Impact of Urbanisation on Agricultural Land Use in Sri Ganganagar, Rajasthan: Socio-Economic and Environmental Implications

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***Abstract*—In the most north-eastern part of the State, Sri Ganganagar is considered as one of the most agricultural productive districts of the State as the land of the district was turned into an intensive farm land after the canal irrigation. Concurrently, residential colonies, commercial buildings, roads, public buildings, agro-processing units and industrial estates have grown in the district headquarters, Sri Ganganagar town and in the smaller towns. In this paper, this process of urbanisation is analysed as an influence on the use of agricultural land and its socio-economic and environmental consequences are assessed. It takes a case-study approach to secondary data and adopts Census linked district profiles, Central Ground Water Board (CGWB) reports, agriculture land-use data and urban infrastructure and planning documents. The evidence presented indicates that urban expansion takes place in a district characterised by the economic value of cultivable land, its dependence on irrigation and its environmental fragility. The total geographical area is around 10.93 lakh ha. According to available district land-use data, the net sown area was approximately 7.70 lakh hectares in 2010–11, and the total cropped area was approximately 10.73 lakh hectares ((Central Ground Water Board [CGWB], 2013)). Another agricultural profile estimated that about 9.12 lakh hectares were cultivated and reported the gross cropped area as 10.54 lakh hectares with a cropping intensity of 145.4 per cent. These statistics take into account the significance of agriculture and variations from one reporting year to the next and changes in the classification of land use ((Krishi Vigyan Kendra, Sri Ganganagar, 2026).**

The analysis reveals that urbanisation does not only lead to a decrease in the area of farms. It also reduces parcel size, increases land values, affects tenancy and labour relations, affects water demands, is a driver to peri-urban change in land use, and affects crop selection. Some outcomes are positive: better market access, opportunities to diversify into services and agro-processing, employment opportunities, improved education and health infrastructure and increased land values for some landowners. But these benefits are not universal. Conversion can result in small farmers and tenants losing land, or in landless labourers receiving little of the benefits in terms of capital gains. Environmental pressures also are very important. The district is already plagued by water logging, salinity and low quality of water in the canal command area. These vulnerabilities might be exacerbated by urban wastewater, leakage, impervious surfaces, and unplanned peripheral development if land-use planning, drainage, and sewage treatment don't match up. The paper suggests that Sri Ganganagar is in dire need of both land-and-water sensitive urbanisation approach: safeguarding high value irrigated farmland, compact urban growth planning, peri-urban zoning, transparent urban land conversion, drainage and wastewater management, and protection of livelihoods of farm households.

***Index Terms*—Urbanisation, agricultural land use, peri-urbanisation, Sri Ganganagar, Rajasthan, land conversion, canal irrigation, waterlogging, salinity, livelihoods and environmental planning.**

I. INTRODUCTION

One of the most apparent features that is changing the social geography of India is urbanisation. It means more people live in statutory towns and cities and more built-up land, markets, transport routes, institutions, industries and services move outward to surrounding rural areas. This shift is significant in areas where agriculture is the key source of livelihood in the districts. Issues are not only those of the change of ownership, or those of the change of land use, where towns encroach into the irrigated agricultural areas. It's

about food production, water resources, livelihoods on land, social inequality, environmental quality and regional development nature.

Sri Ganganagar is a place of great interest in addressing these issues. The district is situated in the North of Rajasthan, bordering on Punjab and Pakistan. Canal irrigation has played a significant role in its agrarian development such as the Gang Canal, Bhakra canal system and the Indira Gandhi Nahar Pariyojana (IGNP) network (Bundela & Singh, 2021). The district is part of the larger Thar Desert, with fairly low precipitation, but through the irrigation of canals, intensive cultivation of wheat, mustard, cotton, guar, sugarcane, rice, gram and other crops is possible. This has led to close linkages between the district economy and agriculture, agricultural trade, agricultural input supply, transport and storage and agro-processing ((Krishi Vigyan Kendra, Sri Ganganagar, 2026).

The process of urbanisation in Sri Ganganagar thus needs to be understood in an entirely unique land and water landscape. The district is also endowed with a productive irrigated canal belt and eco-sensitive areas under saline ground water, shallow water table, water logging and drainage problems and sandy land. In the past the district headquarters was always designed to be a grid town, but the outer colonies and commercial strips, institutional planning, warehousing and industrial development are all parts of the district's growth in the modern era. Smaller Urban centres like Suratgarh, Raisinghnagar, Padampur, Anupgarh, Sadulshahar and others also have influence on the land-use patterns in the district.

The population of Sri Ganganagar district in 2011 was 1,969,168. The people in the district are estimated to be approximately 1.43-1.46 million rural and 0.51-0.54 million urban. Therefore even in the face of rapid urbanisation and non-farm jobs, agriculture plays a social role (Census2011.co.in, 2011). The ability of a significant workforce of rural people to live in a region with rapidly increasing demand for infrastructure and services is a crucial planning challenge.

This paper aims to study the effects of urbanisation on agricultural land use in Sri Ganganagar emphasizing the socio-economic and environmental aspects. There are the following objectives of this study:

(i) To know agricultural and urban setting of the district.
(ii) To know the effect of urbanization on agriculture land use.
(iii) To know about the urban expansion interaction with waterlogging, salinity and wastewater problems.
(iv) Policy measures those can reconcile urban development with agriculture sustainability.

It is not the purpose of this paper to make any attempt to estimate the annual amount of land converted by remote-sensing techniques. This would need to be done with time series satellite imagery, cadastral data and field verification. Instead, it offers a closely-contained secondary-data analysis and defines evidence required for future empirical studies. This distinction is significant because general urban growth is not actually an indication of conversion rate.

II. LOCATION

Sri Ganganagar is the most north-eastern district of Rajasthan. According to the profiles of government districts, this geographical area is approximately 10,978 km² or approximately 10.93 lakh hectares. It features alluvial plains, flood plains, sand dunes and inter-dunal depressions. The main drainage is from the Ghaggar, but it is seasonal. Arid-Semi Arid with very hot summers and cold winters. A reliable surface irrigation and water management is essential to agriculture and settlement development, as normal annual rainfall has been reported to be about 228 mm for long term and 255 mm for 2001-2011.

Soil is heterogeneous soil environment. Arid or sierozem soils, usually loamy sand and sandy loam, predominate in the northern parts while the southern parts have desert soils with low moisture holding capacity and high permeability (Preveen Kumar et al., 2009). These qualities enable the production of irrigated crops but high irrigation levels, inadequate drainage and unsuitable land filling can cause waterlogging and salinization. The district's physical environment is therefore such that urban development must be considered along with drainage, management of groundwater and canals.

Crop	Area (ha)	Production (quintals)
Mustard	310,351	567,942
Cotton	231,830	660,716
Wheat	221,120	1,110,022

Cluster bean (guar)	222,814	219,026
Barley	106,451	479,030

Agriculture and irrigation

The district's economic backbone is the agriculture sector. According to CGWB data 2010-11, out of the 1,072,730 ha of total cropped area, 769,860 ha is reported to be net sown area. There were 570,799 hectares of canal-irrigated land and 3,920 hectares irrigated by tubewells and 423 hectares irrigated by other wells. Net irrigated area was 575,142 hectares and gross irrigated area 866,419 hectares. The figures highlight the importance of canal irrigation in the agricultural system of the district (Krishi Vigyan Kendra, Sri Ganganagar, 2026).

Indicator	Area (ha)
Net sown area	769,860
Total cropped area	1,072,730
Net irrigated area	575,142
Canal-irrigated area	570,799

Source: Central Ground Water Board, 2013 (land-use data for 2010–11).

Yet another agricultural profile states that the geographical area of around 1,093.3 thousand hectares, a net sown area of 724.7 thousand hectares, an area sown more than once of 329.3 thousand hectares, a gross cropped area of 1,054.0 thousand hectares, and a cropping intensity of 145.4 per cent. Care must be taken with the variation among the sources, since data are from different years and because it is possible that different definitions of cultivated area are used. The general consensus is that agriculture is extensive, intensive and relies on managed water supplies.

Wheat, mustard, cotton, guar, barley, sugarcane, rice and gram are the major crops and horticultural crops such as kinnow etc. Mandi activities, cotton ginning, oil mills, sugar related processing, transport services and repair of farm machinery are the activities associated with the agricultural economy. Therefore, the loss or disintegration of agricultural land does not just impact on farmers, but can have a broader influence on the rural-urban value chain.

Urbanisation and Urban infrastructure

Sri Ganganagar town is the administrative and commercial head of Ganganagar district. Urban planning and infrastructure documents suggest that considerable investments have already been made in water distribution and sewerage for urban growth (Biswas, 2006). The 2014 urban infrastructure assessment revealed that the current town water supply network is covering approximately 80 per cent of the town area and the individual water service connections were approximately 61 per cent. Water supply was irregular with water provision for about 1.5 to 3 hours a day and high leakage losses in the system (Asian Development Bank [ADB], 2014).

The same assessment predicted that water requirement will rise from 41 million litres per day (MLD) in 2016 to 54 MLD by 2031 and 71 MLD by 2046. Parts of the planning response consisted of the replacement of 668 km of water distribution system pipes, construction of 37 km of new water distribution system pipes, installation of 44,341 domestic meters, and development of 417 km of sewer network. Those numbers illustrate that urban expansion is not just about how to use land, it's also about the additional demand urban expansion creates for water, drainage and waste management (Burark et al., 2026).

The land use information at the town level also shows the built-up structure of Sri Ganganagar from the early 2000s. Residential land in 2001 covered 898.40 hectares or 59.84 per cent of 1,501.39 hectares of developed area. Commercial use accounted for 109.27 hectares (7.28 percent) and industrial use accounted for 81.75 hectares (5.44 percent). The residential nature suggests that outward growth will continue to put pressure on housing land and associated roads, shops, schools and utilities in the peri-urban areas.

III. METHODOLOGY

This study is descriptive-analytical with a case study type. Sri Ganganagar is taken up as a case study for Agricultural Intensification and Urbanisation in the District Level. The approach is relevant as it involves the interplay of various demographic, economic,

hydrological and institutional processes in shaping land conversion, not one solely.

Secondary data analysis and documentation-based analysis is used in this study. The goal is to create a unified viewpoint on land-use pressures and impact that is conveyed by official and institutional evidence. No household survey and no satellite-based change detection dataset is presented in the paper. Therefore, it considers the risks and tendencies observed, and not an exact estimation of the hectares converted each year.

IV. DATA SOURCES

The analysis is based on four main categories of sources:

Demographic and industrial profiles of the District: These offer information on population, rural/urban distribution, land utilisation, industrial estates, roads and structure of local economy.

Agricultural land use and irrigation information: These sources give information on geographical area, net sown area, total cropped area, cropping intensity, principal crops and irrigated area.

Groundwater and environmental reports: CGWB material includes groundwater depth, quality, salinity, nitrate, sulphate, groundwater waterlogging and recommendations for conjunctive water management.

Records of urban infrastructure and planning: Water supply and sewerage reports contain data on urban service coverage, current demand, network growth and sanitation issues (Asian Development Bank [ADB], 2014).

There are three caveats to be noted. First, this district-wide information is available for various years and may not be easily comparable. Second, information on land use in agriculture does not determine what the conversion location or cause is. Thirdly, the study of secondary sources is not deep enough to capture differentiated experiences of women farmers, tenant cultivators, informal workers, and landless households. Satellite imagery and revenue maps, land-registration records, household surveys, focus group discussions, and groundwater sampling should be integrated in a future mixed-method study.

V. DISCUSSION

Pressure of Urbanisation on Agriculture Land

Urban development is occurring in an area where irrigation is very productive and is economically tied to the land, hence the central land use tension in Sri Ganganagar (Blakeslee et al., 2023). The peri-urban land around Sri Ganganagar town is generally in closer relation with foodgrain, cotton, oilseed, vegetable and fodder production, and with availability of canal water, roads and markets, compared to the dryland fringe areas with very limited cultivation. Thus the conversion process may involve loss of productive land as well as the encroachment upon vacant land (Islam et al., 2011).

The process of urbanisation affects agricultural land use in a number of ways. The most obvious is direct conversion for housing colonies, commercial plots and roads, public buildings, warehouses, educational institutions, health institutions, utility sites and industrial development. Partial conversion is another pathway where farm houses are established, storage yards are built, shops and workshops line the roads or marriage gardens and informal plots are planted on farm parcels before the final stage of urban development. A third pathway is anticipatory land holding – where landowners decrease their investment in crops due to expected sale or acquisition. This may even lead to temporary under cultivation prior to the formal land-use conversion.

The district's industrial profile reveals an extra land demand source. As of March 2016, the district has 15 industrial areas, with a total area of 1221.72 hectares in total and 1008.78 hectares developed ((MSME Development Institute, 2016)). According to the profile, there were 2,735 registered industrial units. These are the agro-based units, the food-product units, the cotton texture units and the mineral-based units and service enterprises in the local economic structure. As industries and agro-processing expand, their growth can bolster the agricultural markets but they need land, water, roads, electricity and waste-management facilities.

Urban expansion does not always have a detrimental impact on agriculture. Transaction costs for farmers can be lowered due to better roads, proximity to markets, cold storage, transport, financial services and telecommunications. Veteran producers have the potential to take advantage of vegetables, dairy,

poultry, fodder production, nurseries, and flowers and high-value crops for urban consumers in peri-urban areas. But such benefits rely on the ability to keep access to land and water. When the conversion is fragmented and uncertain, it is hard to maintain continuity in agriculture and the advantages of geographical proximity are sacrificed.

Fragmentation, changing land values and land tenure

Increases in land prices often occur in the urban fringe as a result of land conversion. This can generate significant capital gains for landowners who have clear title and acreage large enough for them to take advantage of this. Families can sell for use to build houses, educate children, invest in shops, buy vehicles or move into non-farm jobs. This diversification can look like a good idea in a district where there are weather, price and water uncertainties in agriculture.

But with the increasing land values are also the distributive effects. Smallholders might be forced to sell their land because they need to pay off their debts, they cannot afford to pay their bills, there are speculators looking for land, or they may face difficulties with the surrounding development. After the land is sold, the seller may have difficulty getting the land back as the closer the land is to the market, the more expensive it gets. Tenant farmers and the sharecroppers are particularly vulnerable if they have no rights to ownership or compensation claims. Labourers in agriculture can be deprived of employment, and no part of the proceeds of the land sale will be given to them ((Government of India, 2013)).

Another form of fragmentation is when a holding is broken up into small parcels. This can decrease the efficiency of the farming operation, complicate irrigation channels and access paths and make mechanisation more difficult. Focussed discontinuity of built plots in cultivated fields can cause conflicts in traffic, dust, livestock movement, pesticide usage, drainage and security. It can also cause a progressive loss of the viability of agriculture even when some land is still technically considered to be agricultural (Vaishnava & Kannan, 2026).

The process is relevant to gender. Farm women are frequently heavily involved in farming activities, livestock keeping, food production and informal agricultural operations, while control of land is in the hands of male relatives. If land is put up for sale, women have reduced access to alternative livelihoods and/or reduced control over compensation, investment decisions or access to alternative employment opportunities. Research and planning efforts in the district should therefore separately document ownership, inheritance, compensation and livelihoods for women and men.

Employment transition and work transition in rural areas

There are at least three ways that urbanisation changes employment. Firstly, masonry, transport, earthworks, material supply, retail and domestic service are temporary jobs that are created during construction. Secondly, commercial and institutional development can create more employment opportunities over the longer term in shops, schools, clinics, offices, repair, warehousing and logistics. Thirdly, agro-processing and market expansion can provide jobs associated with the agricultural value chains.

This mixed relationship is revealed in the district industrial sector. In 2015–16, there were 304 agro-based and food-product units, 246 cotton-textile units, and many service and repair units with a total workforce of 3,662 and 782 people, respectively. They can also supplement farming and add value to crops and generate non-farm income. However, not every person who has lost their job in the agricultural sector finds a job in industry. The job skills, capital, mobility, and social networks needed for employment may not be available to the landless workers and small farmers. Quality of jobs is as important as number of jobs. Construction work is frequently seasonal, informal and physical work. Women farmers and older workers in urban areas may have challenges in accessing urban services, while young people can access them. The overall livelihood impacts will therefore not be captured by a land-conversion policy that does not take into account the compensation of land owners ((Government of India, 2013)). Skill training and employment facilitation as well as support for women's businesses and credit access for affected households should be incorporated in the planning process.

The vulnerability of canals to water demand

The greatest environmental issue is the relationship between urban development and the district's already fragile water system. The canals play an important role

in Sri Ganganagar in terms of farming and settlement water supply. The primary source of water for Sri Ganganagar town is from the Gang Canal (Suthar, 2011). The urban population expands the demand for treated water and wastewater disposal, and agriculture necessitates judicious water irrigation management to prevent waterlogging and salinity.

Based on CGWB evidence, the major constraint is the quality of the groundwater. The native groundwater is mostly brackish to saline in most areas except in the Ghaggar flood plain and where canal seepage is a factor. In shallow aquifers, conductivity throughout most of the district was 2,000 to 10,000 µS/cm, and up to 10,490 at one monitored site. The range for nitrate was 0.20-375 mg/l with some sites exceeding the 45 mg/l limit. Groundwater found deeper is likely to be more saline and not potable for unrestricted consumption.

This context reinforces the need not to take the "easy" way out and use groundwater instead of surface water supply and demand management. It also implies that contamination caused by leaking sewers, septic tanks, solid waste and industrial effluents can pose severe problems in areas where potable fresh water pockets are small. According to the urban assessment, carried out in 2014, there was no comprehensive sewerage network at the time of assessment and many households had septic tanks with their effluents and sullage flowing to open drains which led to streams and ponds. These conditions can lead to surface-water and soil pollution and can impact shallow groundwater.

An improved urban infrastructure is thus an essential component of sustainable land use. Planned 417 km sewer network, replacement of leaking water lines, and household metering were planned to minimize losses, enhance public health and decrease the potential for contamination. The infrastructure, however, should be in place when the peripheral colonies are developed and not after they settle into a dense colony. Whereas fringe urbanisation can establish a pattern where agricultural drainage channels become informal waste channels.

Waterlogging and salinity

The water logging and salinity are perennial problems in the canal command area. Waterlogging is a serious groundwater related problem in canal command areas and along the natural depressions identified by CGWB. Waterlogging occurs when canal seepage, irrigation return flow and shallow impermeable layers, and ineffective natural drainage cooperate to increase the water table. The issue is particularly significant in the vicinity of pits and in areas of the IGNP command. This can be worsened by urbanisation in the following three ways. The first is the change in natural micro-drainage which is brought about by the alteration of roads, buildings and plot filling. Second, drainage channels can be clogged, constricted or utilized for dumping. Third, paved surfaces accelerate the flow of runoff during rain events and poorly designed storm drains can carry the water to low lying agricultural fields. Fourth, local recharge will be added from leaking water networks and unlined drains. Lastly, land use can also cause disruption to field drains and Gross irrigated area outlets, which would have been part of a larger farm plan.

It is well known that salinity is closely related to waterlogging in arid areas. As water tables approach the surface, dissolved salts may be drawn up into the root zone by evaporation. This can decrease the yields of the crops and in extreme cases may render the land unusable for crops. Loss of high-quality farmland can then create environmental costs of degradation of the remaining farmland. Drainage should not be an afterthought in a land-use strategy, but rather a regional system.

CGWB suggests conjunctive use of surface + ground water, promoting suitable groundwater development if water quality allows, use for micro-irrigation if possible, use of crops with lower water consumption, bio-drainage, use of piezometers to monitor the groundwater. The recommendations are relevant to urban fringe planning. Ecological constraints such as waterlogged depressions, saline areas, canal alignments and drainage corridors should not be part of a city expansion plan, but should be recognized as such.

Food security and agriculture production

The land conversion impact is not only limited to individual farms, but is also significant for agriculture in Sri Ganganagar. The district's intensive farming practices enable the production of grain, oilseed, fibre and sugar crops as well as livestock production and agro-processing. In many areas, a significant amount of land was used more than once through more than one crop cycle, as evidenced by both Net sown area

and Gross cropped area. Even if the well-irrigated land is taken off only in small amounts, a greater production impact may result than if the dry land is taken off in the same amount ((Central Ground Water Board [CGWB], 2013)).

It is neither practical nor desirable, however, to prevent every acre of farmland from becoming available for urban use. Towns need housing, education, health care, infrastructure and employment. Spatial prioritisation, the question of what land must be protected, what land can be dedicated to planned growth, and how planned growth can be implemented with the minimal loss of productive land and the minimal adverse effects on the ecology is the policy question.

A helpful guideline is to develop in small increments, redevelop underutilized or abandoned urban property, and use sub-optimal or disturbed land, where possible. More protection should be given to high value irrigated agricultural land, particularly to land that has consistent access to canals, and has good soil quality. Soil quality, irrigation command, drainage, groundwater depths, existing built-up patterns and proximity to infrastructure are all factors that should be considered in land suitability analysis.

Governance challenges

Land-use change is shaped by institutions. Agricultural land can change hands via formal approval, through private subdivision, for public projects, or market transactions and informal construction (AECORD Editorial Team, 2026). A loose linkup between the municipal body, development authority, revenue authority, irrigation authority and pollution control boards and panchayats may lead to disjointed results.

There are three governance gaps that are important. First, master plans can be drawn up to encompass large tracts of urbanisation of land without properly distinguishing productive irrigated land from environmentally limited land. Secondly, infrastructure services are provided may lag behind the approval of plots leading to un-serviced sprawl. Thirdly, compensation arrangements can be biased in favour of title holders and against tenants, women farmers and agriculture-dependent labourers and small businesses.

These risks can be mitigated by participatory planning. Before the approval of large peri-urban schemes, farmers, women groups, agricultural labourers, resident associations, traders and irrigation users should be consulted. It is also essential to make public disclosure of land-use maps, drainage plans, environmental assessments and environmental compensation criteria. Transparent planning does not eliminate conflict, rather it can provide affected groups with an understanding and an opportunity to challenge decisions before they are irrevocably made.

Socio-Economic Implications

Urbanisation brings both positive and negative socio-economic impact on Sri Ganganagar. Some landowners may find that conversion brings them a cash bonanza. It can pay for education or migration, entrepreneurship or improved housing (Burark et al., 2026). Proximity to the city can also facilitate access to hospitals, colleges, banks, markets and digital services. The farmers access to mandis and input suppliers could be enhanced through the development of new roads and transport.

If you are not one of these, conversion may affect your future security. Agriculture yields CASH, subsistence, feed for livestock, social status and a foundation for family labour. The cash payment can be depleted rapidly, particularly if the households have no access to alternative employment or to business networks, or do not plan their expenses. The losses are harsher for the marginal farmers, tenants and landless who are dependent on agriculture but do not receive proper compensation ((Government of India, 2013)).

The impact on youth is also unclear. Positive aspirations to education and paid employment because of urban growth. However, if skills is not adequate to the needs of the labour market, youth could shift from agriculture to insecure informal employment. Women might gain from proximity to services as well as from working outside of the home, but this needs to be properly supported by addressing mobility, safety, skills, childcare and ownership issues.

The socially just urbanisation policy should therefore not simply be about the purchase of land in the market. Should include livelihood restoration, legal assistance, financial education, capacity building through vocational training, access to credit and tracking of the family's performance once they convert. It should also promote agro-processing, dairy, horticulture and logistics which maintain a viable linkage between town and country.

Policy Recommendations

The district should create a map of land suitability that includes areas of irrigated farm ground, canal-command, fertile soils, drainage corridors, waterlogging, and saline areas, along with existing built-up land. The high productivity agricultural land should be declared as an agricultural protection zone and its conversion should be allowed only in the presence of well-defined public interest criteria.

Urban development should be based on redevelopment of vacant plots, farmland and contiguous development, not on scattering colonies on farmland. Compact development lowers the cost of roads, water lines, sewers and drainage per person, and maintains larger single farm blocks.

All major peri-urban developments must have guaranteed water supply, sewerage, storm water drainage, solid waste and road access. Developers and public agencies need to show how the wastewater will be treated, and how the runoff will be controlled without causing any harm to nearby farms.

The planning, irrigation management, monitoring of groundwater and agricultural extension services need to be coordinated via a shared spatial database. Development controls should be based on canal alignments, distributaries, drains, low lying depressions, groundwater-depth zones, and water-quality hotspots.

Compensation not restricted to those who have officially recorded landowners. Policy should specify the tenants, women cultivators, agricultural labourers, the dairy workers and small rural enterprises that are impacted by conversion. Livelihood packages should contain training and job placement, enterprise support and social security enrolment.

Increase in population or peripheral development should be dealt with by sewer systems and treatment facilities before they reach the point of becoming too large to manage. Wastewater treatment may only be reused within monitored standards with protection of soil, crop and worker health. The discharge of waste materials to drains, canals and ponds should be strictly monitored and controlled.

Built-up expansion, conversion of agricultural land, acreage of crops, groundwater depth and salinity, waterlogging and household livelihood outcomes should be monitored annually by a district observatory, etc. Revenue maps and field checks should be used in conjunction with remote sensing to differentiate between actual conversion and temporary fallow.

Women farmers, tenant cultivators and landless workers should be engaged in the public hearings and consultations at the village level. Land ownership should be made available to the public as should information on compensation, as well as development proposals. Collected data must be disaggregated by gender, including data on ownership, compensation, and employment and resettlement outcomes.

VI. CONCLUSION

Sri Ganganagar is a case study of a larger problem in Indian regional development of how to be urban without destroying productive land and water uses that support the urban economy. The district has an extensive and intensive agricultural base, mainly irrigated by canal. The statistics available indicate a large net sown area, a high gross cropped area and a significant area of canal-irrigated land. Growth and infrastructure expansion and industrial development poses both opportunities for employment and market integration and for provision of services, but also puts pressure on productive peri-urban agricultural land.

There are many dimensions to the impact of urbanisation. All of these factors, among others, have been shown to be harmful to the previous and current uses of land and water on the farms and reduce farm viability: direct conversion of land, fragmentation of land ownership, a rise in land value (gains to some, losses to others), new demands for water and sanitation, along with other risks from salinity and waterlogging. These environmental factors are of special significance in Sri Ganganagar as the groundwater is saline, canal command areas are prone to shallow water table and poor drainage or untreated wastewater can have adverse impacts on health and agriculture.

The answer is not to stop urbanisation, but to better manage it. A sustainable pathway would help to safeguard the high value irrigated land, guide development toward compact and serviced areas, maintain drainage systems, minimize water losses, provide improved sewerage and treatment, and fairly redistribute the benefits of land use change. Future research needs to quantify land conversion using GIS and remote sensing, measure household level livelihood change and explore gendered effects of

peri-urbanisation. By adopting evidence-based planning, Sri Ganganagar can simultaneously develop its urban infrastructure and maintain its agricultural strength and environmental sustainability.

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