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RESEARCH PAPER

The impact of urbanisation on crop–livestock farming system: a comparative case study of India and Bangladesh

Braja Bandhu Swain[1] · **Nils Teufel**[2]

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Abstract The paper has attempted to explore the impact of urbanisation on crop–livestock farming system in changing economic space and the livelihood impact of these changes. Urbanisation in South Asia is gaining momentum in recent years with rapid changes in economic activities and migration from rural space to urban centres for better live. This results in increasing the share of non-producer; declining agricultural land and increasing food prices; and putting pressure on the livelihoods of rural as well as urban poor. All these changes specially the land use patterns brought changes in crop–livestock farming system which dominates in South Asia. The study is based on a trans-regional household-level survey in three regions across India and Bangladesh. The results reflect that the intensification and interdependence between crop–livestock is highest where farmers have better access to urban market. In regard to system sustainability, the low-intensity zone appears to be most threatened as farmers have less access to urban market and more pressure on biomass. Non-farm income plays a major role in financing for innovation in agriculture sector in low urbanised area. There needs deeper understanding to integrate the crop–livestock in efficient way that can improve the livelihood without compromising sustainability of the system.

Keywords Urbanisation · Crop–livestock farming · Livelihood and South Asia

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✉ Braja Bandhu Swain
brajacds@gmail.com

[1] International Livestock Research Institute (ILRI), NASC, New Delhi, India

[2] International Livestock Research Institute (ILRI), Nairobi, Kenya

Introduction

Urbanisation in South Asia is increasing considerably in recent years due to rapid changes in economic activities and outward migration from rural space to urban centres for better employment and livelihood (Kundu and Maitra 1999; Ellis and Roberts 2016). The urban population in this region grew by 130 million between 2001 and 2011, and it is expected to increase by 250 million more in the next 15 years (Ellis and Roberts 2016). On the global level, the UN projection indicates that the world's urban population will grow by more than a billion between 2010 and 2025 (United Nation 2008). Rapid growth of urban population means an increasing demand for food especially high-value crops as well as land for expansion of basic infrastructure that ultimately affects the rural–urban fringe areas (Aguilar 2008). As urban space expands, the rural–urban frontier experiences new challenges like reduction in landholding size, increase in wage rate and difficulty in access to natural resources. The land use for agricultural purposes has been declining due to urbanisation along with infrastructure expansion and high population growth (Sharma 2015; Kalamkar 2009). For example, in India the area under for non-agricultural purposes, mainly for housing, infrastructure and industry has increased from 21.3 million ha in 1991–1992 to 26.3 million ha in 2011–2012 (23% increase) (GOI 2015), while a total of 3.16 million ha agricultural land was lost. In addition, land fragmentation and declining landholdings along with low levels of technology have kept agricultural productivity at low levels. Simultaneously, the share of consumers (not producing food) is likely to increase while the number of producers will decline (Satterthwaite et al. 2010a, b). As a result, the gap between demand and supply of food may increase, pushing food prices higher. High food prices have a negative impact on the livelihoods of rural as well as urban poor and increasing hunger and deprivation.

The demand for high-value products like milk, meat, egg, fish and fruits has been increasing due to urbanisation accompanied with high income growth (Delgado et al. 1999), and on the other hand, the demand for labour has also been increasing. Acharya and Mitra (2000) argued that due to high demand for labour from urban space, the wage rate in rural sector is rising over the years. The high wage rate induces mechanisation to address the labour problem. For example, the use of technologies like combine harvester or thresher has been increasing considerably to save labour costs during harvesting. On the other hand, there has been declining the use of animal power for land preparation. Thus, there has been a change in the interdependence between crop–livestock farming system as well as livelihood dependency. It calls for an attention to inspect the interdependency between crop–livestock that dominates in South Asia.[1] Two-thirds of the rural population in this region depend on mixed-farming systems for their livelihood despite an emerging trend towards more specialised forms of farming. The importance of this mixed-farming system is also increasing as global demand for animal products especially milk, meat and egg is on the rise due to increasing incomes. For example, this farming system contributes 90% of milk and 70% of ruminant meat to the total world output (Costales et al. 2007). It is being argued that smallholder livestock operations will continue to be an important part of the milk and meat supply chain and contribute significantly to the food supply in the developing world for the coming years, despite the trend towards specialised as well as intensive livestock production (Thornton 2010; Costales et al. 2007).

[1] Within agriculture, the great majority of (self-) employment is generated by small-size farms, irrigated or rain-fed, engaging in the production of crops and livestock (Costales et al. 2007).

Mixed-farming systems contain several subsystems including crop, livestock and sometimes fish. The synergetic interactions have a greater total effect than the sum of individual effects on total farm income (Edwards et al. 1988). Combined production also helps farmers to mitigate risks including climate variability, as it provides a greater number of options (crop, livestock and fish). Thus, the ecological and economic sustainability of this farming system is achieved by the synergetic interactions between the resources like land, water, crops and livestock. In an integrated farming system, crops and livestock interact to create a synergy, with recycling allowing the maximum use of available resources. In South Asia, while the crop component provides feed (grain and residues) to the animals, the livestock component supplies manure which enhances agricultural productivity by supplying nutrients that improve soil fertility while reducing the use of chemical fertilisers. Also, fodder crops might improve soil fertility besides producing feed for livestock and animal power for land preparation. Beyond physical relationships, livestock ownership is considered an important savings option as well as an important source of cash income that enables farmers to purchase agricultural inputs, food and other goods and services (Christiaensen et al. 1995; Fafchamps et al. 1998; Moll 2005). Obviously, crop–livestock farming systems have both advantages and disadvantages. For instance, farmers have to divide their attention and allocate resources over several activities. This may reduce the economies of scale and reduce the profit per hectare as it limits specialisation and allows less concentration on the most profitable activity.

The benefits and interactions between crop and livestock vary over time and intensification level. At low levels of population density, the interaction between crop and livestock production is often low because land is abundant. With growing population, the system generally moves towards intensification (and increased interactions) due to changes in relative factor prices and preferences (Valbuena et al. 2012). Then specialisation sets in with increased market integration and greater requirements of knowledge and capital.

The farming systems in South Asia have undergone an evolutionary process that has developed as a response to economic and environmental dictates, especially food shortages, un-economic land holding sizes, rainfall, urbanisation, farm intensification and population growth. These farming systems are facing challenges and constraints like modern technology, input and output markets and capital requirements along with competing demands for natural resources. The situation is becoming worse due to increasing climate variability and growing population. Urbanisation along with population growth in these countries has brought significant change in land utilisation patterns. Land converted to urban uses is increasing while reducing the crop land (Kalamkar 2009; Sharma 2015). Demand for land, included for urban development, has led to privatisation and cultivation of rangelands. The reduction in grazing available for livestock has led to increased demand for agricultural by-products such as crop residues and greater interdependency between crops and livestock. On the other hand, increased food demand calls for specialisation in farming involving a high use of agrochemicals, as well as a focus on mono-cropping and mechanisation.

Urbanisation provides a number of opportunities to those who move to cities and as well as to those who stay in rural areas. People who migrate to urban spaces have better employment, housing and education opportunities, while people remaining in rural area have better access to modern knowledge and technologies as well as a ready market for their agricultural products and access to non-farm income. This paper attempts to explore the impact of urbanisation on crop and livestock farming systems in the changing economic space and the livelihood impacts of these changes in South Asia. Urbanisation affects the rural economy in various ways like increasing demand for crop and livestock

products, increasing land prices, enhancing non-farm income and improving access to input and output markets. Bhagat (2015) argued that urban centres provide vital links to the rural areas and are instrumental in rural development. This paper analyses the differentiation in income share, use of livestock by-products for crop production, crop by-products for livestock production and future strategies for livelihood improvement in the study area. The study is based on a trans-regional household-level survey in three regions across India and Bangladesh. It does not claim to have discovered full answers to what are the impacts of urbanisation on crop–livestock farming systems in India and Bangladesh. However, it does offer a window for partial understanding of the changes in farming systems due to urbanisation in South Asia that induce migration (seasonal or permanent) to district/state headquarters or megacities.

The paper presents a descriptive and comparative analysis of diverse crop–livestock farming systems across three sites in terms of farming system, importance of crop residues (CR) in livestock feeding, importance of manure for soil fertility, contribution of crops and livestock in total household income and future strategies to livelihood improvement in different urban set-ups. Households income (farm, non-farm income, remittances and own business) was calculated to assess the importance of crop and livestock income in respect to urbanisation. The paper is divided into five sections including the present one. Section two discusses the development of crop–livestock farming systems in India and Bangladesh and relates to urbanisation. Section three discusses the sampling methods used for primary data collection and the methodology used for analysis. Section four interprets and discusses the results while section five concludes.

Understanding of crop–livestock farming systems and urbanisation in Indian and Bangladesh

Growth and performance of crop and livestock sector

Crop and livestock production are interlinked with each other, and both systems are crucial for overall food security in South Asia. This production system has been a way of life and continues to be the single most important source of livelihood for the majority of South Asia's population and has a high trickledown effect on poverty reduction (FAO 2001) even as the services and industrial production have emerged as drivers of the economy. In addition, it is considered as the basic element of economic development in India and Bangladesh due to the gross domestic product obtained from this sector and has generated employment opportunities for a large section of rural population. For instance, it employs 55% of population in India and 63% in Bangladesh, while it contributes 15 and 30% to GDP in respective countries. Hence, growth in agriculture and allied sectors remains a "necessary condition" for inclusive growth and poverty reduction in these economies. In addition, to improve the nutritional status of rural poor and control the food price inflation, crop and livestock production should grow faster.

Since India achieved independence, agriculture has undergone a significant changes and transformations. The underlying factors for these changes could be seen differently in different periods. During 1950s and 1960s institutional reforms like land reforms and development of irrigation and other infrastructure played a major role in agricultural output growth. This is manifested in higher growth rates during the first decade of independence (3.3% per annum), which was followed by a lower growth phase (2.2% per annum) during

the second decade (1961–1971). The reduction in growth rate could be attributed to structural deficiencies like slow pace of institutional changes and droughts in 1965, 1966 and 1971 (Rao and Deshpande 1986). The spread of new technologies (green revolution) initiated in the mid-1960s, and strong emphasis on agricultural R&D along with expansion of rural credit led to a modest increase in yield and production of food grains in 1970s. However, the yield increase was confined within a few regions especially in Northern Indian states (Punjab, Haryana and Uttar Pradesh) and did not have significant impact on the country's growth performance. The diffusion of green revolution technology to other parts of the country especially in Eastern and Southern India led to an increase in yield further in 1980s. As a result, agriculture recorded the highest growth rate of 3.9% per annum in 1980s (Bhalla and Singh 1997) followed by a declining phase (2.8% per annum) in 1990s (Dev 2008).

Livestock holding is more equitable than the landholdings, where 87.7% of livestock are owned by marginal, small and semi-medium farmers having less than 4 hectares of land. Though, the contribution of the livestock sector to India's GDP has declined from 4.8 in 1980–1981 to 3.9% in 2009–2010, India ranks first in the world in milk production and fifth in meat production. India is a major exporter of meat and it contributed 1.4% of country's total value of export in 2014. The milk production went up from 17 million tonnes in 1950–1951 to 146.3 million tonnes in 2014–2015. The Indian diary sector acquired substantial growth momentum since the Ninth Plan achieving an annual output of 121.84 million tonnes of milk during 2010–2011 (Economy Survey 2011–2012). The per capita milk availability has also increased from 112 g per day in 1968–1969 to 322 g in 2014–2015 while world per capita availability is 294 g. The trend shows sustained growth in availability of milk and milk products for the growing population of the country. While mechanisation has increased considerably in crop farming, draft animals still play an important role in land preparation in rain-fed and tribal areas.

Agriculture in Bangladesh is transforming from a devastated sector in the early 1970s into one of the most productive farm economies of South Asia in the present period. The food security of the country in 1970s depended on imported food. Now, however, it is essentially self-sufficient in rice, emerging as a significant exporter of high-value agricultural products and enjoys the second highest per capita income in South Asia (Ziauddin 2003). The population pressure continues to have a high burden on productive capacity, creating a food deficit, especially of wheat. Foreign assistance and commercial imports sometimes fill the gap, but seasonal hunger remains a problem for the very poor. Like farmers in India, Bangladeshi farmers are exposed to various risks like climate variability, input and output market risks. As a result, the poorest farmers are limited in their ability to enhance agriculture production and their livelihoods. However, the present system is showing a rapid diversification particularly in the crop, livestock and poultry sector.

Livestock constitutes an important part of Bangladesh's wealth, since in addition to draft power and leather, it provides manure for crop production, meat and milk to the majority of country's population. Rahman et al. (2012) argue that livestock is an integral part of the complex farming system in Bangladesh as it not only serves as a source of meat protein but also as a main source of farm power services as well as employment. Statistics show that about 2.9% of country's GDP is contributed by the livestock sub-sector, with an average annual growth rate of 5.5%. In regard to employment, this sub-sector provides full-time and part-time employment to 20 and 50% of the total population of the country, respectively (Begum et al. 2011). In addition, the study by Rahman and Bhuiyan (1991) indicated that livestock by-products like leather and leather products have high demand in

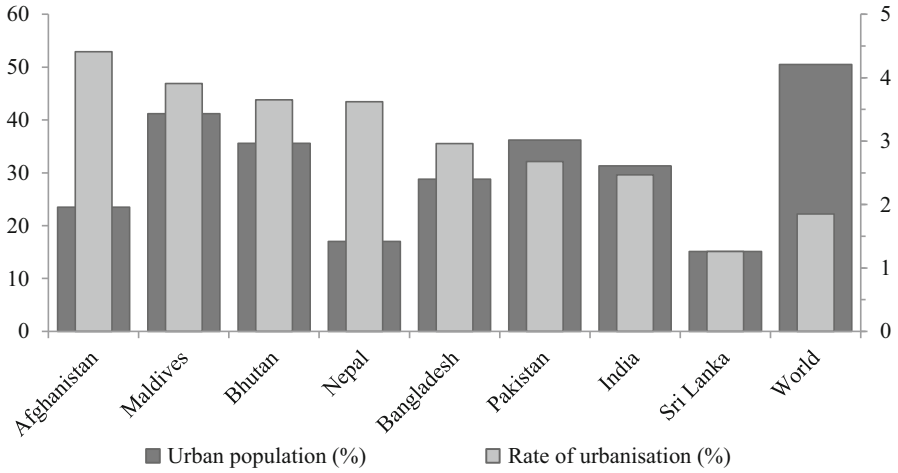

Fig. 1 Rate of urbanisation in South Asian countries

foreign countries, which contributed about 13% to total foreign exchange earnings during 1970s and 1980s.

Growth of urbanisation

Within the world's economic geography South Asia is gaining importance as urbanisation is taking place more rapidly compared to other countries and continents (Kim 2012). In South Asia this trend has led to a restructuring of industries and land use which has consequently helped in economic growth of cities on the one hand but has also brought about severe ecological, economic and social inequalities between regions and classes on the other hand (Fujii 2004). Figure 1 presents the rate of urbanisation in South Asian countries and a comparison with the world. The statistics show an increasing trend of urbanisation (or urban habitants) and a higher urbanisation rate in all South Asian countries except Sri Lanka compared to the world average. The highest urbanisation rate is found in Afghanistan, the lowest in Sri Lanka. However, the share of urban population is highest in Maldives followed by Pakistan. The rate of urbanisation is higher in small countries in South Asia compared to India. According to the Indian census of 2011, about 32% of the population is living in urban spaces, an increase of 28% from 2001. In the case of Bangladesh, the level of urbanisation is slightly lower than India, at 28%. Nevertheless, a very large section of the country's population (42.7 million) is already living in 570 urban centres (Islam 2015). The UN (2015) has projected that the urban population in Bangladesh will reach 50% by 2047 and 40% in India by 2031. The rise of the urban population in these countries is part of a wave of demographic and economic transitions as well as redefinition or urban areas.[2] It is estimated that the increase in urban population are partly due to natural population growth (60%) (a higher birth than death rate) and due to rural–urban migration (40%) (Montgomery 2008).

The high rate of urbanisation is creating challenges like increasing slums, problems of access to drinking water, adequate housing as well as traffic (United Nation 2011). It has a

[2] Census (2001); Islam (2015).

significant impact on urban food security and rural farming systems. A study by Chen and Ravallion (2007) on the relationship between poverty and urbanisation based on times series data found that the poverty rate is increasing continuously in urban spaces despite the fact that the population majority resides in rural areas. Ellis and Roberts (2016) found that although the growth of basic amenities and infrastructure facilities are impressive since 2000, the majority of South Asia's cities remain characterised by high levels of poverty, bad housing conditions and generally poor liveability for many inhabitants. Estimates indicate that at least 130 million urban residents in South Asia live in slums and are disproportionately deprived of basic infrastructure and access to basic services (Ellis and Roberts 2016).

Theoretical understanding of the interactions between urbanisation and farming systems

Mixed farming is an agrarian system that includes several sub-farming system like crop, livestock, fish or bee keeping. In this farming system, the by-products of one component serve as resources for the other, for example, manure from livestock is used to enhance crop production while crop residues or other by-products from crops are used for livestock feed. Changes in this farming system can occur due to variations in weather/climate, policies advocacy, historical developments, institutional changes, resource availability (e.g. declining landholdings) and economic drivers (e.g. markets, demographic structure, changes in consumption patterns) (Anderson 1992; Kuyvenhoven 2008; Satterthwaite et al. 2010a, b; Herrero et al. 2012). Market forces induced by urbanisation are found to be an especially important driver for the changes in crop–livestock farming system in South Asia (Devendra and Chantalakhana 2002; Diego et al. 2015).

Urbanisation affects crop and livestock sectors in various ways though it has strong linkages with the rural sector. It has brought major changes in demand for crop as well as livestock products due to increases in per capita income and changes in lifestyle and consumption patterns (Regmi and Dyck 2001). An empirical study by Huang and David (1993) using 1960–1988 data found that urbanisation leads to a significant reduction in demand for cereals while increasing the demand for non-traditional crops and high-value products. Urbanisation generates new kinds of non-farm activities such as road construction, supply chain management, hotels and other such activities, which provide a major source of non-farm income to rural youth. This contributes to its high positive impact on rural household income. It is estimated that non-farm income accounts for 30–50% of total rural household income in Africa, about 60% in Asia (Ellis 1998) and 40% in Latin America (Reardon et al. 2001). The remittances from urban household members and earnings from non-farm activities also have a major role in financing innovation and intensification of farming in Africa (Tiffen 2003) and also in Asia (Hoang et al. 2008). The remittances from urban centres reduce resource constraints and insure rural households against adverse shocks (Stark and Lucas 1988). It has been shown that even small urban centres in agricultural areas have a positive impact on the livelihoods of the poorest rural people by providing access to non-farm activities that require limited skills (Hoang et al. 2008). Further, in many rural areas local traders also contribute to the creation of non-farm jobs through local processing of agricultural produce to meet urban demand (see Fig. 2).

The emergence of new urban centres in developing countries providing markets for rural produce is known to often transform subsistence to commercial cultivation, especially in peri-urban areas, but also in rural areas (Narain 2009). Cropping patterns often develop from cereal-based to non-cereal-based cropping system in peri-urban areas. Small family

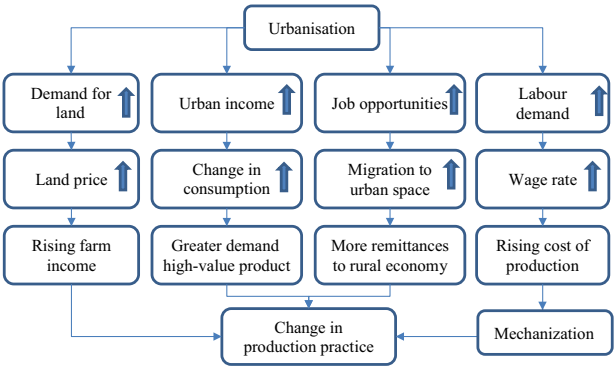

Fig. 2 Impact of urbanisation on crop–livestock farming system

farms become well connected to markets which facilitates the growing of high value crops and also motivates specialised farming. As the urban space expands, the demand for agricultural land increases for residential and industrial purposes. Thus, economic value and market prices of this land increases considerably (Cali 2013). As a result, various interdependence between crop and livestock production has been changing.

Data and method

The study is based on both quantitative and qualitative research based on a well-structured interview with rural farm households having both crops and livestock, direct observations and focus group discussion. Three sites were selected purposely from two countries in South Asia (India and Bangladesh). The sites were selected with regard to diverse crop–livestock farming systems along with different rural–urban linkages in contrasting agro-ecologies and socio-economic settings (Fig. 3). The sites include: Karnal and Udaipur districts from India and Dinajpur district from Bangladesh. A two-stage sampling method was followed to identify the villages and select households. The objective for the selection of these villages is to ascertain the impact of urbanisation on crop–livestock farming systems and the impact on livelihoods among farmers. From each study site, two local markets (mainly sub-district headquarters) were selected randomly. Two roads leading out of these towns were selected based on random compass degrees. Subsequently, the maximum sampling distance was determined from a particular market place. Typically this distance is half the distance to the next market place of the neighbouring sub-district. Two points were randomly determined along each selected main road —one within the "near" and one within "far" distance bracket.[3] Next, the closest side road to the selected points on the main road was identified, and the travel distance ("near" or "far") from the main road was randomly determined. Finally, the village closest to the determined travel distance along the side road was selected. Four villages were selected from each sub-district, two villages per selected road, resulting in the following distance combinations: "near–near", "far–far", "near-far" and "far-near". In total, 24 villages were selected from three sites consisting of eight villages in each site. Twenty households per village were randomly

[3] "near" = from 10% of max distance (avoid peri-urban area) to 50% max distance; "far" = from 60% max distance (force separation of distance classes) to 100% max distance.

Fig. 3 Study sites in South Asia

selected per village, based on a household census of selected villages, and surveyed. This resulted in 160 households per site and a total of 480 households.

Data were collected through a structured questionnaire including information on: (1) basic household information (i.e. demographic, education and decision-making); (2) access to services and market (inputs, output, technology and credit); (3) crop and livestock management; (4) crop residue (CR) and manure use trends; and (5) sources of income and future strategies for livelihood improvement. Farmers were interviewed regarding their cropping and livestock production practices, linkages with the neighbouring towns, means of commuting to the urban centres and access to benefits. A group discussion was organised in each villages in order to ascertain the degree of interaction of village economy with urban centres. The paper presents a descriptive and comparative analysis of diverse mixed-farming systems in different rural–urban linkages. Two major analyses were done—(a) impact of urbanisation on crop and livestock production system (b) the share of non-farm income in different sites.

Generally, cropping pattern entails the proportion of area under various crops at a point of time. Here we have estimated the total gross cropped area in a year to then calculate the relative land allocation for particular crops. Only large ruminants were considered to assess the livestock holdings. The producers' links with different markets (i.e. input and output markets for crop and livestock products) were assessed. Farmers were asked whether they sell their crop and livestock products at markets, in which markets and at what distance.

Households income patterns, especially non-farm income (e.g. remittances and own business), were also calculated to ascertain the importance of non-farm income in the total household income. CR uses and their trends in the past five years were also assessed. The analysis focused on cereal residues, the predominant CR type at all the selected sites. CR used for livestock feed (stall feeding and grazing) was estimated. CR uses were assessed in percentages for each crop type. The aggregated volumes of cereal residue used for the

different purposes were calculated by multiplying the total cereal residue production with the percentages of the different uses of all the surveyed households for each site. However, here we have presented only the CR use for livestock feeding. The impact of urbanisation on land prices was assessed during the group discussion.

To identify future strategies among farmers for improving their farming in different socio-economic set-ups and at various intensification levels, six questions were asked relating to crop and livestock production and ranked from the most important strategy to the least important. The ranking was analysed by pair-wise comparison to identify the most important future strategies chosen by farmers. The calculation process for this method is as follows: (1) club the strategies pair wise based on farmers response; (2) frequencies are calculated, where the column headings stand for X and the row headings for Y in "X more important than Y"(F-Matrix); (3) next step involved the shares/probabilities of "being more important"(P-matrix); (4) which are then normalised (transformed into a normal distribution) (Z-matrix); (5) in next step, these values are averaged by column (the "X" objective), indicating the average "normal" value of being the superior objectives; and (6) the smallest z-value-avg. is added to all averages to have 0 as starting point and lastly the resulting values are standardise to have the maximum value as 1 (divided by maximum average value). A value closer to one shows most important.

Results and discussion

Characteristics of study site

Table 1 presents the characteristics of study sides. Among three sites, the highest share of urban population was found in IND-1 (Karnal) with 30%, followed by IND-2 (Udaipur), at 20%, which is lower than the national average (32% in 2014). In BD (Dinajpur) 13% of population live in the urban space which is also lower than the country's average (28%). However, population density [inhabitant/km^2] is highest in BD followed by IND-1 and lowest in IND-2. The cropping intensity is found to be similar in IND-1 and BD. Better access to markets due to urbanisation and irrigation facilities appear to be the main drivers for high cropping intensity in IND-1 while it is the population pressure that induces high cropping intensity in BD. The average landholding size is largest in IND-1 followed by IND-2 and lowest in BD. However, a large proportion of land in IND-2 remains uncultivated. The percentage of "forest land" is highest in IND-2 followed by BD and least in IND-1, though one should be aware that definitions of "forest land" may vary.

Cropping pattern

The trend of cropping patterns provides an insight of farming development in an economy. A cropping pattern dominated by food/traditional crops is closer to subsistence farming. Diversifying from food crops to non-food (or cash crops) is an indicator of growing commercialisation of agriculture following market signalling. This market signalling could be due to rapid urbanisation along with high income growth. The studies have revealed that urbanisation along with rise in buying power have moved up the food chain leading to increasing demand for high value crops and animal products (Kalamkar 2009). Narain (2009) argues that the emergence of new urban centres provide the markets for rural produce and facilitate farmers to shift from subsistence farming to commercial cultivation in peri-urban areas as well as in rural. Households who migrate to the urban space seasonally to earn non-farm income try to invest their income in agriculture to improve

Table 1 Characteristics of study sites. *Source*: Agricultural Census 2014

Indicators	IND-1	BD	IND-2
Intensity	High	Medium	Low
Population density (c/km^2)	598	868	242
Urban population (%)	30	13	20
Crops/year	1.9	1.9	1.5
Average land holding size (ha)	2.37	1.34	1.46
Average annual rainfall (mm)	696	2536	596
Forest land (%)	0.41	1.58	28
Pasture and grazing (%)	3	NA	6

NA not available

Table 2 Percentage of land allocated to a particular crop in a cropping year

Crops	IND-1	BD	IND-2
Maize	0 (0.0)	8 (0.4)	55 (0.3)
Rice	36 (1.9)	80 (0.5)	0 (0.0)
Wheat	43 (2.3)	2 (0.3)	40 (0.3)
Cowpeas	0 (0.0)	0 (0.0)	1 (0.3)
Tomato	0 (1.1)	0 (0.0)	0 (0.0)
Watermelons	0 (1.3)	0 (0.0)	0 (0.0)
Onion/garlic	0 (0.0)	1 (0.5)	0 (0.0)
Cabbage	0 (0.0)	0 (0.1)	0 (0.0)
Potato	0 (0.4)	8 (0.3)	0 (0.0)
Fodder grass	9 (0.3)	0 (0.0)	0 (0.0)
Sugarcane	5 (6.4)	0 (0.0)	0 (0.1)
Other	1 (0.5)	1 (0.2)	4 (0.2)
Basmati	5 (1.3)	0 (0.0)	0 (0.0)

() shows average land (ha) allocated to a particular crop

irrigation facilities as well as other infrastructure facilities that allow the cultivation of cash crops. Uma et al. (2013) found that rural semi-educated youth, particularly males, who had moved to urban areas for earning higher income brought big changes in farming practices—farmers were now concentrating more on growing commercial crops, while they had previously focused on staple or traditional crops.

As discussed, crop production in areas with higher urban population tends to be more diversified and more focused on cash and high-value crops to meet the urban demand. This is confirmed by the study results: agricultural production is most diversified and focused on cash crops in IND-1 followed by BD and then IND-2 (Table 2). Due to better access to government support such as the "Minimum Support Price (MSP)", farmers in IND-1 are allocating most of their land to cereals, i.e. wheat and rice, for sale. Similarly, farmers in BD allocate 80% of gross cropped area (GCA) to rice production (winter and rainy season rice), while the rest of land is utilised for cash crops like potato, maize, banana and vegetable. Around 8% of land is allocated for growing maize, with poultry farms being the main grain consumers. In IND-2, maize is the main staple crop, covering 55% of GCA, followed by wheat (40%). Fodder cultivation was found to be the third important crop in IND-1 representing 9% of GCA, due to intensive dairy production. Comparing land allocation between food and cash crops, farmers in IND-1 have allocated proportionally more land to high value crops as they have better access to markets and more strongly affected by urbanisation compared to other sites (IND-2 and BD).

Table 3 Households having different types species/breeds livestock and its average

Type of spices and breeds	IND-1	BD	IND-2
No livestock	0	0	0.6
Cattle, local			
Total	12 (2)	88 (3)	48 (2)
Adult female in milk	8 (1.0)	39 (1.2)	17 (1.0)
Adult female in dry	3 (1.0)	43 (1.5)	31 (1.3)
Cattle, cross			
Total	34 (3)	4 (2)	1 (5)
Adult female in milk	28 (1.5)	1 (1.5)	0
Adult female in dry	11 (1.5)	1 (1.0)	1 (3.0)
Buffalo			
Total	91 (5)	1 (3)	28 (2)
Adult female in milk	84 (2.0)	0 (0)	15 (1.0)
Adult female in dry	41 (1.6)	1 (1.0)	14 (1.5)

() shows average number of particular breeds

Livestock holdings

Urbanisation affects not only the cropping pattern but also the livestock holdings. With rapid urbanisation, land availability per livestock declines and induces farmers to minimise the herd size and maximise yield. An attempt has been made to understand the livestock holding dynamics across different rural–urban set-ups and presented in Table 3. The analysis shows that local dairy animals are the main livestock type in BD and IND-2 while it is the buffalo in IND-1. In IND-1, around 91% of households keep on average 5 buffaloes and 34% of households have on average 3 crossbred dairy animals. 88% of farmers in BD keep on average 3 local dairy animals while 48% of households have only 2 local cattle each. Further, only 4% of farmers in BD keep crossbred dairy animals, while it is only 1% in IND-2. Urbanisation influences the type of livestock production carried out and the demand for feeds independently of either human population or due to income growth among livestock farmers. In this regard FAO (1993) indicated that with expanding urbanisation the demand for livestock feed, especially concentrates, would increase. Correspondingly, farmers in IND-1 proportionately feed the highest amounts of concentrate feed followed by BD and IND-2. The above discussion also indicates that in regions with high urbanisation, crossbred animals play a more important role in livestock products can be more easily sold in these areas compared to sites with low levels of market access and urbanisation.

Market access and integration

The economics of institutions often evolves in a way to minimise overall costs, especially the costs of transactions (Simmons et al. 2005) and so institutions affect the performance of an entire economy (North 1990). Thus, an efficient institutional framework plays an important role in the development processes of an economy by mobilising higher investment, while an inefficient institution keeps the economy at a low level of development.[4] Studies have observed strong relations between poverty and institutional weaknesses (North 1990; Bardhan 1999). The institutional structures of such economies, illustrated by

[4] Low equilibrium means low investment leading to low growth leading to low level of better paying employment.

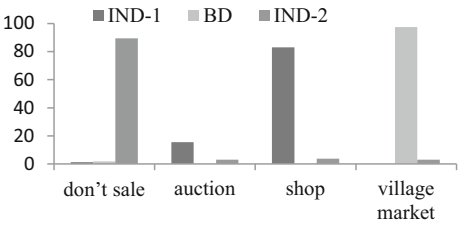

Fig. 4 Access to agricultural output market and % hhs selling

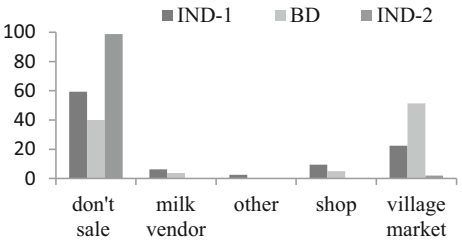

Fig. 5 Access to livestock output market and % hhs selling

high transaction costs, do not create incentives for economic actors to perform productive activities. Market deficiencies are more pronounced in rural areas with lack of supporting institutions, like under-developed roads, limited cold storage and other infrastructure facilities. In the absence of these institutions, producers in the agricultural sector bear large costs in transacting their products. This undermines the processes of exchange and keep markets localised with less rural–urban linkages. The study tries to explore the producers' links with markets by identifying the percentage of farmers selling crop and livestock products and distances to particular markets (crop and livestock output) in different rural–urban set-ups.

The result shows that shops and local traders represent the main market place where most farmers in IND-1 and IND-2 sell their agricultural output (Fig. 4). In BD, weekly village markets play an important role in selling agricultural output. It is surprising to know that 90% of farmers in IND-2 do not sell any output as they have only very little marketable surplus—85% of households in IND-2 can fulfil their household food requirements for only six months in a year from their own production. Due to shortage of own crop production, farmers migrate to urban places like district headquarter or metro cities in India in search of casual jobs, for instance in hotels or with road construction. In regard to market distance, the average distance from households to market is highest in IND-1, followed by IND-2 and the least in BD. The long distance from households to markets in IND-1 could be attributed to the geographical location and to the fact that in this site most farmers like to sell their products at formal market yard and so would accept longer distances. Further, they have better access to road and transportation facilities as compared to farmers in BD. This difference is also linked to urbanisation—the role of formal markets increases along with the rate of urbanisation. Village markets are found to be the main market place for farmers in BD and IND-1 for selling their livestock and livestock products (Fig. 5). It is surprising to note that about 99% of farmers in IND-2 and 40% in BD do not sell any livestock product, especially milk. The average distance to livestock output markets from household is highest in BD followed by IND-1 and least in IND-2. Most farmers in IND-2 sell the livestock production in the village as they do not have good access to other markets.

An attempt has been made to examine the extent of market integration across different rural–urban set-ups. The proportion of agricultural output being sold indicates the degree of market integration. It is observed that proportionately more grain is being sold in markets in IND-1, while almost all the production is kept for home consumption in IND-2. However, the trend is slightly diverse in BD where most wheat grain is sold in the market, while rice is partly sold and partly kept for household consumption. About 92% of produced rice is being sold in IND-1 while it is only 43% in BD. In case of wheat, 65% of production sold in the market in IND-1 while it is only 7% in IND-2 and rest is kept for home consumption and also seed purpose. The highest proportion of produced maize being consumed at home is found in IND-2 (89%), while it is only 3% in BD.

The statistics of milk use pattern indicate that farmers in BD proportionately sell more milk compared to IND-1 and IND-2. However, farmers in IND-1 sell a higher quantity of milk compared to farmers in BD and IND-2. This is due to the fact that most farmers in BD consume even less milk than they produce in order to maximise their household income. As discussed earlier, urbanisation has a strong demand side effect on livestock sector as demand increases especially for milk and milk products. Accordingly, farmers in IND-1 and BD are selling more milk due to high demand from the urban space. Although consumption is increasing in both rural and urban areas, urbanisation would remain an important driver of the overall growth in demand for milk because of faster increase in the urban population as well as the increase in consumption at the individual level.

Value of land and wage rate

It is discussed earlier that urbanisation leads to increases in job opportunities, which tend to pull the labour force away from agriculture towards more lucrative non-farm activities (Kalamkar 2009). Thus, the high labour demand from the urban space also leads to a rise in wage rates in the rural sector (Acharya and Mitra 2000). Table 4 presents the wage rate per day and land values in different sites. The results show that the wage rate is very high in the region that is more urbanised compared to others. The wage rate per day of male labour in IND-1 is 3.7 USD while it is 1.6 USD in BD and IND-2. A similar pattern is also observed for female labour. Similarly, the land price is found to be highest in IND-1 compared to BD and IND-2. The price of irrigated land per acre is about 36,153.85 USD in IND-1, while it is only 5929.49 in BD. Farmers in IND-2 have not reported the irrigated land price as there is only very little irrigation. The price of rain-fed agricultural land is 6153.85 USD in IND-1 while it is only 2307.69 in IND-2. The high demand for agricultural land for industrial or business purposes in IND-1 induces the very high land price compared to other sites. However, in BD it is the population pressure which induces high prices.

Table 4 Wage rate and land price

Indicators	IND-1	BD	IND-2
Wage rate (per day)			
Male	3.7	1.6	1.6
Female	3.2	1.2	1.3
Land price (per acre)			
Rain fed	6153.85	NA	2307.69
Irrigated	36,153.85	5929.49	NA

NA not reported

Note: 1 $ =60 INR & 80 BDT

Sources of income

The increasing share of non-farm activities contributing to household income in most study sites illustrates how households are trying to improve their resilience and adaptability (Reardon et al. 2000; Haggblade et al. 2010). Overall, urbanisation has a positive impact on rural household's income. Non-farm income earned from the urban space helps people in the rural economy to sustain their livelihoods. Within this study, the sources of income and the contribution of farm and non-farm income to total household income are assessed and presented in Fig. 6. Income from farming (crop and livestock) is the major source of income in IND-1 followed by the income earned through agricultural labour. Similarly, farmers in BD earn most of their income from crop production. However, business and remittances are the second most important source of income followed by income earned from agricultural labour. The non-farm income (mostly earned from non-farm activities in the urban space) is the major source of income among farmers in IND-2. Farmers have reported that income earned from migration to urban centres has helped them to invest in the agricultural sector for improving irrigation and other infrastructure facilities. In IND-1 and BD, non-farm income contributes very little to total income.

Given the limited access to land and the constraints to crop production in these sites, dairy farming is actually a very complementary pathway to improve rural livelihoods, given an enabling policy and institutional context. However, income from dairy farming contributes only a small fraction to total household income—8.5 in IND-1 and 7.8% in BD. It is almost negligible in IND-2 as farmers in this region do not have high milk production and also do not sell in the market. However, most farmers keep draft animals and small ruminants in IND-2, where the study has not considered the income contribution of draft animals, small ruminants or poultry. It could be argued that the area with the highest rate of urbanisation would benefit most from dairy farming. Livestock intensification can enhance livelihoods by generating additional resources (e.g. food and capital), and by improving the use efficiency of resources such as CR that are often available in the mixed crop–livestock farming system. The relative livelihood benefits from different development pathways would depend on the socio-economic conditions and market in a particular context. Under the current conditions, agricultural production might not be the only pathway to allow smallholder farmers to improve their livelihoods (Dorward 2009; Jayne et al. 2010). Given the increase in share of non-farm income in the total household income and the continuous low production in some farming systems, the R&D community needs to revisit previous achievements and failures.

Fig. 6 Sources of income

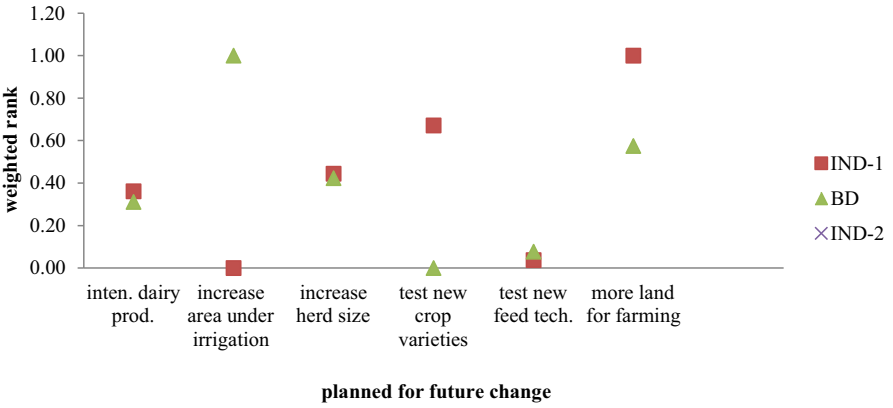

Fig. 7 Future strategies for improving farm income not livelihood

Future strategies

Future strategies for livelihood improvements through farming in the three study sites are also assessed and presented in Fig. 7. As it is well know that water is the main problem in IND-2 for cropping as well as livestock rearing, farmers reported that increasing the area under irrigation and accessing more land would be the most beneficial strategy to improve their livelihoods. Even though agricultural production is currently low in this mixed-farming system, particularly in semi-arid areas lacking access to water, inputs and markets, a great potential for intensification has been identified. To improve the system, irrigation is most important. In BD, farmers would like to access to more land for improving their livelihood, followed by new crop varieties and more livestock holding. This is despite the fact that livestock rearing gives higher profit, but due to low per capita availability of land farmers have not chosen it as a main priority. Farmers in IND-1 see testing of new crop varieties as bringing the most positive change to the farming followed by access to more land, increased area under irrigation and testing of new feed technologies. On aggregate, access to more land is found to be most important for future change in the farm followed by testing of new crop varieties and increased area under irrigation. As it is difficult to increase the cultivable land, testing new crop varieties appears to be most promising to bring the positive change in farming strategies in the farmers' perception. The results also indicate that in the region with highest urbanisation, farmers would like to increase their yield per hectare by testing new crop varieties and through better access to new technologies.

Pressures, synergies and trade-offs in CR and dung use

Agro-ecological and socio-economic conditions limit the intensification of farming systems in South Asia. Poorly developed infrastructure and markets aggravate the production risks, food insecurity and environmental degradation (Clute 1982; Anderson 1992). In the sites with highest cereal intensity (i.e. IND-1 and BD), policies and urbanisation have facilitated improved access to input and output markets and have thereby promoted improved crop production and increased marketing, supplying the demand generated by human population and livestock. As markets develop due to urbanisation, the availability

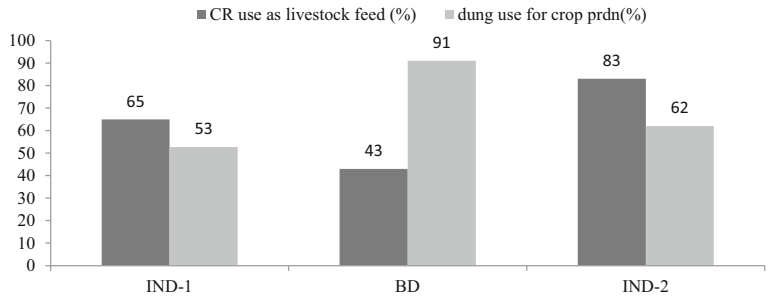

Fig. 8 CR use as livestock feed and dung use for crop production

of different varieties of concentrate feed also increases. Farmers also tend to increase the share of concentrate feed for livestock while reducing the use of crop residue. This is line with the present findings that farmers in IND-1 feed the highest percentage of concentrate feed followed by BD and less in IND-2. However, farmers in IND-2 allocate proportionately more crop residues (83%) for livestock feed compared to IND-1 (65%) and 43% in BD (Fig. 8).

On the other hand, low levels of crop production combined with an increasing biomass demand create considerable pressures on CR use. The pressures are exacerbated by various other factors: a growing human population, whose livelihood is often dependent on non-sustainable crop cultivation practices and natural resource extraction, while market incentives are missing as an instrument for poverty alleviation, increasing their vulnerability (Dorward et al. 2003). Although the site with low population pressure also shows low livestock productivity, livestock represents a major asset for these smallholder farmers, providing draft power, manure, food, saving strategies and cash income, and thereby reducing risks and vulnerability (Fafchamps et al. 1998; Schlecht et al. 2004).

Manure has increasingly become a private resource in IND-1, as a major locally available resource to enhance soil fertility and increase crop production. In BD, where government support for mineral fertiliser is low, the study found the highest proportion of dung being used for manure, followed by IND-2 and less in IND-1. Around 98% of dung is used for manure in BD in all seasons, while it is 70–89% in IND-2. It can also be argued that farmers in IND-1 use higher levels of agrochemicals to intensify their crop production compared to other regions. Farmers in IND-2 have reported shortages of CR for livestock feed. Though in IND-2 crop production is not intensified, pressures on CR use tend to peak during the dry period when other feed resources are scarce and farmers have no access to alternative feed resources. The result indicated that urbanisation plays an important role to intensify the crop–livestock farming system.

Conclusion

The present study has mainly focused on how the level of urbanisation interacts with crop–livestock farming systems as well as on the importance of mixed-farming systems for rural development across different agro-climatic and market conditions (India and Bangladesh). The share of people living in the urban space is highest in IND-1 followed by IND-2 and least in BD. Urbanisation affects the crop and livestock sector on both the supply and demand sides. On the demand side, urbanisation stimulates changes in consumption

patterns and enhances the demand for high-value crops and livestock products. On the supply side, it provides better services and output markets. As a result the various interdependencies between crop and livestock production have been changing. This is highlighted by the variation of crop–livestock interaction across the sites—a high share of crop residue used for livestock feed in the low-intensity site while more use of dung for manure in the medium-intensity site.

Urbanisation in India and Bangladesh is continuing at a considerable pace, impacting crop–livestock interactions and rural development in general, mainly through changes in farming practices and increases in income from non-farm activities. The site with the highest urbanisation shows better access to markets (crop and livestock) and the use of better technologies compared to other sites. Farmers closer to urban centres are better able to intensify their farming system. Crop production is also found to be more diversified and focused more on cash generation through meeting the urban demand. In addition, crossbred cattle are highly popular. Although the use of cereal residues for livestock feed dominates in all three sites, demand of residue for other purposes is increasing—as packaging of pottery, as fuel for brick making and as substrate for mushroom cultivation. As markets develop due to urbanisation, the availability of different varieties of concentrate feed increases. The farmers would like to increase the share of concentrates for livestock feed while reducing the use of crop residues. Non-farm income (mostly income earned from non-farm activities in the urban space) is the major source of income that facilitates farmers to invest in agriculture sector for innovation and develop the irrigation facilities in IND-2. Wage rates and land prices are found to be higher in IND-1 where the rate of urbanisation is highest.

The benefits from urbanisation appear to be region specific. Urbanisation has high positive impacts on crop production in the high-intensity site by improving the efficiency in production management; and better access to output and input markets as well as modern technology. In the low-intensity zone, farmers are able to earn considerable non-farm income helping them to improve their irrigation facilities and other farming instruments. Based on farmers' perceptions, efforts to improve the livelihoods of farmers and to strengthen the rural economy should focus on increasing non-farm income opportunities in the low-intensity zone and on introducing new crop varieties in the high and medium-intensity zones. The inequities in access to resources should be minimised through proper supportive regulatory frameworks.

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