanied by a concentration of economic activity and population in the peri-urban areas in the periphery of the cities. Peri-urban areas are the transitional regions between the natural habitats of the rural areas and the urban areas (Youssef et al., 2020) characterized by processes of socioeconomic and land-use shifts, where rural and urban changes are closely interdependent (Butt, 2013); which are many times ‘peculiar to the fringes’ (Gallent & Andersson, 2007). The process of peri-urbanization is driven by geographical contexts and a variety of socio-economic factors (Butt, 2013). The peri-urban areas continue undergoing socio-economic changes around the world as the cities keep sprawling.

In Europe, urbanization has emerged as a driving factor promoting multifunctional agriculture (Zasada, 2011; Meraner et al., 2018). In response to the demand from urban consumers in terms of post-harvest processing and recreational services, farmers in Europe have responded by intensification and diversification of farm activities (Zasada, 2011). In the Global South, degradation of water and soil quality, livestock and fisheries systems are threatened by urban expansion (Thapa et al., 2021; Hussain & Hanisch, 2014; Youssef et al., 2020). Wastewater-irrigated agriculture, increased farm wages, changing urban weather profile, increasing number of landless farmers, and high cost of farming are the effects of urban growth on UPA in the global south (Padgham et al., 2015; Hussain & Hanisch, 2014; Gumma et al., 2017; Kuusaana & Eldi, 2015; Follmann et al., 2021).

Better education and health infrastructure, higher wages and employment opportunities act as a pull factor for rural-urban migration (Abhishek et al., 2017; Mlambo, 2018). With the increasing urban population and income levels, there is a rise in the quantity and quality of the food demand, which opens various market opportunities for farmers in UPA (Follmann et al., 2021). This subsequently results in a shift in farming activities from traditional staple crops to higher-value farm produce (IFPRI, 2017).

Urbanization is a global phenomenon, though it is particularly rapid in the developing world (UN-WWAP, 2015). Asia and Africa account for approximately 80% of the farmlands prone to sprawl (Arunpandiyana et al., 2015; Kharel, 2011; Uttara et al., 2012; Youssef et al., 2020). Farmers participating in the UPA respond to these challenges and opportunities in accordance with their regional conditions and the socio-economic characteristics of the farm household.

Farming systems are characterized as “open” and “dynamic” (Darnhofer et al., 2012) which interact locally in a particular agro-ecological context (Giller, 2013), and are linked to a variety of economic processes and diverse social networks (Meuwissen et al., 2019). Presently, farming systems are facing several environmental, institutional, social, and economic challenges (Meuwissen et al., 2019). Response strategies to such challenges such as intensification, diversification, land use expansion, or even decline (farm exits) depend on the location-specific circumstances (Follmann et al., 2021). Thus, to understand the dynamic impacts of urbanization on agriculture, we identify and study the farming systems in the peri-urban areas of Hyderabad, India.

This study is part of a joint project between the Swedish University of Agricultural Sciences (SLU) and International Crop Research Institute on Semi-Arid Tropics (ICRISAT) on “The Dynamics of Urban Sprawl: Land-use changes, Food Supply & Sustainable Agriculture Production Systems in the Arid and Semi-Arid Zones”. The project is aimed at identifying the resilience and adaptive capacities of arid and semi-arid agroecological systems to urbanization. The current paper aims to understand the impact of urbanization on the farming systems in the peri-urban region of Hyderabad through the lens of land rent theories.

Materials and Methods

Study Area and Data Collection

Hyderabad, the capital city of the southern Indian state of Telangana, is the sixth-largest metropolis in the country. It is located in the Musi sub-basin which is a part of the Krishna River basin. It consists of twelve municipalities including the Greater Hyderabad Municipal Corporation. Rapid development, increasing job opportunities, and economic growth have attracted skilled and unskilled labor from across the country pushing the city's population to 10.3 million (WPR, 2021). From 2005 to 2016, the built-up area in Hyderabad constituting housing and other buildings has increased from 38,863 ha to 80,111 ha; unfavorably affecting the water bodies and rainfed cropland (Gumma et al., 2017). The land under agriculture within the city limits has decreased with the ongoing infrastructure development with seasonal water-bodies being abused the most for building purposes. This has resulted in a shift in land use, mainly from farmland to built-up areas. There is also a rise in wastewater-irrigated agriculture on the banks of the Musi River, which flows through the city, for vegetables and paddy cultivation to accommodate the rising urban demand (Gumma et al., 2011; Gumma et al., 2017). In Hyderabad, along with an increase in the area under wastewater-irrigated agriculture, there is a trend towards the cultivation of vegetables from the traditional crops of paddy, maize, and sorghum. With the increasing built-up area, the most significant land cover lost is of water bodies which has resulted in an increased area under rainfed agriculture (Gumma et al., 2017).

Based on the findings of (Gumma et al., 2017), field explorations were conducted. Structured interviews were conducted with local experts and officials of the Department of Agriculture to identify the study area. The study employed interviews with local experts, government officials, and local progressive farmers to identify the issues faced by the local farming community and upcoming trends and opportunities due to the proximity of Hyderabad. Based on these interactions, six villages (Gundlapally, Guddamallaiguda, Mothakundur, Mulugu, Fareedpur, Kummera) were identified from blocks (Nalgonda, Ibrahimpattanam, Mothakundur, Mulugu, Haveli Ghanpur, Chevella) around Hyderabad to conduct focus group discussions with farmers. Discussions were conducted in Telugu with the help of enumerators using a predesigned instrument. The discussions were recorded and further translated into English. The predesigned instrument

focused on various aspects of a farming system i.e., crop and livestock production, use of labor and machinery in agricultural practices, marketing channels employed, and the impact of urbanization observed by the farmers on the agricultural activities. In the next stage, blocks of Haveli Ghanpur, Mulugu, and Yacharam were selected for the farm household survey based on the understandings derived from the focus group discussions. The survey was conducted in August-September, 2021. A sample of 400 respondents was selected randomly from 10 villages within these blocks. The farm households were selected at random subject to the consent of an adult male and female household member to participate in an interview. The inter-views were conducted in Telugu and responses were translated into English.

Conceptual Framework

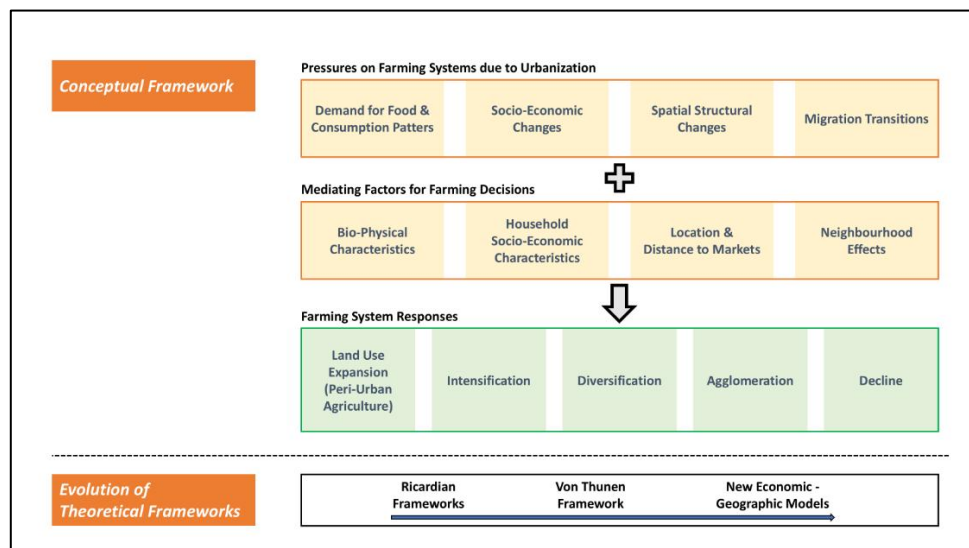


Figure 1: Conceptual Framework

Urban Pressures

We identify four main pressures induced by urbanization affecting the farming systems. The first pressure is the increasing demand for food and the shift in consumption patterns. The rising urban population and inflow of migrants result in an increasing demand for food. Further, a rise in demand for processed foods is leading the way for the expansion of processing industries (IFPRI, 2017; Hazell, 2019). Another urban pressure stressing the farming systems manifests itself through spatial structural changes. Urban expansion results in spatial structural changes which lead to the conversion of farmlands and open spaces to built-up areas for industrial purposes, infrastructure projects, and the provision of basic amenities for the growing urban population (Gyasi et al., 2014). Hence,

agricultural lands converted to urban structures are usually in proximity of the urban region. This further adds to the obstacles in accessing the farmlands and grazing areas in addition to high land prices. Another manifestation of urban stress is migration transition. Proximity to an urban centre provides access to better education, health infrastructure, and off-farm jobs (Hoffman et al., 2019; Mlambo, 2018; Steinhubel & Cramon-Taubade, 2019). Workers face a trade-off between higher-paying non-farm jobs and farm intensification as the proximity to a city increases the opportunity cost of intensive farming with easier access to off-farm jobs (Steinhubel & Cramon-Taubade, 2019). Rapid migration out of rural areas hampers the productivity and development of rural farming in the developing world (Mbatha & Mofokeng, 2021). With the out-migration of rural labor, farmers face a labor shortage and high cost of labor which subsequently leads to a shift in farm activities towards less labor-intensive farming activities (Nguyen & Kim, 2019) or in the favor of high-value products to compensate the high input cost (Hussain & Hanisch, 2014). This intensification of agriculture is also accompanied by an increase in the use of inorganic inputs which subsequently leads to hazardous environmental impact (Hussain & Hanisch, 2014). Urbanization also has an exogenous socio-economic influence on the landscape. It drives economic growth pushing income levels in the upward direction. It facilitates access to a variety of infrastructure. It also exposes the rural population to the urban lifestyle. Aspirations for higher education and preference for high-paying urban jobs by the youth (Nandi et al., 2022) contribute to the discontinuity of generational succession of farming. With access to better education, the opportunity cost of farm labor employable in non-farm jobs, even women, is increasing. The declining fertility rate with higher female literacy is reducing the size of the household making family labor scarce.

Mediating Factors

In addition to the opportunities and challenges posed by urbanization, farm households' decisions are affected by various mediating factors. The socioeconomic characteristics of farm households play a significant role in their decision-making process. Factors such as the age and education of the household members, family farm labor, the demographic composition of the farm household, household income, size of the landholding, ownership of assets, and non-farm employment affect the decisions pertaining to farm and livestock activities such as intensification, diversification, expansion, and farm exits (Khanal et al., 2018; Hussain & Hansch, 2014; Meraner et al., 2018; Zasada, 2011; Mathijs et al., 2012; Ghimire et al., 2021). The location of the farm and its proximity to the market are

important mediating factors. Farm households located closer to urban areas are positioned at an advantage to get associated with the modern value chains (Hazell, 2019; Khanal et al., 2018). Proximity to the city, and access to road infrastructure are conducive to the uptake of modern agricultural inputs and diversification of farm household activities including on-farm non-agricultural diversification (Steinhubel & Cramon-Taubadel, 2020; Wastfelt & Zhang, 2016; Meraner et al., 2018; Zasada, 2011). Farmers, like other individuals, show similar behavioral patterns due to geographical proximity to their peers. The interactions with fellow farmers also contribute to determining the responses of a farm household to changing circumstances. Literature has recognized the contribution of neighborhood effect in the decision-making of farmers regarding adaptive responses (Ambali et al., 2019; Tessema et al., 2016; Ward & Pede, 2015; Krishnan & Patnam, 2014).

Theoretical Framework

The land is used for the activities which bring about the highest output. The classical theories of rent show that intensification and expansion of land use are a function of land rent (Meyfroidt et al., 2018). According to the Ricardian theory, “land rent is derived from the land’s biophysical characteristics such as soil fertility, access to irrigation, and scarcity of productive land” (Ricardo, 1817). With the urban expansion, the shortage of fertile land in the newly urbanized region is reflected in the rising land rent and prices which further encourages the intensification of farm activities. On the other hand, Von Thunen theorizes that rent is a function of the distance to the market implying that the land located at a distance will draw lower rent than the land located near the market (Von Thunen, 1966). Thus, farms located near an urban market will intensify their activities by producing high-value crops (such as dairy, fruits, and vegetables which are otherwise demanding in terms of transport infrastructure) to justify the high land rent. Similarly, the production of lesser-valued crops is pushed away from the city.

Agricultural activities are modeled as an external input while their location is dictated by biophysical conditions and transport cost, in the studies on agglomeration economies in the manufacturing sector (Krugman, 1991). Garret et al., (2013) propose the development of agglomeration economies within the agricultural sector by adapting the conceptual model of circular causality in the spatial agglomeration by Fujitsa & Krugman, (1995). According to Garret et al., (2013), in a region where farmers have a higher income as compared to adjacent areas due to superior biophysical conditions and lower transport

costs, more farmers are encouraged to move in thus generating a higher demand for farm technologies and services. This would result in specialized suppliers of those technologies and services to expand production creating economies of scale. Such access to resources would increase the total factor productivity of the region resulting in higher profits. This will result in a positive circular effect and agglomeration by incentivizing more farmers to move into the area until such time that the high land and water prices begin offsetting the benefits of agglomeration. The agglomeration theory implies that with access to the market for high-value crops and lower transport costs resulting in higher farm incomes, more and more farmers in the periphery of the cities are encouraged to undertake intensive farming activities. The existence of agglomeration economies in the agricultural sector indicates farmers in the region have access to diverse sources of inputs, lower input prices, and better access to information and technology. intensify their activities leading to agglomeration of farmers practicing intensive agriculture. This would further lead to the growth of processing industries complementing the urban food demand and thus creating a positive feedback mechanism.

Table 1: Characteristics of the farming systems

Sr. No.	Components of the Farming System	Indicators
1.	Agro-climatic Conditions	Average Rainfall, Average temperature, Soil type, and Possible extreme weather conditions.
2.	The crop and livestock production system	Season-wise crops cultivated, Yield per acre, Yield per animal, the area under cultivation, Cost of cultivation, Tropical Livestock Units per farm HH, and cost of livestock rearing.
3.	The inputs: Labour, Machinery, Irrigation	Sources of irrigation, Operation-wise dependence on labour, Operation wise dependence on machinery, Outsourcing/renting of farming operations, Cost of irrigation, Cost of renting machinery, Daily wage rates.
4.	Marketing channels and value addition	Marketing channel, Modes of transportation, Price realized, Cost of marketing, Value addition if any at farm level.
5.	Socio-Economic Profile of the farmers	Landholding, Income sources, Credit sources, Subsidies received, Land price, Tenancy Rates.

The term farming system has been described in many ways in the literature (Mahapatra, 1992; Dixon et al., 2001; Rao et al., 2006; Darnhofer et al., 2012; Meuwissen et al., 2019; Kebede et al., 2019). A farming system can be described as a complex and open system that is a “level of hierarchy above the farm” (Geller, 2013) at which characteristics result from the formal and informal interactions and interrelations among farms, accessible technologies, stakeholders in the value chains, actors in rural and urban areas, consumers, policymakers, and the environment (Meuwissen et al., 2019; Darnhofer et al., 2012). Farming systems are characterized based on major farm activities, ownership of farmland, and the type of inputs used (Erkossa et al, 2009; van de Steeg e al., 2010). Geller (2013) has highlighted the importance of context and local adaptation in farming system analysis. Recognizing the nested and connected nature of a farming system, drawing its boundaries can be based on biophysical properties, cultural decisions, political lines, etc. (Cabell & Oelofse, 2012).

With this backdrop, we characterize the farming systems in the study area based on the dominant crop and livestock activities of the farm households. Further, they are characterized by taking inspiration from Meuwissen et al., (2019), Unay-Gailhard et al., (2017), and (Madry et al., 2013). Due to the pragmatic limitations of the study, we limit our analysis to components two, three, four, and five.

Results and Discussion

Table 2: Characteristics of the farming systems in the study area

Sr No.	Characteristics	Monocropping Without Livestock	Diversified Without Livestock	Monocropping With Dairy	Diversified with Dairy	Cropping With small ruminants	
		<i>n=217</i> 54.25%	<i>n=76</i> 19%	<i>n=33</i> 8.25%	<i>n=26</i> 6.5%	<i>n=14</i> 3.5%	
1.	Farm Size	<i>Marginal</i>	133 (61.29%)	43 (56.57%)	20 (60.60%)	6 (23.07%)	7 (50%)
		<i>Small</i>	50 (23.04%)	23 (30.26%)	4 (12.12%)	11 (42.30%)	4 (28.57)
		<i>Semi-medium</i>	23 (10.59%)	7 (9.21%)	6 (18.18%)	6 (23.07%)	2 (14.28%)
		<i>Medium</i>	10 (4.60%)	3 (3.94%)	3 (9.09%)	2 (7.69%)	1 (7.14%)

	<i>Large</i>	1 (0.46%)	0	0	1 (3.84%)	0
2.	<i>Crops</i>	Paddy, Cotton	Paddy, Maize, Cotton, Redgram, Vegetables	Paddy, Cotton, Fodder	Paddy, Maize, Cotton, Redgram, Vegetables	Paddy, Cotton
3.	Irrigation characteristics	Irrigated, Rained	Irrigated, Drip irrigation	Irrigated, Rainfed	Irrigated, Drip irrigation	Irrigated, Rainfed
4.	Livestock	-	-	Local cattle, exotic/cross-breed cattle	Local cattle, exotic/cross-breed cattle	Small Ruminants
5.	Mechanized farm operations:	Land preparation, Harvesting	Land preparation, Harvesting	Land preparation, Harvesting	Land preparation, Harvesting	Land Preparation
6.	Locations	Peri-urban, Rural	Peri-urban	Peri-urban, Rural	Peri-urban	Peri-urban, Rural

(Note: 34 HH were excluded from farming systems categorization. While 29 HH had leased out their farmland, 5 HH could not be categorized due to the nature of their farm activities.)

Farming system challenges

Farmers in the study area are facing multiple challenges. In both rural and peri-urban regions, farmers are facing an acute shortage of labor and high wage rates. This is attributed to rural-urban migration and unavailability of the family labor. In rural areas, farmers lack market access thus constraining them from diversifying their farm activities. This discourages them from diversifying their farm activities. Farmers across the study area have reported a shift away from livestock activity by reducing their herd size in the past 3-5 years on account of the high cost of maintenance and shrinking common property grazing land.

Farming system responses and mediating factors

Table 3: Observed Farming System Responses

Sr. No.	Farming System	Responses	Mediating Factors	Urban Pressures	Location
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1.	Monocrop without livestock	Agglomeration, Land use expansion	Biophysical characteristics, Neighborhood effect, Location, and distance to market	Spatial structural changes, Socio-economic changes, migration transition	Rural Peri-urban
2.	Diverse crops without livestock	Agglomeration, diversification, land use expansion	Location and distance to market, neighborhood effect, socio-economic characteristics	Spatial changes, Shift in consumption pattern, migration transition	Peri-urban
3.	Monocrop with dairy	Decline, diversification, land use expansion	Biophysical characteristics, Neighborhood effect, socio-economic characteristics, Location and distance to market,	Socio-economic changes, Shift in consumption pattern, migration transaction	Rural Peri-urban
4.	Diverse crops with dairy	Decline, diversification, land use expansion	Location and distance to market, neighborhood effect, socio-economic characteristics	Shift in consumption pattern, Spatial structural changes	Peri-urban
5.	Crops with small ruminants	Decline, diversification, land use expansion	socio-economic characteristics, Location, and distance to market	Socio-economic changes, Spatial structural changes	Rural Peri-Urban

(Source: Focus group discussions and household survey)

1. Agglomeration:

The dominance of paddy growers in the study area is explained by a combination of demand and supply factors. While labor shortage is one of the key challenges for the respondents, compared to other crops, paddy requires relatively less labor as many operations are mechanized (Kaur & Singh, 2018). Uncertainties associated with market access and price volatility is another major constraint. Paddy has assured market access through the decentralized paddy procurement system of the Telangana government which also ensures better prices, lower transport costs, fair transactions, and faster payments (Revathi & peddi, 2020). It has also resulted in the agglomeration of the rice mills in the study area resulting in local employment generation (147 and 101 rice mills located in Siddipet and Medak districts respectively). In the peri-urban region, the agglomeration of vegetable growers is observed due to the increasing demand for fresh produce and

ease of market access with lower transport costs. Farmers also report higher price realization through modern supply chains as compared to traditional supply chains. This is in line with the theory by Von Thunen attributing the location of HVC cultivation to the proximity to the city.

2. Diversification:

The intensity of diversity of operations tends to be higher in the proximity to the city (Meraner et al., 2018; Wastfelt & Zhang, 2016). There are three types of diversifications observed in the study area. First is the diversification of farm household activities to non-farm activities. Farm household members across the farming systems are engaged in non-farm activities (construction workers, factory workers, etc.). The second is the diversification of on-farm activities to livestock activities. Here we observe a trend contrary to the secondary data available. The data available from the Livestock census 2012 and 2019 of the study area points to an increasing livestock population. However, we observe a reversal of this trend based on the responses recorded from farm households. Farm households across the study area have reported a reduction in the livestock owned in the last 3-5 years. This is attributed to the high cost of maintenance, the high opportunity cost of family labor (Steinubel & Ramon-Taubadel, 2020), and the shrinking common grazing property lands. (The dairy activity in the study area is of a subsistence nature dominated by indigenous cattle breeds and the average herd size is 3.8 tropical livestock unit.) A city also influences crop diversification by encouraging specialization in high-value crop cultivation (Meraner et al., 2018). We observe farm households in the peri-urban area diversifying their cropping pattern to include HVC along with staples and cotton. This is in response to the rising demand for fresh produce from the city and easy access to markets. This response of the farm households is in line with the Von Thunien theory of land rent.

3. Land use expansion and intensification:

Farmers respond by intensification and expansion in response to the shift and rise in the demand for food and the loss of farmland (Follmann et al., 2021). With the growing demand for fresh produce and access to markets, we observe an effort of land use expansion across farming systems. Farm households are leasing land to expand their cropping activities to meet the rising market demand. Households

that have access to irrigation are intensifying their farming activities by undertaking cultivation across seasons. While the farm households in the rural area are cultivating in Kharif (June to September) and Rabi (October to March) seasons, in peri-urban areas, farmers are undertaking cropping activities in Kharif, Rabi, and summer seasons. This is facilitated by the excessive use of ground water resources and the intensive use of inorganic inputs (Hussain & Hanisch, 2014).

4. Farm exit:

The high opportunity cost of family labor (Steinhubel & Ramon-Taubadel, 2020), rural-urban migration (Ghimire et al., 2021); the transition to smaller households (Hugo, 1987), and the low farm incomes are the factors contributing to the decision to give up farming by the land-owning farm households. The declining livestock activity in the study area is shifting farm households to cropping-based farming systems from mixed farming systems. Further, households that comprise of elderly farmers who are unable to farm their land, farm households where the youth are gainfully employed in non-farm jobs, and households that can survive on dependency benefits and remittance are exiting farming. They are preferring to lease out their land and earn rent as a reliable source of income. Notably, 7.25% of the farm households in the sample reported a complete exit from farming. This category of households comprises 51% marginal farmers, 17% small farmers, 24% semi-medium farmers, and 10% medium farmers.

Changing cropping pattern in the study area

Table 4: Evolving cropping pattern in the study area

Sr. No.	Location	Current Cropping Pattern	Cropping patterns 10 years ago	Cropping Pattern 20 years ago	Mediating factors
1.	Peri-urban	Cereals, Pulses, Vegetables, Flowers, Fruits, fodder grass, Cotton	Cereals, Oilseeds, Pulses, Spices, Vegetables	Oilseeds, Cereals, Pulses, Sugarcane	<ul style="list-style-type: none"> • Socio-economic characteristics of the household • Biophysical characteristics • Location and distance to market

2.	Rural	Paddy	Paddy	Cereals, Sugarcane, Oilseeds, Pulses	<ul style="list-style-type: none"> • Animal Attacks • Location and distance to market • Biophysical characteristics
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(Source: Focus Group Discussions)

In the peri-urban region of the study area, the farmers have reported a shift in cropping pattern from oilseeds (Sunflower, Safflower, Castor, Groundnut), spices (Turmeric, garlic), and sugarcane to high-value crops such as vegetables, fruits, and flowers while retaining pulses and cereals. Cereals and pulses cultivated are mainly paddy, maize, and pigeon pea. This is mainly attributed to the location of the farm households near the urban market. Farmers in the peri-urban area are located at an advantage to exploit the short distance to the market. With the growing demand for fresh vegetables (Hussain & Hanisch, 2014), shorter and alternate supply chains, and easy access to transport facilities, farmers are encouraged to produce high-value crops which are characterized by shorter shelf life. The cultivation of high-value crops in locations closer to the city is explained by Von Thunen's location theory. Additionally, vegetables are characterized by a shorter harvesting period which facilitates a quicker and continuous flow of cash for the farm household. Due to the proximity to the urban area, farm households can diversify to non-farm livelihood activities without the permanent migration of the family members. This allows the farmer to rely on family labor for farm operations. Due to the scarcity of water for irrigation and erratic monsoon, farmers prefer growing vegetables that require lower amounts of water and have easy market access.

In the rural region, we see a shift in cropping pattern from a variety of cereals (Paddy, Millets), Oilseeds (Sunflower, Safflower, Castor, Groundnut), Pulses (Horse gram, Pigeon pea, Green gram, Black gram), to Paddy and Cotton Cultivation. This is attributed to the attacks by wild animals (monkeys, wild bores) on the farms, the access to irrigation and the lack of market access due to difficulty accessing the transport infrastructure.

Conclusion

The farming systems in the study area are dynamic and evolving under the influence of a variety of urban pressures and mediating factors. Spatial structural changes, growing demand for food, and shifting diets are the urban pressures along with the mediating factors i.e., neighborhood effect, biophysical and socio-economic characteristics of the

farm household, location of the farm, and distance to the market are influencing the farming systems in the vicinity of Hyderabad. Farmers are facing several constraints such as a shortage of farm labor, high input costs, shortage of farmland, high land prices, and low farm incomes. Diversification, intensification, agglomeration, land use expansion, and decline are the responses identified. Farm households are shifting away from mixed farming systems. Some farm households are exiting farming due to the high cost of cultivation (Hussain & Hanisch, 2014), and access to non-farm livelihood opportunities.

EFFECTS OF URBANIZATION ON THE RESILIENCE OF THE FARMING SYSTEMS

Abstract: Urbanization is a dynamic process with multifaceted effects on agriculture. While facilitating land use changes, it is also influencing market access, technical efficiency of farming, land prices, and regulatory frameworks. This study aims to understand the effects of urbanization on the resilience of the farming systems in the peri-urban areas of Hyderabad, India. For primary data collection, six focus group discussions were conducted followed by a household survey of four hundred farm households around Hyderabad. Our findings suggest that urbanization has a mixed impact on the resilience of the farming systems. The indirect effects of urbanization contribute positively to the adaptability and transformability of the farming systems by facilitating market access, demand for high-value crops, access to infrastructure, and agricultural services. The direct effects of urbanization contribute negatively to the robustness of the farming systems by constraining access to natural resources i.e. land and water.

Introduction

Urbanization, which is fast-changing, context-specific, and a result of interconnected factors, is the outcome of the rise in urban population, urban expansion (i.e., reclassification of rural areas to peri-urban or urban), and migration from rural to urban areas (FAO et al., 2023). From 1975 to 2020, the city population in low-income countries grew to 300 million, which is expected to reach 700 million by 2070 (UN-Habitat, 2022). As cities grow rapidly, it's expected that almost seven out of ten people will live in urban areas by 2050 (FAO et al., 2023). While urbanization is transforming farming systems around the world through direct and indirect effects, its emergence as a global trend is connected with a variety of challenges and opportunities.¹

Land use change from farm to non-farm uses is a **direct effect** of urbanization. It is estimated that by 2030, 3.7% of global farmland will disappear due to urbanization (Deng et al., 2020). The loss of prime farmland correspondingly poses serious challenges to food security at local, regional, and global scales. However, the impact goes beyond the mere physical loss of land. Urbanization also brings productivity and production relocation challenges. According to FAO et al., 2023, the loss of agricultural land near urban centers is coupled with a higher loss in productivity, estimated at 6-9% in Asia and

¹ This chapter has been accepted for publication in "CABI Agriculture and Bioscience".

Africa. This productivity loss surpasses the absolute loss of land due to the fertility of these lands and historically higher agricultural productivity is found around cities. Furthermore, while in many countries agricultural production can be relocated, there could be regions, where limitations in arable and fertile land hinder this transition, raising concerns about long-term food security at the local scale.

The impact of urbanization on farming systems also goes beyond the simple conversion of farmland into urban areas. **Indirect effects** take shape across four distinct categories (Lopez et al., 1988):

Regulatory effects: Regulatory changes may emerge, affecting land use policies, agricultural practices, and land ownership. These shifts can reshape the regulatory landscape of farming systems, potentially altering production dynamics. For example, Chen et al., (2018) highlighted the role of agricultural land use policies in causing farmland price distortions, land fragmentation and agricultural production.

Technical efficiency effects: Transformation of landscapes necessitates adjustments in land, labor, capital, and material resource allocations impacting technical efficiencies. For example, in the case of many Asian and African cities, farmers in the surrounding areas have responded by turning to wastewater-irrigated agriculture (Gumma et al., 2011; Gyasi et al., 2014; Kuusaana and Eledi, 2015; Gumma et al., 2017), use of chemical inputs (Hussan and Hanisch, 2014; Gyasi et al., 2014) increasing the use of modern inputs (Steinhubel and von Cramon-Taubadel, 2021), use of groundwater (Gyasi et al., 2014; Youssef et al., 2020), changing cropping pattern (Nguyen and Kim, 2019; Hussain and Hanisch, 2014; Youssef et al., 2020), and livelihood diversification (Hussain and Hanisch, 2014; Nguyen and Kim, 2019).

Speculative effects: Urban expansion can create speculative pressures on land prices, causing fluctuations that influence land use decisions and potentially driving some agricultural activities to less urbanized areas. This can make farmers less responsive to what's happening in the market for crops. This is called the "impermanence syndrome," where farmers don't want to invest in machinery or farm systems because they might sell the land soon (Lopez et al., 1988).

Market effects: Urbanization influences consumer preferences, necessitating shifts in the types and quantities of agricultural products demanded (Rao et al., 2006; Birthal et al., 2007; IFPRI, 2017). Additionally, urban centers can become key markets, changing the

dynamics of distribution and supply chains. Urbanization also brings farmers closer to their markets and thus reduces transportation costs. The locational advantage also opens new marketing avenues that can make farmers more competitive (Filippini et al., 2016; IFPRI, 2017, Hazell, 2019).

Urbanization and the changing nature of the farming systems provide both opportunities and challenges. The challenges are particularly exacerbated in the global south, characterized by fragmented land ownership, rural population growth, and the increasing impact of climate change (Pribadi and Pauleit, 2015; Zhu and Guo, 2014; Chen et al., 2018; Follman et al., 2021). To overcome the challenges and seize the opportunities that urbanization creates, actions and policies should support farming systems in the rural-urban continuum to absorb any imminent shocks and challenges, adapt to changes, and continue functioning to ensure food security at multiple scales. Using resilience thinking, this study aims to understand if and what type of farming systems in the rural-urban continuum of Hyderabad, India can evolve and adapt to a changing environment, driven by urbanization and other pressures.

Materials and Methods

Literature Review

A major consequence of urbanization is urban sprawl, which is the informal, fragmented expansion of cities into surrounding rural areas. This process is driven by a variety of factors such as urban planning failure, lower land prices, increasing population, migration, low cost of transport, and rising incomes (Cobbinah and Amoako, 2012; Brody, 2013; Youssef et al., 2020).

The result is the formation of peri-urban areas, transitional zones between rural and urban spaces characterized by poorly defined boundaries, land-use heterogeneity and interdependent rural-urban dynamics (Butt, 2013; Vindigni et al., 2021; Hedblom et al., 2017; Gioffre, 2019). These hybrid spaces contain agricultural lands, residential settlements, and infrastructure such as expressways, railways and dams side by side, and the way land is used within them is constantly evolving. Rather than viewing peri-urban areas as temporary zones awaiting inevitable urbanization, a growing body of research recognizes their critical role in contemporary urban systems. These areas perform several important functions: they absorb urban expansion, house infrastructure, and sustain agricultural production close to consumption centers. Peri-urban agriculture has the

potential to supply fresh food to cities, reduces transport-related emissions, preserves biodiversity, and maintain open spaces that contribute to urban resilience. Designing policies that maximize this potential while limiting negative environmental and ecological impacts is a key challenge for urban planning in the 21st century (Vindigni et al., 2021).

The effects of urbanization on peri-urban farming systems vary considerably across regions. In Europe, urbanization has emerged as a driving factor promoting multifunctional agriculture (Zasada, 2011; Meraner et al., 2018). In response to the demand from urban consumers in terms of post-harvest processing and recreational services, farmers in Europe have responded by intensification and diversification of farm activities (Zasada, 2011). Direct marketing of farm produce, shorter supply chains, on-farm specialization, on-farm diversification to include food processing, and non-productive recreational activities such as horse keeping, agro-tourism, and hobby farming have emerged as a response from farmers in peri-urban areas (Zasada, 2011; Beckers et al., 2020; Meraner et al., 2018; Wastfelt and Zhang, 2016).

In the Global South, urbanization presents a more complex picture of challenges and opportunities. Urban expansion threatens livestock and fisheries systems while contributing to water and soil quality degradation (Thapa et al., 2021; Hussain and Hanisch, 2014; Youssef et al., 2020). Wastewater-irrigated agriculture, increased farm wages, changing urban weather profile, increasing number of landless farmers, and high cost of farming are the effects of urban growth on urban and peri-urban agriculture (UPA) in the global south (Padgham et al., 2015; Hussain and Hanisch, 2014; Gumma et al., 2017; Kuusaana and Eldi, 2015; Follmann et al., 2021). Concurrently, better education and health infrastructure, higher wages, and employment opportunities act as pull factors for rural-urban migration (Abhishek et al., 2017; Mlambo, 2018). This also leads to reduction in the labour available for farming in rural areas, increased urban population, congestion in housing and traffic, urban unemployment, and increased crime rates (Mlambo, 2018). However, urbanization also creates market opportunities: rising urban population and income levels drive increased quantity and quality of food demand, prompting shifts from traditional staple crops toward higher-value produce such as fruits, vegetables, milk, eggs, and meat (Follmann et al., 2021; IFPRI, 2017).

In India, Industrialization, population size, education, and a political bias favoring the state capitals are some of the factors driving urban expansion (Abhishek et al., 2017;

Varkey and Manasi, 2019). The urban population in India has steadily increased at a growth rate of 31.8% which is higher than the average population growth rate of 17.64%. (Shekhar, 2021). Such accelerated urban expansion presents many ecosystem and social challenges (Sultana and Satyanarayana, 2018; Wakode et al., 2018; Gumma et al., 2017).

With urbanization affecting the key resources in a farming system, such as land, water, and labor, it is critical to appraise its role in the evolution of farming systems. A framework to appraise the farming systems from a social, agroecological, and economic perspective is facilitated by the concept of resilience. Resilience is the ability of a system to continue its functions, maintain its identity, and responses under stress while adapting to changing conditions (Walker et al., 2004; Folke, 2002; Carpenter, 2001). Recognizing the factors which enable a system to function in a hostile environment is at the core of the concept of resilience (Ifejika Speranza et al., 2014). It shifts the focus of policies from the changes in the system which are perceived as permanent to the capacities of the socio-ecological systems that enable them to cope and adapt (Berkes et al., 2003; Smit and Wandel, 2006; Folke, 2006). Emphasis on the resilience of farming systems is based on the recognition that it is essential to move away from the analytical concept of equilibrium (Scoones et al., 2007; Darnhofer et al., 2010). Resilience as a concept plays an important role in identifying and strengthening the characteristics of a farming system that can cope with shocks and stresses. To strengthen the capacities of resilience, we ought to measure them empirically (Carpenter et al., 2001). Several theoretical conceptualizations and methodological approaches exist for the assessment of resilience capacities (Roy et al., 2019; Meuwissen et al., 2019; Carpenter et al., 2005; Cabell and Oelofse, 2012; Jacobi et al., 2015; Ifejika Speranza et al., 2014; Cummings et al., 2005; Jacobi et al., 2018). The objective of this paper is to measure the resilience capacities of different farming systems in the study area and to isolate the impacts of urbanization on them to the extent possible.

Study Area and Data Collection

Hyderabad, the capital city of the southern Indian state of Telangana, is the sixth-largest metropolis in the country. It is located in the Musi sub-basin which is a part of the Krishna River basin. It consists of twelve municipalities including the Greater Hyderabad Municipal Corporation. Rapid development, increasing job opportunities, and economic growth have attracted skilled and unskilled labor from across the country pushing the city's population to 10.3 million (WPR, 2021). From 2005 to 2016, the built-up area in Hyderabad constituting housing and other buildings has increased from 38,863 ha to

80,111 ha; unfavorably affecting the water bodies and rainfed cropland (Gumma et al., 2017). The land under agriculture within the city limits has decreased with the ongoing infrastructure development with seasonal water-bodies being abused the most for building purposes. This has resulted in a shift in land use, mainly from farmland to built-up areas. There is also a rise in wastewater-irrigated agriculture on the banks of the Musi River, which flows through the city, for vegetables and paddy cultivation to accommodate the rising urban demand (Gumma et al., 2011; Gumma et al.,2017). In Hyderabad, along with an increase in the area under wastewater-irrigated agriculture, there is a trend towards the cultivation of vegetables from the traditional crops of paddy, maize, and sorghum. With the increasing built-up area, the most significant land cover lost is of water bodies which has resulted in an increased area under rainfed agriculture (Gumma et al., 2017).

Based on the findings of (Gumma et al., 2017), field explorations were conducted. Structured interviews were conducted with local experts and officials of the Department of Agriculture to identify the study area. The study employed interviews with local experts, government officials, and local progressive farmers to identify the issues faced by the local farming community and upcoming trends and opportunities due to the proximity of Hyderabad. Based on these interactions, six villages (Gundlapally, Guddamallaiguda, Mothakundur, Mulugu, Fareedpur, Kummera) were identified from blocks (Nalgonda, Ibrahimpattanam, Mothakundur, Mulugu, Haveli Ghanpur, Chevella) around Hyderabad to conduct focus group discussions with farmers. Discussions were conducted in Telugu with the help of enumerators using a predesigned instrument. The discussions were recorded and further translated into English. The predesigned instrument focused on various aspects of a farming system i.e., crop and livestock production, use of labor and machinery in agricultural practices, marketing channels employed, and the impact of urbanization observed by the farmers on the agricultural activities. In the next stage, blocks of Haveli Ghanpur, Mulugu, and Yacharam were selected for the farm household survey based on the understandings derived from the focus group discussions. The survey was conducted in August-September, 2021. A sample of 400 respondents was selected randomly from 10 villages within these blocks. The farm households were selected at random subject to the consent of an adult male and female household member to participate in an interview. The interviews were conducted in Telugu and responses were translated into English.

Conceptual Framework

“The ability of a farming system to cope with challenges can be conceptualized as resilience” (Meuwissen et al., 2019; Folke et al., 2010; Folke ., 2016; Bullocks et al., 2017). According to Meuwissen et al., (2019), robustness, adaptability, and transformability are the three system capacities that are critical to understanding the resilience of farming systems. Meuwissen et al., (2019) explain robustness as “the capacity of a farming system to withstand stresses and (un)anticipated shocks”; Adaptability as “the capacity to change the composition of inputs, production, marketing and risk management in response to shocks and stresses but without changing the structures and feedback mechanism of the farming system”; and Transformability as “the capacity to significantly change the internal structure and feedback mechanism of the farming system in response to either severe shocks or enduring stress that makes business as usual impossible”. Resilience is a holistic concept that is difficult to measure in its entirety due to its nature and (Cummings et al., 2005; Carpenter, 2005; Darnhofer et al., 2010; Cabell and Oelfose, 2012). Thus, it is suggested that a set of indicators to assess resilience is a more useful approach than trying to measure resilience itself (Darnhofer et al., 2010; Bennet et al. 2005; Carpenter, 2001; Cabell and Oelfose, 2012). Its segmenting into capacities makes it feasible to identify indicators that depict them (Jacobi et al., 2015). Carpenter, (2001) highlights that the attributes of a system that grant resilience depend on its context making the indicators of resilience context-dependent. Against this backdrop, we identified the following indicators for the assessment of the resilience capacities of the farming systems in the study area.

It is important to note that farming systems are highly complex and variable in time and space (Darnhofer et al., 2012) making it very difficult to identify aspects that contribute to their resilience (Cumming et al., 2005). Darnhofer et al., (2010) list the challenges associated with the task of identifying indicators of resilience. First is a temporal challenge i.e., the indicators may change as the farming system evolves. The second is the spatial hurdle i.e., the indicators are specific to location and the third is the human dimension i.e., the farmers’ perceptions and intentions about their farms. The relation between these indicators and resilience is dynamic and multidimensional in nature. There are trade-offs across resilience attributes i.e., an attribute that confers robustness to the system may be doing so at the cost of adaptability. At the same time, as the farming system evolves, an attribute that enhances the resilience today may affect the resilience of the farming system negatively with the change in domain.

Indicators for each resilience capacity were identified through a systematic process combining literature review, field validation, and expert consultation. We began with indicators commonly used in resilience assessments of farming systems, drawing particularly from the Resilience Index Measurement and Analysis (RIMA) methodology (FAO) and frameworks developed by Jacobi et al. (2018) and TANGO International (2018). These were then validated during FGDs with farmers to assess their relevance to the local context and the specific pressures of urbanization in the study area. Final selection was made in consultation with local agricultural scientists based on four criteria: relevance to the urbanization context, measurability, data availability, and feasibility of collection within the household survey.

The selected indicators reflect the specific dynamics of peri-urban farming systems. Indicators such as distance to city, distance to market, and access to infrastructure capture the urbanization gradient and its indirect effects. Cultivation of high-value crops and market access reflect farmer responses to urban demand. Livelihood diversification captures the pull of urban labor markets. Access to land and irrigation—key constraints identified in the focus group discussions—address the direct effects of urbanization on natural resources. Buffer capacity indicators such as agricultural income, assets, livestock, and access to safety nets capture the ability of households to absorb shocks. Finally, indicators related to information access, social networks, and agricultural services capture the enabling conditions for adaptation and transformation.

Table 5: Indicator components in the Robustness index

Robustness Indicators	Description/Interpretation	References
Agricultural income	A total of crop income, livestock income, and farm wages. Agricultural income allows farmers to build wealth thus building buffer capacity and making the system robust.	Cabell and Oelofse, 2012; Jacobi et al., 2018; Ifejika Speranza et al., 2014
Access to safety net	If the farm household participates in MGNREGS ¹ . Access to safety nets makes the farm household robust to shocks and stresses	TANGO International, 2018
Direct benefit transfers	Total benefits from Pradhan Mantri Kisan Samman Nidhi ² and Rythu Bandhu Scheme ³ Benefits from the government schemes add to the buffer capacity and allow farmers to invest in the future	

	Gross irrigated area in acres	
Access to irrigation	Access to irrigation allows the farmer to undertake cultivation across seasons making the system robust to seasonal shocks/stresses	Jacobi et al., 2018
	Gross cropped area in acre	
Gross cropped area	Farmland accessible across seasons makes the farming system robust to seasonal shocks/stresses	Jacobi et al., 2018
	Gross area under food crops in acres (excluding area under HVC)	
Food production	Supply of fresh food is a key function of the farming system which contributes to the food security of the farm household making it robust to the price shocks.	Jacobi et al., 2018
	The total of assets owned by the household	Jacobi et al., 2018; Ifejika Speranza, 2013; Ifejika Speranza et al., 2014;
Assets	These assets indicate the wealth of the farm HH which can be tapped into in times of shocks/stresses.	TANGO International, 2018
	Tropical Livestock units	
Livestock	Livestock serves as a cushion against economic shocks such as crop failure.	Jacobi et al., 2018; Ifejika Speranza, 2013
	Total benefits from various pension schemes and remittances	
Dependency payments	Access to dependency benefits reduces the financial burden of dependents in the household thus freeing up resources for farming	TANGO International, 2018
	If any member of the household is a member of any organization	Cabell and Oelofse,2012; Jacobi et al., 2018; Ifejika Speranza, 2013; Ifejika Speranza et al., 2014
Access to network	Social networks serve as an insurance mechanism in times of economic stress/shocks,	
	If the household is using manure as a farm input	
Use of organic inputs	The use of resources available locally reduces market dependence making the system robust	Cabell and Oelofse,2012

Table 6: Indicator components in the Adaptability Index

Adaptability Indicators	Description/Interpretation	References
Crop diversity	Simpson's Crop Diversity Index Crop diversity indicates the change in crop choices in line with the changing market conditions of the farm household	Cabell and Oelofse,2012; Jacobi et al., 2018; Roy et al., 2019

	No of the markets accessed by the household to sell its agricultural output.	Roy et al., 2019;
Market access	A variety of markets accessible to the farm household allows the farmer to diversify its product basket making it adaptable to changing market demand.	TANGO International, 2018;
	A total of assets owned by the household.	Jacobi et al., 2018;
Assets	Assets indicate the wealth of the farm household which allows it the flexibility to manoeuvre its activities	Ifejika Speranza, 2013; Ifejika Speranza et al., 2014; TANGO International, 2018
	Tropical livestock units	Jacobi et al., 2018;
Livestock	Livestock rearing indicates a change in farmer strategies in line with the market demand	Ifejika Speranza, 2013
	Access to information regarding market price, climatic conditions, agricultural technology adaptation, and agricultural practices through various sources	Cabell and Oelofse, 2012;
Access to information	Access to knowledge adds to the adaptive capacity of the farming system.	TNAGO International, 2018
	If any member of the household is a member of any organization	Cabell and Oelofse, 2012; Ifejika Speranza, 2013;
Access to network	Access to network facilitates the sharing of knowledge and past experiences thus adding to the adaptive capacity	Ifejika Speranza et al., 2014; Jacobi et al., 2018
	Distance to the nearest market in km	
Distance to market	Proximity to the market affects crop choices and production decisions in favor of the changing market conditions.	
	If the household has diversified into non-farm livelihood activities such as business/non-farm salaries employment/wages	Cabell and Oelofse, 2012; Ifejika Speranza, 2013;
Livelihood diversification	Non-farm income sources allow the farm household to invest in new technology and practices thus making it adaptable.	TANGO International, 2018
	The gross area under high-value crops in ac	
Cultivation of high-value crops	High-value crop cultivation indicates farm household adaptability to urban market demand.	Focus group discussions
	If the household is using manure as a farm input	Cabell and Oelofse, 2012; Focus group discussion
Use of organic inputs	The use of manure indicates the preference for organic inputs for soil fertility and a shift away from inorganic inputs	
	Years of experience in the farming of the head of the household indicating indigenous knowledge	Cabell and Oelofse, 2012; Jacobi et al., 2018; Ifejika Speranza et al., 2014
Experience in farming	Experience of shocks/stresses/challenges and indigenous knowledge make the system more adaptable	

Table 7: Indicator components in the Transformability index

Adaptability Indicators	Description/Interpretation	References
Access to network	If any member of the household is a member of any organization.	Cabell and Oelofse, 2012; Ifejika Speranza, 2013; Ifejika Speranza et al., 2014; Jacobi et al., 2018
	Access to the network provides the support and knowledge needed for transformation.	
Access to safety net	If the farm household participates in MGNREGS.	TANGO International, 2018
	Access to the safety net acts as an insurance mechanism to risks involved in transformation.	
Access to agricultural services	Access to agricultural services such as storage facilities, agricultural inputs, veterinary services, and hired labor	Jacobi et al., 2018; TANGO International, 2018
	Access to knowledge and infrastructure adds to the capacity of transformability.	
Access to information	Access to information regarding market price, climatic conditions, agricultural technology adaptation, and agricultural practices through various sources	Jacobi et al., 2018; TANGO International, 2018
	Access to knowledge adds to the transformability capacity of the farming system	
Access to supporting infrastructure	Access to health, education, and transportation facilities	Cabell and Oelofse, 2012; TANGO International, 2018
	Access to infrastructure facilitates transformability and contributes to human capital building which in turn further adds to transformability.	
Gender diverse decision making	Participation of both genders in the decision-making	TANGO International, 2018
	Women's participation in the decision-making process adds to transformability	
Distance to city	Distance to Hyderabad in km	
	Proximity to the city is an indicator of access to markets, infrastructure, and services which add to the transformability.	

Methodology

We use principal factor analysis to combine these indicators of resilience into indexes (TANGO International, 2018). Factor analysis is a multivariate statistical method that uses the relationship among variables to identify one or more underlying factors. A

“factor” is an unobservable or latent variable that can be understood through its relationship with other variables that can be observed and measured. Resilience measurement is not possible using a single variable as the concept is multifaceted. Thus, a scale is developed based on various indicators that capture various aspects associated with resilience capacity. Factor analysis allows the researcher to calculate the relative weights of the respective index components based on these inter-correlations and create a single variable i.e., the index. Data analysis was conducted using STATA 14. Further, orthogonal rotation was used.

We applied factor analysis to calculate index weights which are further used in the calculation of the resilience capacity index. A Kaiser-Meyer-Olkin (KMO) test is used to confirm that the index components have enough in common to warrant factor analysis. In the next step, the index is calculated for the resilience capacities using the weights derived from factor analysis. For reporting purposes, the index is standardized and placed on a scale of 0 to 100 using minimum and maximum values. Further, average values of each resilience capacity for each of the farming systems are calculated to help understand the contribution of each capacity and for comparison of resilience capacities across farming systems.

The current study aims to contribute to the growing literature on understanding the effects of urbanization on the resilience of farming systems in the context of rapidly developing cities.

1. Monocropping without livestock (FS1)
2. Diverse cropping without livestock (FS2)
3. Monocropping with dairy (FS3)
4. Diverse cropping with dairy (FS4)
5. Cropping with small ruminants (FS5)

Table 8: Farming systems in the study area

Sr. No	Characteristic	FS1	FS2	FS3	FS4	FS5	
		<i>n=217</i>	<i>n=76</i>	<i>n=33</i>	<i>n=26</i>	<i>n=14</i>	
		<i>54.25%</i>	<i>19%</i>	<i>8.25%</i>	<i>6.5%</i>	<i>3.5%</i>	
1.	Farm Size	<i>Marginal</i>	133 (61.29%)	43 (56.57%)	20 (60.60%)	6 (23.07%)	7 (50%)
		<i>Small</i>	50 (23.04%)	23 (30.26%)	4 (12.12%)	11 (42.30%)	4 (28.57)
		<i>Semi-medium</i>	23 (10.59%)	7 (9.21%)	6 (18.18%)	6 (23.07%)	2 (14.28%)
		<i>Medium</i>	10 (4.60%)	3 (3.94%)	3 (9.09%)	2 (7.69%)	1 (7.14%)
		<i>Large</i>	1 (0.46%)	0	0	1 (3.84%)	0
2.	Crops	Paddy, Cotton	Paddy, Maize, Cotton, Redgram, Vegetables	Paddy, Cotton, Fodder	Paddy, Maize, Cotton, Redgram, Vegetables	Paddy, Cotton	
3.	Irrigation characteristics	Irrigated, Rained	Irrigated, Drip irrigation	Irrigated, Rainfed	Irrigated, Drip irrigation	Irrigated, Rainfed	
4.	Livestock Characteristics	-	-	Local cattle, exotic/cross breed cattle	Local cattle, exotic/cross breed cattle	Small Ruminants	
5.	Farm operations: Mechanized	Land preparation, Harvesting	Land preparation, Harvesting	Land preparation, Harvesting	Land preparation, Harvesting	Land Preparation	
6.	Locations	Yacharam, Mulugu, Haveli, Ghanpur	Yacharam, Mulugu	Yacharam, Mulugu, Haveli, Ghanpur	Yacharam, Mulugu	Yacharam, Mulugu, Haveli, Ghanpur	

[Farm Size: Marginal= < 1 ha, Small= 1-2ha, Semi-medium= 2-4ha, Medium= 4-10 ha, Large= 10ha <] (Agriculture census by Government of India, 2015-16) (Note: 34 HH were excluded from farming systems categorization. While 29 HH had leased out their farmland, 5 HH could not be categorized due to the nature of their farm activities.)

Results and Discussion

Table 9: Results of the factor analysis

Robustness			Adaptability			Transformability		
Indicator	Unrotated	Rotated	Indicator	Unrotated	Rotated	Indicator	Unrotated	Rotated
Agricultural income	0.8229	0.7883	Crop diversity	0.6811	0.7213	Access to network	-0.2665	-0.1668
Access to safety net	-0.0636	-0.0379	Market Access	0.5899	0.2681	Access to safety net	-0.3220	-0.2324
Direct benefit transfers	0.7550	0.7131	Assets	0.2200	0.0478	Access to agricultural services	0.5246	0.5780
Access to irrigation	0.9621	0.9697	Access to information	0.3414	0.2228	Access to supporting infrastructure	0.7029	0.7068
Access to farmland	0.9629	0.9727	Access to network	-0.0768	-0.1981	Access to information	0.3294	0.2445
Food production	0.9535	0.9716	Distance to market	-0.2736	-0.1161	Distance to city	-0.514	-0.4277
Assets	0.3638	0.3216	Off-farm diversification	-0.1745	-0.1681	Gender diversity	-0.1604	-0.0566
Dependency benefits	-0.0694	-0.0614	Area under HVC	0.6271	0.7325			
Access to network	-0.0039	0.0028	Use of organic inputs	0.4991	0.2505			
Use of organic inputs	0.0199	-0.0008	Years of experience in farming	-0.0023	-0.0659			
No of Livestock	0.0828	0.0681	No of Livestock	0.2649	0.0479			

[For Robustness, KMO value= 0.7271; For Adaptability, KMO value = 0.6406; For Transformability, KMO value = 0.7604]

Factor Analysis

1. Robustness

Based on the results of the factor analysis, agriculture income, direct benefit transfers from government schemes, access to irrigation, access to farmland, and food crop production contribute positively to the robustness of the farming system. While household assets, and livestock (TLU) have no significant impact on the robustness of a farming system, access to safety nets such as MGNREGA

and pension benefits affect it negatively. This is explained by the practice of informally leasing out farmland, thus suspending farming activities.

2. *Adaptability*

Crop diversity and area under high value crops influence the adaptability of the farming systems positively. Livestock (TLU), assets, and the use of organic inputs do not have a significant influence on the adaptability of the farming systems in the study area. Non-farm activities are preferred as the reliable and regular source of livelihood over the uncertainties linked with farm income. Thus, non-farm diversification has a negative impact on the adaptability of the farming systems.

3. *Transformability*

Access to agricultural inputs and services and supporting infrastructure contribute positively to the transformability of the farming systems. Distance to the city has a negative influence on the transformability of a farming system indicating an inverse relationship between the distance to the urban centre and the transformability of the farming systems in the study area. Access to network, access to information, and access to safety nets do not significantly impact the transformability of the farming systems. Notably, women's participation in the decision-making process regarding household activities and control over income does not contribute significantly to transformability. This may indicate that gender diversity in terms of decision-making in itself does not add to transformability without the support of complementary infrastructure and services.

Resilience capacities of the farming systems

Table 10: Resilience capacities index scores

	FS1	FS2	FS3	FS4	FS5
Robustness					
<i>Mean</i>	28.232	25.556	32.373	40.717	30.296
<i>S.D.</i>	27.348	17.824	26.655	24.285	20.398
Adaptability					
<i>Mean</i>	12.743	67.393	10.405	66.731	19.170

<i>S.D.</i>	7.140	13.538	3.600	24.060	11.336
Transformability					
<i>Mean</i>	52.151	70.263	49.397	66.617	54.792
<i>S.D.</i>	22.445	13.538	22.594	15.539	14.781

There is an inherent trade-off in the capacities of the resilience of a farming system (Darnhofer et al., 2010). What may add positively to the robustness of a farming system, may contribute negatively to its adaptability. We observe such trade-offs in our study. FS4 has the highest robustness while FS2 scores highest in terms of the adaptability and transformability. These results highlight the importance of context of the study, the trade-off amongst resilience capacities, and the dynamic nature of resilience as a property of a system.

The farming system FS2 consists of farm households which practice diverse high value cropping without any livestock rearing activities. Majority of the households own small and marginal farms (87%). These farm households are located in the peri-urban region of the study area. Thus, with crop diversity and access to market, this farming system ranks high in terms of adaptability. With access to infrastructure and services, proximity to the city, this farming system ranks high in terms of transformability. However, with lower access to farmland (which also limits access to direct benefit transfers linked to land ownership), this farming system ranks lowest in terms of robustness.

On the other hand, farming system FS4 consists of farm households practicing diverse cropping and dairy activities. While 65% households are small and medium farms, 30% households are semi-medium and medium farms. These households are located in the peri-urban region of the study area. With the supplementary agricultural income from dairy activities, better access to farmland and direct benefit transfers, this farming system ranks highest in terms of robustness. However, it also ranks second highest in terms of adaptability and transformability as well facilitated by crop diversity, market access, access to infrastructure and services, and proximity to the city.

Discussion and limitations of the study

The spatial distribution of farming practices reflects the market effects of urbanization. Diverse cropping households are concentrated in the peri-urban region, with the majority cultivating vegetables for urban markets. This pattern of intensification and diversification in peri-urban areas is consistent with findings from other rapidly urbanizing contexts (Follmann et al., 2021; Wastfelt and Zhang, 2016; Hussain and Hanisch, 2014; Meraner et al., 2018) and confirms that proximity to urban markets drives shifts toward higher-value production systems.

Social protection programs play a complex role in shaping household strategies. Land owning farmers receive cash transfers from two direct benefit schemes i.e. the Rythu Bandhu Yojana implemented by the State Government of Telangana and the Pradhan Mantri Kisan Samman Nidhi implemented by the Government of India. These schemes are aimed at supporting the farmers in the face of rising input costs. While they contribute significantly to the robustness of farming systems, we observe that many farm households, particularly elderly farmers, rely on these benefits as a steady source of income. Additionally, all the households in the study area have access to social safety net schemes through the MGNREGA. However, instead of accessing it in times of economic shocks, it is perceived as a reliable source of paid work. Our findings suggest that rather than serving solely as a safety net during economic shocks, these programs may have become integrated into regular household income strategies. We observe that some farm households, particularly those with elderly members, lease out farmland informally while retaining land ownership to continue receiving land-linked benefits. This pattern suggests a modification of livelihood portfolios in response to improved income security. These observations indicate that direct benefit transfers and access to safety nets may be indirectly contributing to the transformability of farm households by facilitating gradual exits from active farming.

This study has several limitations that should be acknowledged. First, the cross-sectional design captures resilience capacities at a single point in time, whereas resilience is inherently dynamic. The resilience indicators identified may change as farming systems evolve in response to continued urbanization. Second, the findings are context-specific to the peri-urban areas of Hyderabad and may not be generalized to other Indian cities or regions with different urbanization trajectories. Third, indicator selection was constrained

by data availability and feasibility of collection; potentially important factors such as soil quality, tenure security among others were not captured.

Conceptually, this study draws on the framework developed by Meuwissen et al. (2019) but focuses only on a set of resilience capacities rather than the full set of resilience attributes such as system reserves, tightness of feedback, and openness. Additionally, the study assesses overall resilience rather than resilience with respect to specific functions. Farming systems perform multiple private functions (providing affordable food, supplying raw materials, generating livelihoods) and public functions (maintaining natural resources, protecting biodiversity, preserving rural social structures). Assessing the resilience of these specific functions under urbanization pressure remains an important direction for future research. Longitudinal studies tracking the same farming systems over time would also strengthen understanding of how resilience capacities evolve as urbanization proceeds.

Conclusions

Urbanization has a mixed impact on the resilience of the farming systems. The indirect effects of urbanization i.e. market effect and the technical efficiency effect contribute positively to the adaptability and transformability of the farming systems by facilitating market access, demand for high-value crops, access to infrastructure, and agricultural services. It directly affects the robustness of the farming systems negatively by constraining access to natural resources i.e. land and water. It also negatively affects the adaptability of farming systems by facilitating access to off-farm employment which is facilitating farm exits. Of the farming systems studied, FS4 has the highest robustness while FS2 scores highest in terms of adaptability and transformability. Hence, farm strategies and policies that support diversification of on-farm activities and high-value crop cultivation should be promoted. Policy instruments should be designed to ensure access to farmland and irrigation in line with urban expansion. However, urbanization is a dynamic process. Its impact on farming systems, which are dynamic in their own right, will lead to a complex set of interactions having multifaceted effects. As urban expansion continues, it will change the attributes or the nature of attributes that contribute to the resilience of these farming systems.

UNDERSTANDING THE EFFECTS OF URBANIZATION ON FARM LABOR PARTICIPATION

Abstract: Urbanization affects agriculture by constraining access to land and water, facilitating access to markets, transforming consumer demand for agricultural products, providing access to transportation services, and access to non-farm jobs. The study aims to understand the effect of urbanization on the participation of male and female members of land-owning farm households in farm and non-farm activities. It attempts to identify the factors affecting the participation of farm labor in full-time farming, full-time non-farm, and part-time farming activities. A multinomial logit model is estimated with demographic, agricultural, and location variables. Our findings suggest that, while age, household size, and participation in the MGNREG scheme affect female participation, age, land size, and participation in livestock rearing affect male participation across activities. High-value crop cultivation promotes male and female participation in full-time farming. Urbanization affects the participation of household members by creating market access, access to non-farm jobs, and access to farmland.

Introduction

Urbanization is one of the major phenomena of our times that is contributing to socioeconomic and land use changes globally. It is one of the major demographic trends with half of the world's population living in urban areas (United Nations, 2019). By 2050, Nigeria, China, and India are expected to account for 35% of the growth in the world's urban population during 2018-2050 (United Nations, 2019). From 1975 to 2020, the urban population in low-income countries grew to 300 million, which is expected to reach 700 million by 2070 (UN-Habitat, 2022). According to FAO et al., 2023; as cities grow rapidly, it's expected that almost seven out of ten people will live in urban areas by 2050.

Currently, India provides food to 18% of the world's population but occupies only 2.4% of the world's total land area (FAO, 2023). During the past 140 years, India has experienced remarkable land use and land-cover changes including deforestation, cropland changes, and urban expansion (Roy et al., 2015; Tian et al., 2014). Urban sprawl dynamics are expected to play a significant part in the land use changes in India in the future with urban expansion anticipated to occur on all land types including farmland and forest land (Hinz et al., 2020). Urban expansion results in spatial structural changes which lead to the conversion of farmlands and open spaces to built-up areas for industrial

purposes, infrastructure projects, and provision of basic amenities for the growing urban population (Gyasi et al., 2014). Agricultural lands converted to urban structures are usually in proximity to the urban region.

Urban sprawl is characterized by the informal and fragmented spatial expansion of urban areas on the fringe of the cities because of numerous factors such as economic (e.g., lower land prices, increasing income levels) institutional (e.g., urban planning failure), and demographic factors (e.g., increasing population, migration), social, and cultural leading to the formation of peri-urban areas (Brody, 2013; Cobbinah and Amoako, 2012; Naab et al., 2013; Cobbinah et al., 2015; Youssef et al., 2020). Peri-urbanization is linked to urban sprawl by Nechyba & Walsh (2004) and Gilham & Maclean (2002) as they characterize urban sprawl as the low-density development accompanied by a concentration of economic activity and population in the peri-urban areas in the periphery of the cities. Peri-urban areas are the transitional regions between the natural habitats of the rural areas and the urban areas (Doygun, 2009; Youssef et al., 2020) characterized by processes of socioeconomic and land-use shifts, where rural and urban changes are closely interdependent (Butt, 2013); which are many times ‘peculiar to the fringes’ (Gallent and Andersson, 2007). The process of peri-urbanization is driven by geographical contexts and a variety of socio-economic factors (Butt, 2013). The peri-urban areas continue undergoing socio-economic changes as the cities keep sprawling.

The contribution of urban and peri-urban agriculture to urban food security is well-recognized in the literature (Filippini et al., 2018; Abu Hatab et al., 2019; Follman et al., 2021). Urbanization influences the resources required to undertake farming. It restricts the access to land and water by the farm households in urban vicinity as urban expansion results in the loss of farmland and water bodies (Gumma et al., 2017; Xu et al., 2020). It also creates speculative pressure on land prices thus influencing land use decisions (Lopez, 1988). Proximity to an urban center provides access to better education, health infrastructure, and non-farm jobs (Mlambo, 2018; Steinhubel and Cramon-Taubade, 2019). This creates a trade-off for the workers between higher-paying non-farm jobs and farm intensification as the proximity to a city increases the opportunity cost of intensive farming with easier access to non-farm jobs (Steinhubel and Cramon-Taubade, 2019). Urbanization affects consumer preferences, necessitating shifts in the types and quantities of agricultural products demanded (Rao et al., 2006; Birthal et al., 2007; IFPRI, 2017). Proximity to a city also facilitates access to key markets through modern supply chain networks (Filippini et al., 2016; IFPRI, 2017, Hazell, 2019).

Against this backdrop, farm households may choose to intensify and/or diversify their farm activities to include non-farm activities. Farmers may also choose to exit from farming and take up full-time non-farm activities. The choice of taking up full-time non-farm activities is generally overlooked in farmers' time allocation studies (Kimhi, 1994). Many farmers divide their time between farming and non-farm work. Part-time farming is becoming a common phenomenon in India with the growing importance of non-farm income sources to the farm household (Binswanger-Mkhize, 2013). This prompts the question if part-time farming is a stable phenomenon or a move in the direction of exit from farming (Kimhi, 1994). We investigate the participation of farm owners in the study area across four types of choices of time allocation. We incorporate farm households who do not work on their farms at all while retaining the choice to do so in the form of ownership of farmland.

In India, women's work participation is linked to various factors such as economic growth, urbanization, education, family size (Mitra 2019; Sen 2017; Lahoti and Swaminathan 2015; Nagaich and Sharma 2014; Kumari and Pandey 2012; Thomas 2012; Reddy 1979; Kingdon and Unni 2001; Srivastava and Srivastava 2010; Eapen 1992; Dev 2004). Women's work participation is one of the socio-economic issues among the multifaceted issues confronting the peri-urban villages, particularly in developing countries (Sikarwar et al., 2022).

This study aims to understand the factors affecting the participation of farm household members in the peri-urban region of Hyderabad city to participate in farming, part-time farming, and non-farming activities through a gender lens. It contributes to the literature on female work participation from land-owning farm households in the peri-urban and rural areas. We also attempt to understand the role of urbanization in the choice of activities by farmers in the study area.

Materials and Methods

Study Area and Data collection:

Hyderabad, the capital city of the southern Indian state of Telangana, is the sixth-largest metropolis in the country. It is located in the Musi sub-basin which is a part of the Krishna River basin. It consists of twelve municipalities including the Greater Hyderabad Municipal Corporation. Rapid development, increasing job opportunities, and economic growth have attracted skilled and unskilled labor from across the country pushing the

city's population to 10.3 million (WPR, 2021). From 2005 to 2016, the built-up area in Hyderabad constituting housing and other buildings has increased from 38,863 ha to 80,111 ha; unfavorably affecting the water bodies and rainfed cropland (Gumma et al., 2017). The land under agriculture within the city limits has decreased with the ongoing infrastructure development with seasonal water-bodies being abused the most for building purposes. This has resulted in a shift in land use, mainly from farmland to built-up areas. There is also a rise in wastewater-irrigated agriculture on the banks of the Musi River, which flows through the city, for vegetables and paddy cultivation to accommodate the rising urban demand (Gumma et al., 2011; Gumma et al., 2017). In Hyderabad, along with an increase in the area under wastewater-irrigated agriculture, there is a trend towards the cultivation of vegetables from the traditional crops of paddy, maize, and sorghum. With the increasing built-up area, the most significant land cover lost is of water bodies which has resulted in an increased area under rainfed agriculture (Gumma et al., 2017).

Based on the findings of (Gumma et al., 2017), field explorations were conducted. Structured interviews were conducted with local experts and officials of the Department of Agriculture to identify the study area. The study employed interviews with local experts, government officials, and local progressive farmers to identify the issues faced by the local farming community and upcoming trends and opportunities due to the proximity of Hyderabad. Based on these interactions, six villages (Gundlapally, Guddamallaiguda, Mothakundur, Mulugu, Fareedpur, Kummera) were identified from blocks (Nalgonda, Ibrahimhattanam, Mothakundur, Mulugu, Haveli Ghanpur, Chevella) around Hyderabad to conduct focus group discussions with farmers. Discussions were conducted in Telugu with the help of enumerators using a predesigned instrument. The discussions were recorded and further translated into English. The predesigned instrument focused on various aspects of a farming system i.e., crop and livestock production, use of labor and machinery in agricultural practices, marketing channels employed, and the impact of urbanization observed by the farmers on the agricultural activities. In the next stage, blocks of Haveli Ghanpur, Mulugu, and Yacharam were selected for the farm household survey based on the understandings derived from the focus group discussions. The survey was conducted in August-September, 2021. A sample of 400 respondents was selected randomly from 10 villages within these blocks. The farm households were selected at random subject to the consent of an adult male and female household member to participate in an interview. The inter-views were conducted in Telugu and responses were translated into English.

Out of the 400 households surveyed, a sample of 387 males and females were selected for the study. Based on their time allocation for a variety of activities including domestic chores and leisure, they were segregated into groups of those participating in full-time farming (working on own farm and/or as farm laborer), full-time non-farming, part-time farming i.e. working in both farm and non-farm activities, and idle i.e. those who did not participate in any type of livelihood activities at the time of the survey. The farm households in the sample undertake a variety of farming activities such as sheep and goat rearing, dairying, and cropping. Paddy, Maize, Cotton, pulses, and vegetables are the major crops grown by the farm households. While the farmers in the peri-urban grow multiple crops including vegetables, the farmers in rural areas are predominantly paddy growers. While paddy, maize, cotton and pulses is mainly sold through the government procurement drives and traders, vegetables are sold in the markets in Hyderabad directly or to the traders. Additionally, vegetables are also procured by organized retailers such as Reliance Fresh and Big Basket, Spencer's from the farm gate. Livestock activities such as sheep and goat rearing and dairying are of a subsistence nature. Additionally, household members participate in non-farm activities such as working in local government offices, running small shops, bidi making, working on construction sites, and in factories. The majority of farm households own small and marginal landholdings. Farm operations such as land preparation and harvesting are mechanized by renting in farm machinery from the large farmers in the village.

Methodology

We estimate a multinomial logit model that involves four choices of time allocation for the farm households.

A multinomial logit model is employed to understand the choice behavior of a farm household member, male and female, out of the four options that are available to the respondents: Part-time farming, full-time farming, full-time non-farming, and idle.

The multinomial logit model estimates the probability of a farm household member choosing a particular time allocation category for the given set of independent variables. The extent of positive or negative effect of an independent variable on the choice made by the respondents is also estimated. The probabilities of the choice are calculated relative

to the base category. Statistically significant results are used for interpretation of the analysis.

Let Y_i denote the categorical outcome for individual i taking values in the set $\{1, 2, \dots, J\}$ representing the J possible choices. The probability that individual i chooses alternative j is given by:

$$p_{ij} = p(Y_i = j) = \frac{\exp(\beta'_j X_i)}{\sum_{k=1}^J \exp(\beta'_k X_i)}$$

where β'_j is the vector of estimated coefficients for the j th category and X_i is the i th case (row) of the data matrix.

Marginal effects are calculated to quantify the change in the probability of choice of a dependent variable with a unit change in an independent variable.

A multinomial logit model facilitates in understanding the choice behavior of the respondent depending upon a set of independent variables. In this study, the members of the farm household have the option to choose from four categories of time allocation: Part-time farming, full-time farming, full-time non-farm, and idle. Their decision is assumed to be affected by a group of independent variables consisting of demographic variables, agricultural variables, participation in MGNREGS (Mahatma Gandhi National Rural Employment Guarantee Scheme, which provides a legal guarantee of one hundred days of employment to adults of rural households willing to do unskilled manual work at statutory minimum wage), livestock rearing, high-value crop cultivation, and distance from the city.

The model is estimated independently for the pooled sample, the peri-urban sample, and the rural sample in order to capture the nuanced effects of the geographical location of the farm household. Additionally, the model is estimated independently for the male and female respondents in order to understand the gendered nuances of the choices they make.

The demographic variables of age, household size, number of children in the household, and level of education are incorporated into the analysis. While the household size is an indicator of the family labor available, the number of children in the household also indicates the dependents in the family which influences the workforce participation of the female members of the households (Pattanaik and Lahiri-Dutt, 2020). The rural youth aspire for urban non-farm jobs due to the low profitability of agriculture (Nandi et al.,

2022). A higher level of education enables a shift from a farm to a non-farm job. The urban expansion in the vicinity facilitates access to non-farm jobs (Hazell, 2019; Steinhubel and Cramon-Taubade, 2019). The age of the farmer influences their choice of farm activities. Young farmers, who are not averse to risk-taking may choose to intensify, diversify, or migrate, while the old farmers tend to be risk-averse and are likely to refrain from intensification/diversification (Meraner et al., 2018). Older farmers are less likely to participate in non-farm activities compared to younger farmers (Dary and Kuunibe, 2012; Asfaw et al., 2017; Pattanaik and Lahiri-Dutt, 2020). They may choose crops that are easier to cultivate, shift to hobby farming, or exit farming (Meraner et al., 2018; Zasada, 2011).

Landholding is an important variable affecting the household's decisions about farm and non-farm activities. Large farmers, who often tend to be resource-endowed, have the choice to expand, intensify, or diversify their farm activities. Small and marginal farmers are more likely to lose their access to land and other inputs due to high prices. They find it unaffordable to experiment and may end up selling their farmland. On the other hand, they may end up intensifying their farm activities to compensate for the high cost of inputs (Hussain and Hansch, 2014).

The location of the farm and its proximity to the market, i.e. distance from the city are important mediating factors. Farm households located closer to urban areas are positioned at an advantage to get associated with the modern value chains (Hazell, 2019;). Access to roads and towns affects the uptake of modern farm inputs (Steinhubel and Cramon-Taubadel, 2020). Proximity to the city also encourages the diversification of activities by farm households (Wastfelt and Zhang, 2016; Meraner et al., 2018) including uptake of on-farm non-agricultural diversification (Zasada, 2011). The rising urban population and inflow of migrants in the city result in an increasing demand for food. With the growing middle class and rising income levels, a shift in the diets of the urban consumer is observed from staples and coarse grains to high-value foods such as meat, dairy, fruits, and vegetables (Deshingkar et al., 2003; Rao et al., 2006; Rao and Joshi, 2009; IFPRI, 2017). With easier access to urban markets, farmers may shift/diversify their farm activities to high-value crop cultivation and livestock rearing encouraging them to continue full-time farming. Thus, whether the household undertakes cultivation of high-value crops and livestock-rearing activities is incorporated into the analysis.

Participation in MGNREGA is a significant factor influencing the choice of time allocation. It influences the decision on seasonal migration for non-farm work in addition to the impact of MGNREGS on the rural wage rates (Imbert and Papp, 2020). It also betters bargaining conditions for laborers (Carswell and De Neve, 2014).

Table 11: Proportion of male participation across activities

Activity	Pool		Rural		Peri-urban	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Part-time	101	26.10	42	22.95	59	28.92
Farm	260	67.18	124	67.76	136	66.67
None	14	3.62	8	4.37	6	2.94
Non-Farm	12	3.10	9	4.92	3	1.47
Grand Total	387	100	183	100	204	100

Table 12: Proportion of female participation across activities

Activity	Pool		Rural		Peri-Urban	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Part-time	18	4.65	8	4.37	10	4.90
Farm	306	79.07	131	71.58	175	85.78
None	45	11.63	32	17.49	13	6.37
Non-Farm	18	4.65	12	6.56	6	2.94
Grand Total	387	100	183	100	204	100

Table 13: Variables used in multinomial logit estimation

Variable	Description
Dependent Variables	
Full time farming	1=yes; 0=otherwise
Part time farming	1=yes; 0=otherwise
Full time non-farm	1=yes; 0=otherwise
Idle	1=yes; 0=otherwise
Independent Variables	
Age	No. of years
Household size	No. of household members
No. of children	No. of household members below age 14.
Level of education	1=No school
	2=Primary classes 1-5
	3=Secondary Level classes 6-10
	4=Technical or vocational training
	5=Intermediate
	6=Graduation/University
	7=Post Graduation
High-Value Crop Cultivation	Whether the household participates in high-value crop cultivation: (1 = yes; 0 = otherwise)
Livestock rearing	Whether the household participates in livestock-rearing activities: (1 = yes; 0 = otherwise)
Participation MGNREGS	Whether the household member participates in the MGNREGS scheme: (1 = yes; 0 = otherwise)
Distance to the city	Distance between the household village and the center of Hyderabad in kilometers.

Table 14: Descriptive Statistics

Variable	Mean	S.D.	Min	Max
Female Age	43.09	11.02	19	70
Male Age	47.95	12.34	20	80
Household Size	3.89	1.43	1	9
Landholding	3.36	3.80	0.25	40
No of children	0.78	0.98	0	4
Distance to the city	75.65	29.27	40	130

Table 15: Categorical Variables

Variable	Proportion of participation	Proportion of non-participation
High-value crop cultivation	15.76%	84.23%
Livestock rearing	19.89%	80.10%
MGNREGS Male	69.76%	30.23%
MGNREGS Female	66.92%	33.07%

Results

Marginal effects after estimating the multinomial logit model are as follows:

Table 16: Marginal effects estimated for the male pool

Variable	Part-time Farm	Full-time Farm	Full-time Non-Farm	Idle
Age	-0.005	0.005	0.000	0.000
HH Size	0.011	-0.012	-0.000	0.000

Education	0.028	-0.028	0.000	0.000
HVC	-0.168	0.181	-0.002	-0.010
Landholding	-0.032***	0.032**	-0.000	0.000
NREGA	-0.164	0.167	-0.000	-0.002
Livestock Rearing	-0.153	0.158	-0.003	-0.001
Distance to City	-0.002**	0.002	0.000	0.000

(* p < 0.05, ** p < 0.01, *** p < 0.001.)

In the case of male farmers, a larger landholding increases the probability of their opting for full-time farming. At the same time, as their farm location moves away from the city, their chance of opting for part-time non-farm activities decreases.

Table 17: Marginal effects estimated for the peri-urban male

Variable	Part-time Farm	Full-time Farm	Idle
Age	-0.007**	0.007	0.000
HH Size	0.016	-0.016	0.000
Education	0.030	-0.030	-0.000
HVC	-0.190***	0.209***	-0.019
Landholding	-0.044**	0.044**	0.000
NREGA	-0.127	0.127	-0.000
Livestock Rearing	-0.091	0.091	-0.000
Distance to City	-0.006	0.006	-0.000

(* p < 0.05, ** p < 0.01, *** p < 0.001.)

Note: The variable of Full-Time Non-Farm was dropped as the sample size was 3.

In the peri-urban region, a younger male farmer is more likely to diversify their activities by opting for part-time farm and non-farm activities. Male farmers who undertake high value crop cultivation are more likely to opt for full time farming. As the size of the landholding increases, the farmers are more likely to opt for full time farm activities.

Table 18: Marginal effects estimated for the rural male

Variable	Part-time Farm	Full-time Farm	Full-time Non-Farm	Idle
Age	-0.003	0.003	0.000	0.000
HH Size	0.011	-0.011	0.000	0.000
Education	0.018	-0.020	0.002	0.000
Landholding	-0.030	0.031	-0.001	-0.000
NREGA	-0.258	0.264	-0.005	-0.000
Livestock Rearing	-0.227***	0.281***	-0.054***	-0.001
Distance to City	-0.002	0.003	-0.000	0.000

(* p < 0.05, ** p < 0.01, *** p < 0.001.)

In rural areas, male farmers who undertake livestock rearing activities are less likely to opt for non-farm activities either part-time or full-time.

Table 19: Marginal effects estimated for the female pool

Variable	Part-time Farm	Full-time Farm	Full-time Non-Farm	Idle
Age	-0.000	-0.006	0.002**	0.004
HH Size	-0.000	-0.010	0.013**	-0.003
Education	-0.000	-0.034	0.007	0.028
No of children	0.000	-0.006	-0.003	0.009
HVC	-0.000	0.085**	-0.023	-0.062

Landholding	-0.001	-0.002	0.001	0.002
NREGA	0.000	0.195**	-0.054**	-0.141
Distance to City	-0.000	-0.002	0.000	0.001
Livestock Rearing	-0.008	0.055	-0.013	-0.034

(* p < 0.05, ** p < 0.01, *** p < 0.001.)

In the case of female farmers, the probability of choosing full-time non-farm employment increases with their age and the size of the household. In the case of households undertaking high-value crop cultivation, female farmers are more likely to opt for full-time farming. Participation in the MGNREGA scheme also increases their probability of choosing to stay in farming full-time.

Table 20: Marginal effects estimated for the peri-urban female

Variable	Part-time Farm	Full-time Farm	Full-time Non-Farm	Idle
Age	-0.000	-0.002	0.001	0.001
HH Size	-0.000	0.018	-0.000	-0.017**
Education	-0.000	-0.013	0.004	0.009
No of children	-0.000	-0.022	0.005	0.017
HVC	-0.000	0.027	-0.012	-0.015
Landholding	-0.001	0.000	0.001	-0.001
NREGA	0.000	0.072	-0.035	-0.038
Distance to city	-0.000	-0.003	0.001	0.002
Livestock Rearing	-0.016	0.028	-0.010	-0.002

(* p < 0.05, ** p < 0.01, *** p < 0.001.)

In the case of peri-urban regions, the probability of a female member of a farm household not participating in any activity decreases as the size of the household increases.

Table 21: Marginal effects estimated for the rural female

Variable	Part-time Farm	Full-time Farm	Full-time Non-Farm	Idle
Age	-0.000	-0.006	0.002	0.004
HH Size	0.000	-0.064**	0.029**	0.034
Education	-0.000	-0.036	0.006	0.030
No of children	-0.000	0.045	-0.024	-0.022
Landholding	-0.000	-0.000	-0.000	0.000
NREGA	0.000	0.340***	-0.069	-0.271***
Distance to city	0.000	0.014***	-0.003	-0.011***
Livestock rearing	-0.000	0.040	-0.009	-0.031

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

In rural areas, as the size of the household increases, the probability of a female member of a farm household opting to work full-time in non-farm jobs increases. At the same time, as a farm household moves away from the city, the probability of the females working full time in the farm increases, while decreasing the probability of staying idle. Undertaking livestock-rearing activities also decreases the probability of females staying idle in the rural area.

Discussion

This paper attempts to understand the factors affecting the participation of farm household members in farm and non-farm activities in light of the urban influences on agricultural activities from a gender perspective. For this purpose, a multinomial logit estimation was estimated by employing a set of demographic, agricultural, and geographical variables.

In the case of female members of the household, older females are more likely to opt for full-time non-farm employment. As the household size increases, the likelihood of females working full-time in the non-farm increases. This is a peculiar finding as the literature suggests that females are less likely to participate in non-farm activities due as

they are time-poor due to household responsibilities (Matshe and Young, 2004; Pattanaik and Lahiri-Dutt, 2020). This can be interpreted as a larger size of the household providing a higher number of helping hands to work on the family farm, thus enabling the females to participate in non-farm activities to supplement the farm income. If a farm household is undertaking high-value crop cultivation, it contributes positively towards the females working full time on the farm. High-value crops cultivation, in this case, vegetable cultivation is a labor-intensive activity whilst providing higher economic returns. Many aspects of vegetable farming are carried out by females such as sowing, weeding, and harvesting. Proximity to markets, access to transportation and infrastructure are conducive to vegetable production (Mariyono et al., 2020). Participation in the MGNREG scheme increases the likelihood of female participation in full-time farming. Women are one of the important social groups benefitting from the MGNREG scheme. It provides them with better bargaining power by pushing up rural wage rates (Carswell and De Neve, 2014). As the location of the household moves away from the city, they are more likely to opt for full-time farm activities as access to non-farm jobs becomes scarce (Dary and Kuunibe, 2012).

In the case of the male members of the household, the size of the landholding is an important factor influencing their participation in full-time farm activities. While a higher land size increases the likeliness of opting for full-time farming, it simultaneously reduces the probability of part-time farming. This is consistent with the existing literature which also suggests that farmers who have access to smaller land are more likely to participate in the non-farm activities (Matshe and Young, 2004). In peri-urban areas, the size of the landholding and cultivation of high-value crops are the factors positively influencing the choice of farming full-time while reducing the chances of part-time farming. As the land prices in peri-urban areas are high, farmers are choosing to intensify their farming activities by undertaking vegetable cultivation (Hussain and Hanisch, 2014). As vegetable farming has higher economic returns due to the access to urban markets, farmers are opting to work full-time on the farm. As the age of the farmer increases, he is less likely to work part-time in farm and non-farm activities. This is consistent with the literature as older farmers tend to be risk-averse; they are less likely to diversify their portfolio of livelihood activities (Meraner et al., 2018; Dary and Kuunibe, 2012). In rural areas, farmers are more likely to opt for full-time farming and less likely to opt for part-time farming if the household is undertaking livestock-rearing activities. Livestock rearing is

a labor-intensive activity providing supplementary farm income. Additionally, access to non-farm jobs is limited.

Conclusion

In this paper, we attempt to understand the factors responsible for the participation of male and female farm household members in farm and non-farm activities against the backdrop of the effects of urbanization. Our results confirm that urbanization affects the participation of farm household members in farm and non-farm activities by influencing variables that contribute to the decision of participation. With urban expansion, accessing farmland becomes difficult thus affecting the landholding of the farmers. Proximity to the city facilitates market access thus promoting the cultivation of high-value crops. A larger size of the household and access to non-farm activities is promoting female participation in non-farm activities. Participation in the MGNREG scheme and high-value crop cultivation is encouraging females to undertake farming activities. Access to land, livestock rearing, and high-value crop cultivation is promoting male participation in farming activities. Given the importance of peri-urban agriculture to urban food security, policy instruments should be designed to ensure access to farmland for the farmers in the peri-urban areas. Further, the cultivation of high-value crops should be promoted by providing support for micro-irrigation and other modern inputs.

Failure to capture the permanent shift of farm labour to the non-farm sector triggered by the urban expansion, which in turn influences farm labour available to the farming systems, is a clear limitation of this study. Permanent migration of farm household members, its effect on household farm activities, particularly in the context of livestock activities, should be explored in the future research.

CONCLUSION AND POLICY IMPLICATIONS

Urbanization is a reality of the current times. With the interwoven impact of urbanization and climate change (Ababor and Zakir, 2019), agriculture is prone to stress on a variety of fronts (for eg. migration, land use changes, lower yields, high costs of cultivation). From the perspective of food and nutritional security in general, and for urban poor in particular, the resilience of urban and peri-urban agriculture is an important policy concern. More so, for developing countries like India, China, Nigeria who are not only poised to contribute significantly to the urbanization globally but also are more vulnerable to the adverse impacts of climate change. The interlayered connections of urbanization and agricultural systems in general make it a complicated task to govern and regulate the process of urban expansion, an inevitability, and the evolution of agricultural systems, a necessity. This thesis aims to shed light on the impact of urbanization on the farming systems in the vicinity of a city through their interactions across multiple layers.

In order to do that, it has employed a rich and comprehensive dataset, both qualitative and quantitative, collected through expert interviews, focus group discussions and household survey. This study provides a number of insights that contribute to the understanding of the complex nexus and dynamic interactions between urbanization and farming systems. The logical message, that can be concluded from the finding of this study, is that urbanization through its direct and indirect effects is affecting agriculture across levels and stakeholders, which can be used to an advantage with comprehensive and visionary policy interventions and framework of governance.

At the primary level, urbanization is responsible for spatial land use changes, conversion of farm land to non-farm land and loss of water bodies. It thus directly influences land available for farming and water available for irrigation. Concentration of population in an urban area further stresses the water bodies in the region as a dense population demands a regular supply of potable water for domestic uses. This pressure is further exacerbated by the demand of water for industrial purposes in the urban areas. Hence, urbanization stresses two key resources essential for agricultural activities; land and water. At another level, urbanization creates a large number of non-farm job opportunities, thus attracting migration from rural areas. This in turn creates shortage of farm labour in the rural areas, while simultaneously creating high demand from urban areas for food. A city is typically

characterized by high income households demanding high value agricultural products such as fruits, vegetables, meat, eggs, and dairy products. This encourages the farm households in the vicinity of the city to undertake intensive, high value farming activities involving use of advanced technology and livestock activities. Additionally, farm households as decision makers are influenced by biophysical characteristics of their farmland, climatic conditions of their region, socio-economic and demographic characteristics of the household, and their location in the context of the city (distance to the urban market and access to transport infrastructure). On this backdrop, the dominant farming systems in the study area have emerged.

Evolving farming systems

Farming systems, by their nature, are dynamic and work in the open, while being linked to a number of social networks and economic processes (Meuwissen et al., 2019); hence, they are evolving all the time in response to the changing circumstances. The evolution of the farming systems in the study area are aptly explained by the Von Thunian model where farming systems characterized by high value crops cultivation and diverse livestock activities are located in the peri-urban region of Hyderabad. The agglomeration of the farm households undertaking diverse, high value cropping in the peri-urban area, agglomeration of paddy growing farmers in the rural area, land use expansion by means of land-lease and intensification of farming activities, even farm-exits are the responses of the farming systems identified in the study area.

One of the challenges that emerged during this study was defining the boundaries of a farming system. A farming system is characterized by a number of stakeholders, actors, and nested levels (Meuwissen et al., 2019). The variety of resources in a farming system, such as natural, social, economic, infrastructural, and institutional resources, that contribute to the economic processes in the farming system, should be deliberated upon while describing a farming system (Madry et al., 2013). While a farm household is the primary actor in any farming system, depending on the regional context, at other nested levels of the farming system such as supply chain actors, regional authorities, a number of stakeholders and actors also contribute to the evolution of a farming system holistically. Due to resource and methodology constraints, stakeholders and actors other than farm

households could not be incorporated analysis. The role of such stakeholders in the context of urbanization can be explored further.

Resilience of farming systems

Resilience is a holistic concept which is challenging to measure exhaustively (Darnhofer et al.; 2010). Its subdivision facilitates the identification of proxy indicators for its analysis (Jacobi et al; 2015). Urbanization, through its direct and indirect effects, bears upon the three capacities of resilience of a farming system, i.e. *robustness, adaptability, and transformability*, both positively and negatively. While it constrains the robustness of farming systems through its influence on land and water resources, it promotes adaptability and transformability by facilitating access to market, access to infrastructure and services, access to technology, and access to non-farm job opportunities. While resilience as a concept has been discussed across disciplines in the literature for a few decades, the empirical methods for measurement of resilience in general and resilience of agro-ecological systems in particular need further exploration. This study is limited to the understanding of the capacities of resilience, from the vantage point of the primary actor, the farm household. Lack of exploration of the perspective of other stakeholders in the farming systems and the generic principles of resilience, i.e. diversity, openness, tightness of feedback, system reserves, and modularity (Resilience Alliance, 2010) are the clear limitations in the exploration of resilience of farming systems in this study. Rigorous systematic empirical framework is needed for furthering the understanding of resilience of farming systems in general.

Farm labor participation

Another aspect of a farming system influenced by urbanization is the farm labour. Urbanization affects the farm labour supply by creating alternate non-farm job opportunities, which are unaffected by the volatilities involved in farming as an enterprise. It facilitates rural-urban migration, constraining the access to farm labour by farm households. As farm households diversify their portfolio of livelihood activities to incorporate non-farm activities, the reliance on the family labour is constrained as well. As urbanization creates avenues of non-farm diversification, a variety of factors such as

demographic variables, scale and scope of the farming activities of the household, social networks, location of the farm household influence the participation of farm labour across farm and non-farm activities. This study attempted to understand the farm labour participation in the vicinity of Hyderabad through a gender lens. However, its clear limitation is the failure to capture the permanent shift of farm labour to the non-farm sector triggered by the urban expansion, which in turn influences the farming systems. Permanent migration of farm household members, its effect on household farm activities, particularly in the context of livestock activities, should be explored in the future research.

Policy Implications

Policy responses in a multi-level hierarchy are needed to address the issues identified. It is vital to recognize the contribution of peri-urban agriculture in providing ecosystem services to the urban areas and urban food security while designing policies for urban planning and development. Thus, polycentric governance with coordinated actions by stakeholders such as urban planners, agricultural policymakers, and industry actors can pave the way for improved and efficient governance and policy interventions with respect to agriculture and urbanization.

Connecting and communicating with the youth to understand their issues, expectations, and perception of farming is necessary to engage them in agriculture (Farooq and Ullah, 2021). Training and workshops should be conducted at the village level to spread awareness about modern techniques of farming. Farming techniques that reduce the dependency on hired labor should be promoted. To enhance production, preservation of biodiversity, soil fertility, and water quality, incentives should be provided for the adoption of crop diversification strategies such as intercropping, and crop rotation. This can be achieved by making the direct benefit transfers (e.g. Rythu Bandhu) to farm households conditional to the adoption of crop diversification strategies. Such measures can be used to ensure the cultivation of crops significant to local diets which would contribute to local food and nutritional security. This would further result in the benefits of agglomeration to the farmers and other stakeholders. While diminishing common property grazing land and insufficient family labor appear to be the reasons for declining livestock activity, further investigation is required for a better understanding of the issues faced by dairy farmers and shepherds.

Custom hiring centers can make farm machinery accessible to farmers at reasonable rates (Sarkar, 2020). Innovative platforms should be developed to match the demand and supply of farm machinery and equipment to improve the efficiency of rental services. Such centers can also be developed as demonstration spaces for modern farming technologies and techniques such as ICT and AI in agriculture to facilitate knowledge transfer. Further, steps should be taken to create awareness about the benefits of integrated farming practices. Expert consultation and guidance should be ensured to farmers who aspire to transform and modernize their farming activities.

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APPENDIX

Appendix 1: Study Area

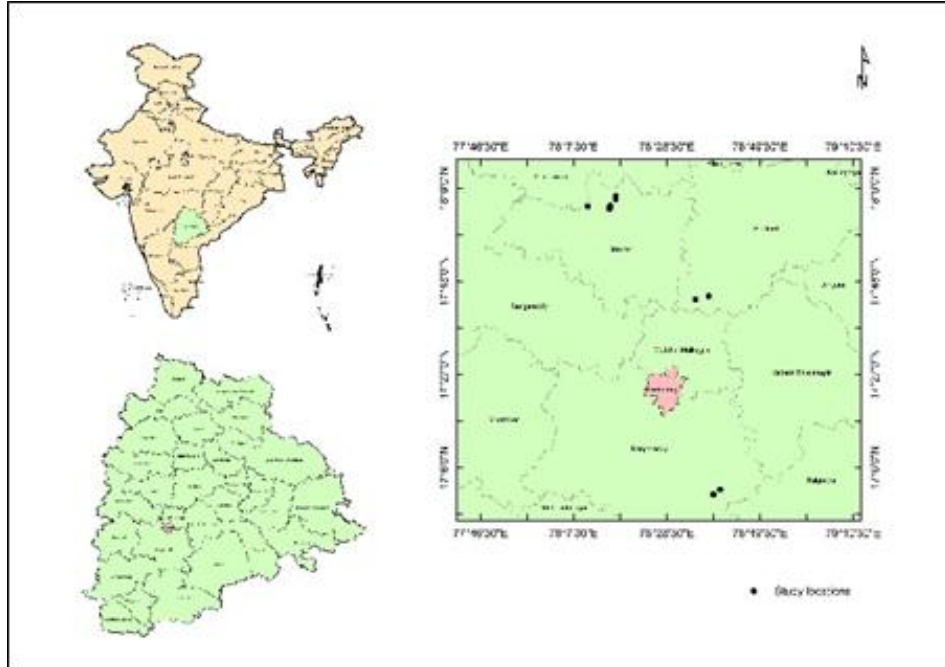


Figure 2: Study Area

Appendix 2: Survey Instruments

Survey Instrument used for the Exploration

Section 1: Effects of Urbanization

1. What changes have you observed in your area in last 10-15 years due to urban sprawl?
2. Do you think of these changes as opportunities or constraints?
3. How are you coping/exploiting with these constraints/opportunities?

Change in last 15 years	Opportunity or Constraint	Why is it an Opportunity or constraint?	How are you coping/exploiting it?	Remarks

4. Have you made changes in your agricultural practices in last 15 years? Why?
5. Do the members of your household work in the non-farm sector? Which non-farm sectors do they work in? Have they been working in non-farm before 10-15 years ago?
6. Do they engage in non-farm sector in the vicinity or have they migrated? If migrated, fully or partially?
7. Do you engage in non-conventional marketing activities like contract farming?
8. Which is the nearest market to you? Do you have weekly markets?
9. Do you have any SHGs in your village? Do you get any other benefits from them other than financial help?

Section 2: Dietary Habits

	Present	5 years ago	10 years ago
Food eaten			
No. of meals/day by age			
What changes have they noticed?			
Why?			
Outside Eating behavior			
Awareness about nutrition			
Who cooks for the HH			
Who is responsible for buying foods?			
Who decides what to cook?			

Survey instrument used for the Focus Group Discussions

Section 1: Farm Characteristics

1. What is the proportion of marginal, small, medium and large farms in your region?
 - Marginal: Less than 1 hectare, Small: 1-2 hectares, Medium: 4-10 hectares, Large: 10 hectares and above.
2. When and why do you hire labour for agricultural activities? Is there any seasonal variation in the availability of the labour?
3. What types of livestock do the farm households own? What are the livestock activities undertaken by the HH?

Type of Livestock	Type of Farmer (S, M, L)	Breeds	Purpose of the Livestock	Yield per Animal	Price Realized per Unit

4. What are the crops currently grown in each season? What were the crops grown in each season 20 years ago? What is the percentage of the crops grown in terms of area?

	Kharif	Rabi	Summer
At present (Last 3-5 years)			
10 years ago			
20 years ago			

5. What type of crops are grown by the following types of farmers?

Large and Medium Farmers		Small and Marginal Farmers		Tenant Farmers	
Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed

6. What are the reasons behind the change in the cropping pattern over the years? What were the reasons behind the change of crops in each season over the years?

Season	Crop	Change	Reason

7. What are the farm assets currently owned by the farm HH? What were the farm assets owned by the farm HH 20 years ago?

Present	10 years ago	20 years ago	Services/Assets outsourced/ Rented At present	
			Machinery	Rent

8. State the sources of the following in the present times and 20 years ago:

	Current sources	10 years ago	20 years ago
Inputs (Seed, fertilizers, etc.)			
Technology/Machinery			
Expert Guidance			
Farm Credit			

* For farm credit, ask for the percentage of contribution of each source

9. What are the crops cultivated in case extreme weather events such as drought?

	Kharif	Rabi	Summer
Present			
10 years ago			
20 years ago			

10. How is the HH income supported in case of a bad monsoon year or in case of loss of production?

Please fill the following:

Crops Cultivated in recent crop year	Yield per Ha	Price realized	Cost of cultivation per ha

Section 2: Agro-ecological characteristics

1. What are the water resources available to you?
2. Have you noticed any changes in the following factors in the last 20 years?

Factors	Changes if any	Reasons for the Changes	Coping Strategies Implemented
Soil Fertility			
Ground water Depth			
Ground Water Quality			
Pests and diseases			
Rainfall			
Diseases in Livestocks			

Section 3: Institutional and cultural characteristics

1. Do you consider agriculture as a profitable activity? In your opinion, is it a viable activity in future?
2. Would your children continue to farm your lands?
3. According to you, is urbanization a positive or negative development? Or is it a mix of both? Why so?
4. Challenges faced by the farmers due to urbanization? What are the adaptation/coping strategies implemented so far? What, according to you, should be the solution implemented to better cope with these challenges?

Challenges faced	Strategies implemented	Preferred solutions to be implemented	Rank in order of severity

5. What changes have you noticed in your vicinity in last 20 years? What do you think are the reasons behind it? (Changes could be social, economic, environmental, physical, etc.)

Changes observed in the vicinity	Reasons behind the changes	Rank in order of intensity

6. What kind of Farmers' organizations are you affiliated with?
For e.g. FPOs, Agricultural co-operatives, Fishermen's Co-operatives, Credit Co-operative societies, others if any.
7. Do you attend any workshops or training programs organized by extension agencies in your region? If yes, how frequently in a year?

Section 4: Market Characteristics

1. What are the methods used to market crop and livestock produce in your region?

Type of produce	Marketing Channel	Mode of Transportation used	Ownership of the vehicle used

2. Do you have access to storage facility i.e. warehouses or cold storage?
3. Is any contract farming undertaken in you region? If yes, what are the terms of contract? What are the crops cultivated under contract?
4. How do you get the information about the prices of the agricultural produce in the market?
5. Are you able to sell your produce at MSP rates? If not, why so?
6. Do you undertake any value addition activity at the farm level? If yes, does it help you fetch a better price for your produce?

Section 5: Socio-Economic characteristics

1. What is the average age and education level of farmers in your region? State % of farmers based on their education level.
2. Who owns the land? Men/Women? Which communities? State the % of ownership with respect to men and women.
3. Those who don't own any land, do they undertake agricultural activities?
4. If yes, from whom do they lease in the land? If no, what are their livelihood activities?
5. What are the general terms of tenancy? Is it continued over the years? How much land is leased?
6. What are the farm and non-farm wage rates in peak season and slack season?
7. Do the members of the farm household participate in the non-farm livelihood activities?
8. What is the annual income of a farm household? What is the proportion of non-farm and farm income in total family income?

Type of produce	Marketing Channel	Mode of Transportation used	Ownership of the vehicle used

9. What are the land prices and tenancy rates in your region?
10. If agricultural land is sold, who are the buyers? What is their purpose behind buying the land?
11. Do you receive any subsidy or direct transfer benefit from the Govt? If you have received any direct transfer benefits, then how do you utilize it?

Comments from the participants if any:

Comments and observations of the moderator:

Questionnaire used for the Household Survey

Informed Consent

Informed Consent: It is necessary to introduce the household to the survey and obtain the consent of all prospective respondents to participate. If a prospective respondent, in this case the head of the household or the spouse, adolescent male or female aged above 18 years, be sure to obtain verbal and written consent before interviewing them.

Thank you for the opportunity to speak with you. We are a research team from ICRISAT. We are conducting a survey to learn about your cultivation practices, the dynamics encountered during sale of your produce, on-farm practices and issues faced in post-harvest phase of farmers in this area. Your household has been selected to participate in an interview that includes questions on the above topics. The survey will require your co-operation in providing with responses as accurate as possible.

These questions in total will take approximately 45 mins to 1 hour to complete and your participation is entirely voluntary. If you agree to participate, you can choose to stop at any time or to skip any questions you do not want to answer. Your answers will be completely confidential; we will not share information that identifies you with anyone. After entering the questionnaire into a data base, we will destroy all information such as your name which will link these responses to you.

Please ask the participants if they consent to the participation in the study and put their signature or thumb impression below:

Household Unique ID No:	Date of interview:
Name of farmer:	

The enumerator responsible for the interview certifies that he/she has read the above statement to the participant and they have consented to the interview. The enumerator also pledges to conduct this interview as indicated on instructions and inform the supervisor of any problems encountered during the interview process.

Name of the enumerator:

Signature of the enumerator:

Household Identification and Demographics	
Name of the village:	Name of the Mandal:
Name of the district:	Name of the enumerator:
Date of the visit:	Start time of the interview: (hh:mm)
Name of the head of the household:	Contact No of the head of the household:
Main religion of the household:	Main caste of the household:
Sub-Caste of the household:	Distance to Hyderabad City (km):
Distance to the nearest market (km):	No of years of experience of the head of HH in farming:
Main Religion: 1 = Muslim 2 = Hindu 3 = Christian 4 = Buddhist 5 = Navbuddha	Caste Category: FC = Forward Caste BC = Backward Caste SC = Scheduled Caste ST = Scheduled Tribe NT = Nomadic Tribes

Section 1: Household Roster

1.1 Household Roster								
ID Code	Name of HH Member. (Start with Head of the HH and then continue to other HH member.)	Relationship to the Head of the HH	Age (In completed years.)	Can you read and write?	Is currently attending school? 1=Yes 2=No	Have ever attended school? 1=Yes 2=No	What is the highest grade of schooling completed by [Name]?	Whether member of any Organisation? Y/N If yes, name of the organisation.
Relation to the Head of the HH: 1. Head of the HH 2. Spouse/Partner 3. Son/Daughter 4. Son-in-law/Daughter-in-law 5. Grandson/Granddaughter 6. Mother/Father 7. Brother/Sister 8. Niece/Nephew 9. Nephew/Niece of spouse 10. Cousin of primary respondent 11. Brother/Sister-in-law		12. Mother/Father-in-law 13. Cousin of primary respondent's spouse 14. Other relative 15. Servent/Maid 16. Labourer 17. Other relative (Please specify.)	Literacy 1. Cannot read and write 2. Can sign (write) only 3. Can read only 4. Can read and write		Level of Education 1. No school 2. Primary classes 1-5 3. Secondary Level classes 6-10 4. Technical or vocation training 5. Intermediate 6. Graduation/University (B.A./B.Com/B.Sc./B.Tech) 7. Post Graduation 8. Adult literacy only (No formal education) 9. Religious only (No formal education) 10. Other (Specify)		Organisation 1. SHG 2. PACCS 3. Farmer Cooperative 4. Gram Panchayat 5. MPTC 6. Education Committee 7. Water User Association 8. Others (Specify)	

1.2 Yearly Income of the Household		
Type of the Household/Card	APL/BPL	Others
Source of Income	Annual Income (Rs)	Remarks
1. Farming (If yes, please fill the cropping pattern table)		
2. Livestock (If yes, please fill the animal inventory table)		
3. Wages		
3.1 On-farm		
3.2 Off-farm		
4. Business/Salary/Others		
5. Remittances		
6. Pension		
7. Income from Govt scheme		
8. Others (Please specify)		

Section 2: Farm Characteristics

1. How would you rate the soil fertility and water quality of your farm?

(Please (√) the box)	Poor	Moderate	Great	Don't know
Soil Fertility				
Irrigation water quality				

2. Details of assets

“Now I'd like to ask you about your household's access to and ownership of a number of items that could be used to generate income.”		Does anyone in your household currently own any of these [ITEM]?	Do you own any of the item?
		1 - YES 2 - NO	1 - YES, SOLELY by Adult male 2 - YES, SOLELY by Adult female 3 - YES, JOINTLY
A	Agricultural land (pieces/plots)		
B	Large livestock (Buffaloes, cattle)		
C	Small livestock (goats, sheep)		
D	Chickens, Ducks		
E	Farm equipment (non- mechanized: hand tools, animal-drawn plough)		
F	Farm equipment (mechanized: tractor-plough, power tiller, treadle pump)		
G	House or other structures		
H	Large consumer durables (refrigerator, TV, sofa)		
I	Small consumer durables (radio, cookware)		
J	Mobile phone		
K	Asset (sheller, a processing machine, any capital asset used for income generating activity)		
L	Other land not used for agricultural purposes (pieces/plots, residential or commercial land)		
M	Means of transportation (bicycle, motorcycle, car)		

3. Details of sale of produce and Information about market conditions

Produce	Where do you sell your produce?	Distance (Km)	Do you have problems accessing the market? 1 - YES 2 - NO If yes; What is the main problems?
	1 - In the field 2 - Village market 3 - Market of the neighboring village 4 - Urban market 5 - Others (specify)		1 - lack of means of transport 2 - high cost of transportation 3 - very low selling price 4 - lack of market information 5 - No knowledge of the market 6 - Not allowed to sell at the market or by myself

			7 - I do not have time to sell the produce 8 - others (to be specified).
Cereal grain			
Legume grains			
Small ruminant			
Large ruminant			
Cereal processed produce			
Animal processed produce			
Cereal by-product			
Animal by produce			
Crop residue			
others (specify)			

4. Please state all the possible sources of the following inputs:

Input	Sources of access
Irrigation	
Labour	
Seeds	
Fertiliser	
Pesticides/Insecticides	
Manure	
Machinery	
Fodder	
Animal Supplements	

Sources of Irrigation: 1 - Canal, 2 - Borewell, 3 - Open well, 4 - Dam, 5 - Other (Specify)

Sources of Labour: 1 - within village, 2 - nearby village, 3 - nearby town

Sources of seeds: 1 - self-produced, 2 - within village from fellow farmers, 3 - purchased outside the village, 4 - relatives in other village, 5 - Govt subsidy

Sources of pesticides: 1 - self-produced, 2 - within village from fellow farmers, 3 - purchased outside the village, 4 - relatives in other village, 5 - Govt subsidy

Sources of manure: 1 - self-produced, 2 - purchased from fellow farmers in the village, 3 - Govt subsidy

Sources of machinery: 1 - Owned, 2 - hired within the village, 3 - hired outside the village

Sources of fodder: 1 - Owned produce, 2 - Common property resources, 3 - Govt subsidy, 4 - Bought from fellow farmers

Sources of Animal supplements: 1 - Govt subsidy, 2 - Purchased within village, 3 - purchased outside village

5. What kind of marketing facilities/infrastructure is available in your village for the agricultural produce?

- i. Agricultural Produce storage Godown
- ii. Cold Storage Facility
- iii. Market Yard
- iv. APMC

6. In the light of the urban expansion, have you made any changes to your marketing strategies in the recent past? (Last 3-5 years). If yes, please elaborate your answer.

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7. Sources of information:

How do you get information? Source: 1 - Mobile phone 2 - television; 3 - neighbour/friend 4 - Association/cooperative/social group 5 - spouse/family 6- Extension staff 7- Radio; Others-Specify (to be specified) Level of access: 1 - Rarely available 2 - Occasionally 3 - Regularly available	Market price information	Source: Level of access:
	Agricultural practices	Source: Level of access:
	Advanced Technology Adaptation	Source: Level of access:
	Weather/climate	Source: Level of access:

8. Access to credit

Source of credit	Credit in last 1 year		Medium/Long term credit in the last 5 years		
	Amount (₹)	Purpose	Amount (₹)	Outstanding amount	Purpose
Cooperative Bank					
Money lender					
Relatives/friends					
Commercial bank					
Input dealer					
Others (Specify)					

9. Cropping Pattern

Purpose of credit: 1. Crop loan 2. Buying machinery 3. Land purchase/development 4. Others

Plot Code	Name of Crop	Crop Type 1- Sole crop 2- Intercrop	Area (AC)	Variety cultivated	Yield/Acre Q/Ac	Price realised Rs/Q
Rainy (Kharif Season)						
Post Rainy (Rabi) Season						
Summer Season						

10. Horticultural Crops

Fruit Crop Name	Number of plants/trees currently grown	Total area covered	If it is agro-horticultural system, then what are the ratio of the crops?

11. Please list the crops cultivated in the last 3 cropping years

Season	2020	2019	2018
Kharif			
Rabi			

Summer			
Horticultural crops			

12. Wage rate for hiring labour for farm work

Period/ Seasons	Adult (₹/day)		Elderly (₹ /day)	
	Male	Female	Male	Female
June to September				
October to January				
February to May				

13. Livestock Activities

Animals	Numbers	Mode of Acquiring	Average Market price (Rs./Kg)
1. Draft Animals			
1.1 Bullocks			
1.2 He Buffaloes			
2. Milking Animals			
2.1 She Buffaloes			
2.2 Local Cows			
2.3 Cross Breed Cows			
3. Young Stock			
4. Goats			
5. Sheep			
6. Pigs			
7. Camel			
8. Poultry			
9. Donkey			
10. Horses			
11. Others (Specify)			
<p>Mode of acquiring:</p> <p>1. On farm rearing 2. Purchase 3. Received as gift 4. Sharing in 5. On farm rearing + Purchase</p> <p>6. On farm rearing + received as gift 7. On farm rearing + Sharing in 8. Purchase + Received as gift 9. Purchase + sharing in 10. Purchase from SHG loan</p>			

14. Milking details

Livestock	Milking days per year	Average milk per day	Average Milk price (₹/lt)
Milking buffaloes			
Local cows			
Cross-breed cows			
Goat			

Other-			
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15. Labour Use for livestock:

Do you hire labour for livestock activities? If yes, please fill the following table.

Period/ seasons	Adult male			Adult Female			Elder		
	No. of days in a month	Hours/day	Wages/Salary	No. of days in a month	Hours/day	Wages/Salary	No. of days in a month	Hours/day	Wages/Salary
June to September									
October to January									
February to May									

16. Input cost of livestock: (2019)

Inputs		Bullocks	Goats	Sheep	buffaloes	Local cows	Cross-breed cows	Poultry	Pigs
		Feed/ Supplements	Price/ Kg						
Kg/ Day/ Animal									
No. of days/ year									
Fodder: Harvest Residue	Price/ Kg								
	Kg/ Day/ Animal								
	No. of days/ year								
Fodder: Green grass	Price/ Kg								
	Kg/ Day/ Animal								
	No. of days/ year								
Medicines/ Veterinary services (Rs/ Animal/ Year)									
Others (Specify)									

17. Farm Overhead Cost:

Particulars	Cost (₹) (Annual)
General farm maintenance	
Vehicle and machinery maintenance	
Fuel costs	
Electricity for farm house	
Other farm costs- repairs etc	

Section 3: Coping and adaptation strategies

1. How concerned are you about the loss of agricultural land due to urban sprawl? (Please (√) the box)

Not at all concerned	Not very concerned	Neutral	Somewhat concerned	Very concerned

2. Could you please explain your answer: Why do you think that?

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3. How concerned are you about the current rate of urban expansion in your neighborhood? (Please (√) the box)

Not at all concerned	Not very concerned	Neutral	Somewhat concerned	Very concerned

4. In the light of the ongoing urban expansion, are you facing any challenges in your farming activities regarding following resources? If yes, have you adopted any adaptation strategies for coping with the challenges?

Resources	Please explain the challenges	In your opinion, what are the reasons behind these challenges?	Have you employed any strategies/ changes to adapt to these challenges?	If yes, please explain.
Water Supply (Drinking water)				
Water Supply (Irrigation)				
Electricity Supply				
Soil Quality/Fertility				
Quality of the ground water				
Access to Farm Labour				
Access to Farm Land				
Others (Specify)				

5. Has urban sprawl presented you with any new business opportunities? Have you explored them? Please elaborate your answer.

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6. Have you made any adjustment to your agriculture practices/activities to adapt to this long-term change? If yes, in which aspect has this change been and how was it?

Change aspects	Description of the change	Please explain to me why this change happened
Change in crops		
Change in crop variety		
Change in cultivated area	(e.g. increased/decreased? By how much acres?)	
Production practices and techniques	(e.g. new practices such as organic farming, poly-house, changes in harvesting techniques, etc.)	
Change in irrigation	(Switch to micro irrigation such as drip, sprinkler, etc.)	
Markets/Marketing channels	(e.g. increased/decreased number and types of traditional markets? new markets? Direct marketing, contract farming, etc.)	
Change in livestock practices	(Investment in hybrid breeds, feed, change in marketing channel, new livestock activities)	
Other aspects, please list		

7. Have you adopted any adaptation strategies to adapt to the long-term stress of urban sprawl? If yes, please list below.

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8. Check the strategies listed and ask for the unchecked ones.

MGNREGA: Mahatma Gandhi National Rural Employment Guarantee Act

B2B: Business to business

Reasons: 1. Don't need it 2. Never heard of it 3. Resources not fit for it 4. Others

(√)	Why did you not	Reason	(√)	Why did you not	Reason
	Practice crop rotation			Change from crop to livestock	
	Zero tillage farming			Permanent migration to city by family members for non-farm jobs	
	Cultivate short duration crops			Seasonal migration to city	
	Undertake organic farming			Self-employed (Plumber, electricians, carpenter, etc)	
	Agro-forestry			Lease out your land	
	Personal upskilling			Lease in more land	
	Undertake poly house/green house cultivation			Sell your land	
	Switch to improved variety			Informal cooperation for labour/machinery	
	Reduce the no of livestock			Work in MGNREGA	

	Irrigate more			Agro tourism	
	Contract Farming/B2B selling			Direct marketing (farmers ' market)	
	Floriculture			Seek professional advice/consultation	
	Undertake hydronic farming			Undertake food processing	

9. How are your neighbors/ peers coping with their challenges? What kind of adaptation strategies have they adapted?

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10. What possible interventions farmers/stakeholders think can enhance resilience and profitability of their farming systems related to:

Cropping systems:	
Livestock production/fodder:	
Fodder conservation & utilization:	
Marketing of livestock:	
Horticulture/ agro forestry:	
Farm machinery:	
Marketing of crops:	
Water and soil:	
Others:	

Agricultural Infrastructure and Institutional Support

11. Please share your opinion about the following statements. (Please (√) the box)

Statement	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree	Don't know
We have many businesses that support the farms around here.						
Farmers can get the supplies and services they need to run their farms effectively without having to travel long distances.						
Farmers get the reliable and timely information they need for running their farms from Extension and other sources						
Farmers around here have little trouble finding reliable hired farm labour.						
Farmers around here have little trouble finding affordable hired farm labour.						
We have easy access to affordable and reliable hospitals and medical supplies						

We have easy access to affordable and reliable Veterinary services						
We have easy access to affordable and quality educational institutions						
We have easy access to affordable and timely transport and travel facilities						
We have easy access to affordable and reliable storage facilities						
I think that the prospects for most agricultural support businesses around here will be good in the next 5 or 10 years.						
I think that the prospects for my businesses or agency will be good in the next 5 or 10 years.						
Our local schools do a good job of educating young people about agriculture and agricultural careers.						
Our local government officials value having agriculture around here.						
Agriculture interests are well represented in the county legislature.						
Our local government decisions usually support and promote farming.						

Training and technical assistance:

12. In the last 12 months, how many times have you received technical assistance (an expert counselled you about a problem in your land) and training (attended an exchange, workshop, demonstrative plot)?

Source of assistance and training	Frequency
Government Agency/ Agricultural department	
Research Institute/ Agricultural University	
Farmers Organizations such as Cooperative/ FPO/ SHG	
Non-Governmental Organization	
Others (Please specify)	

Section 4: Household Time Allocation

- Please share how you have spent your time in farm and non-farm activities over the last week and whether or not it was typical.

Note: There are 168 hours/Week

Was the last week normal/typical week? Yes/No

(A typical week is the one without any personal events such as marriage or any not so common travel/trade fare/political events etc.)

Instruction to the enumerator: Please fill the following table for 1 male and 1 female member of the family.

Gender: F/M Age:

Code	Activity	Hours spent on the activity in last 7 days	Did you spend a usual amount of time on the said activity in the last 7 days? 1 - Yes 2 - Next Activity No 3 - N/A	Since the last week was not usual, within the current season, how much time do you spend on the activity per week?	Is this how you spend your time per week in all seasons? If not, how much time do you spend on the given activities in the respective seasons?		
			Select one	Hours	Hours	Hours	Hours
		Hours			Kharif	Rabi	Summer
	Agricultural work on own farm						
	Agricultural work as farm labourer						
	Collecting forest produce						
	Agriculture- Others (Specify)						
	Salaried/Formal employment- Government (Specify)						
	Salaried/Formal employment- Private (Specify)						
	Salaried/Formal employment- Other (Specify)						
	Non-farm Wages (Specify)						
	Non-farm- NREGA						
	Non-farm- Business/Petty vending (specify)						
	Non-farm- Self-employed (Specify)						
	Non-farm- Others (Specify)						
	Domestic HH work./Indirect care activities						

Direct Care activities							
Personal care							
Travelling and Commuting							
Sleep							
Recreation and leisure/Social activities							

Gender: F/M Age:

Code	Activity	Hours spent on the activity in last 7 days	Did you spend a usual amount of time on the said activity in the last 7 days? 1 - Yes 2 - Next Activity No 3 - N/A	Since the last week was not usual, within the current season, how much time do you spend on the activity per week?	Is this how you spend your time per week in all seasons? If not, how much time do you spend on the given activities in the respective seasons?		
					Hours	Hours	Hours
		Hours	Select one	Hours	Kharif	Rabi	Summer
Agricultural work on own farm							
Agricultural work as farm labourer							
Collecting forest produce							
Agriculture- Others (Specify)							
Salaried/Formal employment- Government (Specify)							
Salaried/Formal employment- Private (Specify)							
Salaried/Formal employment- Other (Specify)							
Non-farm Wages (Specify)							
Non-farm- NREGA							
Non-farm- Business/Petty vending (specify)							
Non-farm- Self-employed (Specify)							
Non-farm- Others (Specify)							
Domestic HH work. /Indirect care activities							
Direct Care activities							

Personal care							
Travelling and Commuting							
Sleep							
Recreation and leisure/Social activities							

Notes:

- Sleep should include the rest/nap/sleeping done even during the day time. There should be a probe whether they take rest/little nap/sleep during afternoon as well
- Personal care includes attending to calls of nature, brushing, bathing, combing, dressing up
- Travelling and commuting includes both travelling for economic purposes (from their field to residence and vice versa) and also travelling for recreation/social purpose (ex: recreation: travelling to nearby town to watch a movie, Ex: social: travelling to temple to worship)

Own Farm Agricultural Work	Agricultural work as farm labourer	Domestic HH work/ Indirect care activities	Direct Care activities	Recreation and Leisure/ Social activities
Ploughing, Levelling, Bundling Sowing Weeding Fertiliser Application Irrigation Pesticides Harvesting Threshing/Post harvesting Livestock care and management	Ploughing, Levelling, Bundling Sowing Weeding Fertiliser Application Irrigation Pesticides Harvesting Threshing/Post harvesting Livestock care and management	<i>washing clothes/utensils</i> Cooking Sweeping, Mopping Collecting Drinking water Collecting fuel	Care of family members Care of children Care of elderly Care of disabled or sick	Watching television Listening to radio Reading newspaper Gossiping with the peers or family members/Neighbours playing cards Any other games/sports Watching puppetry shows Others

2. Participation in Decision-Making

Activity Description	Who gives their inputs in the decisions regarding the activity? 1 -men, 2 -women, 3 -both	Who gives their inputs in the decisions regarding the income from the activity? 1 -men, 2 -women, 3 -both
Food Crops farming: These crops are grown primarily for HH consumption purposes		
Cash Crops Farming: These crops are grown primarily for sale in the market		
Livestock activities		
Non-farm economic activities: This would include activities such as self-employment, small businesses, etc.		
Farm Wages and salaried employment: This would include work that is paid for in cash or kind in agriculture.		
Wages and salaried employment: This would include work that is paid for in cash or kind in non-farm sector.		

Appendix 3: Photographs of the Field Investigations



Figure 3: Hydroponic vegetables plantation in Mulugu



Figure 4: Poultry farm in Yacaharam



Figure 5: Vegetables collection centre for BigBasket at Mulugu



Figure 6: Focus group discussion at Kummera



Figure 7: Focus Group Discussion at Gundlapally



Figure 8: Focus Group Discussion at Fareedpur



Figure 9: Household Survey in the Study Area