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Review Article

Socio-Economic Dimensions of Crop- Livestock Integration in Sub Mountainous Zone of Punjab: A Review

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A B S T R A C T

Livestock is an integral part of the production system in the sub mountainous zone of Punjab, India. Crop-livestock systems play a major role in the dynamics of many agricultural systems. They occur in many forms and allow more efficient use of resources than specialized systems and spreading of risks. A variety of economic and biological interactions in crop-livestock integrated system have the potential to make the system attractive to the farmers. Mixed farming systems make the largest contribution to world livestock products by producing 50 per cent of the meat and 90 per cent of the milk. The impact analysis of integrated watershed management on livestock and village economy in a Shivalik foothill village of Northern India indicated that the village derived 54 per cent of its total income from animal husbandry, 33 per cent from agriculture and the rest from off-farm activities. Employment potential of mixed farming system was higher than arable farming. The main source of income and livelihood support to resource poor farm women in north-western Himalayan region is livestock-based agricultural activities. The major constraint faced by the farmers of the Shivalik foothill villages of Punjab in livestock farming was non availability of green fodder all through the year and they were underfed.

Keywords

Constraints, crop, livestock, integration, sub mountainous zone

Introduction

Crop-livestock systems are often referred to as mixed farming systems, where livestock and crops are produced within a co-ordinated framework to the advantage of those practicing it (Sere and Steinfeld, 1996). Mixed farming is the largest category of livestock systems in the world in terms of animal numbers, productivity and the number of people it serves (Thornton *et al.*, 2002). They involve several sub-sectors like crops, animals and fish which are used in a mutually reinforcing manner. The interactions of these components are synergistic and result in greater total effect than the sum of their individual effects (Edwards *et al.*, 1988). Crop-livestock systems play a major role in the dynamics of many agricultural systems. They occur in many forms and allow more efficient use of resources than specialized systems and spreading of risks (Van Keulen and Schiere, 2004). A variety of economic and biological interactions in crop-livestock integrated system have the potential to make the system attractive to the farmers. This system is characterized by a strong complementarity

in resource use, with outputs from one component being supplied as inputs to the other, for example manure from livestock is used to enhance crop production, whilst crop residues and by-products feed the animals. In addition, inclusion of livestock provides a labour opportunity in slack times of crops and adds value to crop by products. Livestock thus affect the socio-economic and biophysical dynamics of the entire farming system. Generally speaking, the interactions of crop and livestock increase productivity and enhance the income of farmers. The influence of these interactions is much greater in the livelihood of poor people especially in the rain-fed agro-ecosystem, where crop failures are common and livestock provides supplementary income and increased economic stability.

Mixed farming systems utilize about half of all the land used for livestock production systems, or roughly 2.5 billion hectares, of which 1.1 billion hectares are arable rain fed cropland, 0.2 billion hectares is irrigated crop land and 1.2 billion hectares grassland. Mixed farming systems make the largest contribution to world livestock products by producing 50 per cent of the meat and 90 per cent of the milk (Van Keulen and Schiere, 2004). It is virtually impossible to quantify their indirect effects on crop production, soil fertility and the socio-economic dynamics of rural societies. Moreover, given the forecasted increase in demand for livestock products for the coming decades, mixed systems are going to be the provider of a disproportionate part of this increase, especially in developing countries, hence becoming even more important than these systems already are. At present, livestock rearing is the fastest growing agricultural sub-sector globally, sustaining livelihood of 1.3 billion people and directly supporting the livelihoods of 800 million poor small-holder farmers (Rota and Sidahmed, 2010). This sector is contributing approximately 40 per cent of the gross value of agricultural production worldwide (Rao *et al.,* 2005). In present review effort has been made to enrich the knowledge about importance of crop and livestock integration in the zone.

Crop-livestock integration

The mixed farming systems of Asia have a marked complementarity in resource use, with inputs from one sector being supplied to others and more so in small scale agriculture (Devendra and Thomas, 2002). The case studies have demonstrated the important contribution that animals make to increased production, income generation and the improved sustainability of annual and perennial cropping systems. It has been emphasized that the future research needs to focus on the rain-fed production systems, where most of the livestock are found. Three quarters of the world's poorest people live in rural areas and most of them depend on livestock (Rota and Sidahmed, 2010). In general, mixed farming systems combining annual crops were more common in irrigated and lowland areas where water is available and enables intensive crop production but systems combining animals and perennial crops are more common in upland rainfed areas (Devendra, 1996).

Dikshit and Birthal (2013) reviewed that in the mixed farming systems followed in India, the livestock help in saving natural resources through their synergistic relationship with cropping activities. These include: land saving due to recycling of agricultural by-products as animal feed and also due to use of dung- cake as domestic fuel; saving of chemical fertilizers due to use of dung as manure and prevention of carbon dioxide emission due to use of animal energy in agriculture. Land saving from livestock production system due to

recycling of crop by-products as animal feed and use of dung as domestic fuel has been estimated as 42 Mha. The use of dung as manure saves 1.2 Mt of soil nutrients. Likewise, use of animal energy as a substitute for mechanical energy has potential to save diesel consumption to the extent of 13 Mt and prevents greenhouse gas emission due to burning of diesel. Integrated farming systems are common throughout the world. They involve several sub-sectors like crops, animals and fish which are used in a mutually reinforcing manner. The interactions of these components are synergistic, and result in greater total effect than the sum of their individual effects (Edwards *et al.,* 1988). More specifically, the benefits often result in ecological and economic sustainability.

A study carried out in watersheds of *kandi* area of Punjab by Kaur and Sidhu (2010), highlighted that milch animals constituted 68 per cent and 60 per cent of total livestock per household among landless and land holders respectively. The study came out with the conclusion that area was deficient in the availability of green fodder. The forest contributed 32 and 12 per cent of green and dry fodder respectively in the case of landless and it was 13 and 14 per cent respectively in case of land holders. Grazing was found to be an important source of feeding in the area. In the Himalayas, livestock was found to be a major livelihood asset of the people as livestock related activities had the potential to cope with the risk of erratic monsoons in these rainfed areas by providing alternative employment or supplementary meagre incomes (Arya and Samra, 2006; Dev *et al.,* 2003; Gupta *et al.,* 2004; Singh *et al.,* 2005).

Three typical Shivalik foothill watersheds (two treated and one untreated) were taken for study by Arya *et al.,* (2011) in the Panchkula district of Haryana. The results indicated that the watershed programme was an important intervention in dry land areas to improve livestock productivity through increased feed and fodder supply.

The study focused on the impact of watershed interventions on crop-livestock linkages with particular emphasis on how the interventions affected the quantity of stovers/straws as livestock feeding materials in bridging the demand-supply gap. Adult cattle units per household and per hectare of cultivated area were found to be high in the untreated watershed.

The integration of a grazed forage crop can also enhance soil organic carbon (SOC) which provides multiple co-benefits such as accumulation and retention of N and P and other ecosystem services, except when external fertilizer applications are excessive (Carvalho *et al.,* 2010; Palmer *et al.,* 2017).

Economic issues related to crop-livestock integrated system

The impact analysis of integrated watershed management on livestock and village economy in a Shivalik foothill village of Northern India indicated that the village derived 54 per cent of its total income from animal husbandry, 33 per cent from agriculture and the rest from off-farm activities (Arya *et al.,* 1994).

According to another report, income from livestock production accounted for 14 to 40 per cent of farm households' total earnings in India (World Bank, 2011). In the country, milk production on an average contributed 27 per cent of the household income; its contribution varied from about 19 per cent in the case of large farmers to about 53 per cent in the landless category (Shukla and Brahmankar, 1999).

The rearing of animals generated income and improved sustainability of annual and perennial cropping systems (Devendra and Thomas, 2002). Another study by Sanni *et al.,* (2004) revealed that livestock provided about 20 per cent of the annual household income. The study conducted by Singh (2006) on sustainable livestock-crop production system for livelihood in different agro-climatic sub-zones of the states of Bihar and Jharkhand, highlighted that Buffalo + Crop Production System was the most sustainable production system for generating income and employment, followed by the Crossbred Cow + Crop Production System. Whereas in the Jharkhand state, Livestock (more than one) + Crop Production System was found to possess much potential in generating income and employment in rural areas of all the agro-climatic zones. However, Goat + Crop Production System has been found to be adopted by nearly half of the households and has much potential in raising income and employment in the case of landless, marginal and small farmer households.

The importance of livestock goes beyond its food production function (Birthal *et al.,* 2002). It provides draught power and organic manure to crop sector and hides, skin, bones, blood and fibers to the industrial sector. Livestock sector also makes significant contributions towards conservation of environment. According to another study in the Shivalik foothills of Punjab, dairy income constituted about nine per cent of total family income (Kaur and Sidhu, 2010). In Shivalik foothills of Haryana, livestock sector accounted for as high as 65 per cent of total income in the untreated watershed and 20 to 42 per cent in the treated watersheds (Arya *et al.,* 2011).

In Punjab, livestock contributed nearly 14 per cent to the state domestic product and one third to the gross value of agricultural output (Grover and Kumar, 2013). The yield of dairy animals in the state, though higher than the national average, was much less than the levels attained in developed countries. The daily fodder availability in the state was found to be 10-12 kg per animal, which was quite low as compared to the optimum requirements of 40-50 kg per animal resulting in undernourishment, and low productivity of milch animals. It has been highlighted that about 5.68 lakh hectare area in the state was under fodder cultivation constituting about 7 per cent of gross cropped area. Sorghum was an the important fodder crop covering about 40 per cent of total fodder acreage during *kharif* season in the state.

Kaur and Bhullar (2012) found that dairy sector in Punjab state has shown tremendous growth in terms of milk production. The distribution of animals shifted from low to high milk yield levels. They said a structural change in the composition of milk production has taken place in the state. The dominant factor contributing to the growth in milk production was the productivity of animals. It was concluded that the relative contribution of yield effect in the growth of cow and buffalo milk production increased and that of population declined overtime.

Integrating cropping, livestock, and forestry in Cerrado regions in Brazil has been found to increase the eco-efficiency of agricultural production (Pacheco *et al.,* 2012). Rangnekar (2006) indicated that most of the traditional systems were highly efficient and self-sufficient and thus sustainable. The combination of livestock with crop production was an effective risk aversion mechanism, developed out of generations of experience of farmers in rainfed areas. The system was a very good example of recycling of all the products of the farming

operations, local material, household waste, etc., with little dependence on outside resources. According to the author it was an appropriate and sustainable approach for remote rural areas, where accessibility to outside resources or services is difficult. In India 70 to 80 per cent of the total livestock produce is contributed by the under privileged families (Kurup, 2004) and livestock are central to their livelihoods and culture. Studies showed that crop–livestock mixed farming can increase income to the extent of 20 to 30 per cent and employment by 40 to 50 per cent for smallholder farms. Livestock generates more employment than crop production.

In the end, a challenge to scientists is indicated: to develop technologies and recommendations which will improve productivity (not just production of one sub-system) in a sustainable, environment-enriching and energy efficient manner but without competing for human food and, at the same time, benefiting small, underprivileged farmers. Some caution is required: the benefit is not always a straightforward equation of rupees in and rupees out.

Employment related issues in crop-livestock production system

Employment potential of mixed farming system was higher than arable farming. In a mixed farming system of 1.5 acre land, the employment generation was 316 man days with almost uniform distribution throughout the year compared to 165 man days in arable farming with more labour employment only during July-August period of agriculture operations (Ramrao *et al.*, 2006).

The employment from livestock activities was inversely related to farm size. Livestock constituted about 39 per cent of total income of marginal farmers while its share was only about eight per cent for large farmers. It indicated that the dairy business has wide scope on all farm size categories. Elasticity of coefficients in general varied from 0.096 for fertilizer consumption to 0.282 for area under other crops i.e. cereals, pulses, oilseeds and fodder etc. Elasticity coefficients for dairy animals were significantly positive for all size of farms indicating very good scope of livestock for increasing farm income. Farmers were agreeing that integrated farming system maintained suitable production system without damaging resource base/environment. It provided family employment throughout the year. It enabled recycling of the waste within farming system and provided balanced food, ultimately proving to be a good approach for improving standards of living by increasing resource use efficiency and income generation round the year (Singh *et al.*, 2009).

Rural Poverty is largely concentrated among the landless and the marginal households comprising about 70 percent of rural population (Kozel and Parker, 2003; Taneja and Birthal, 2004). Livestock sector is one among the few growth sectors in India, which is· directly linked with the livelihood of more than 70 per cent of rural population. Moreover, India has great potentiality to export animal products (Das, 2006). It generates a continuous stream of income and employment and reduces seasonality in livelihood patterns particularly of the rural poor (Birthal and Ali, 2005). In India, over 70 percent of the rural households own livestock and a majority of livestock owning households are small, marginal and landless households. Small animals like sheep, goats, pigs and poultry are largely kept by the land scarce poor households for commercial purposes because of their low initial

Rural India provides home to more than 60 per cent of the population. It is expected that nearly 30 per cent of the below poverty line (BPL) farm families depend on livestock for their existence income and employment in rural areas. Dairying is over whelmingly a rural activity and is practised by millions of smallholders (< 2 ha of operational holding) as a part of mixed crop-livestock farming system. They comprise about 62 per cent of rural households and own 34 per cent of the arable land of the country.

Among them holders of less than 1.0 ha of land (marginal household) are predominant comprising 48 per cent of the total rural households (Taneja and Birthal, 2004). These small and marginal farmers and landless labourers own 68 per cent of the livestock in this country. An average Indian dairy herd is consisted of 1- 2 animals and annual milk yield per dairy animal is about 6 litres per day in crossbreds, which are popular among smallholders and landless farmers (Kurup, 2004).

Gender related issues in the crop livestock production system

Contribution of women in the agriculture and allied activities in the developing countries is well known. One of the studies, conducted by Deoghare (1997) highlighted that irrespective of the flock size, women and children constituted about 90 per cent of the labour force. The study of integrated watershed management projects revealed that the burden of the development has fallen disproportionately on women in comparison to men (Arya and Samra, 2007). It was noticed that women carried out much of the increased agriculture, dairying and fodder collection tasks whereas men often controlled the income generated. Further, stall feeding took more of the women's time than grazing, consequently their labour input into livestock husbandry has increased since the inception of the watershed project.

Livestock enterprises provide employment and economic support to rural families, primarily small land holders and landless. Many of the important tasks in animal husbandry activities are performed by women besides fulfilling their responsibilities as home makers. The crucial role of women in agriculture and allied activities has however been grossly under estimated and undervalued. In the participation, actual doing of the work was more in management (85.5 %), feeding (79.7 %), health care (68.7 %) and breeding (61.3 %). But their actual participation was very low in marketing, selection of livestock enterprises, availing credit facilities and record maintenance (Narmatha *et al.,* 2009).

The main source of income and livelihood support to resource poor farm women in north-western Himalayan region is livestock-based agricultural activities. Activity analysis showed that 78 per cent of the farmwomen were engaged in domestic activities followed by service (14 %) and business (8 %). The farm women in the middle age group of 25 to 50 years spent maximum time (5.04 hrs/day) on animal husbandry activities whereas the young (< 25 years) and old (> 50 yrs) spent about 4 hrs per day each. Most of the time was spent on collection and feeding of fodder as they had to travel long distance for collection from grasslands followed by tending of the animals for grazing (Dev *et al.,* 2011).

A study conducted in different agro-climatic zones of rural Punjab indicated an active participation of women in agricultural and allied fields (Sidhu, 2011) and the highest participation of women was observed in the sub-mountainous zone. The participation of women was observed mainly in harvesting

and weeding. The high level of women participation in farm operations could be attributed to very small landholdings in the foothills, which led the menfolk to seek other employment opportunities outside the villages, leaving them to perform most of the tasks at the farm level. The men returned to perform major farm operations at the time of sowing and harvesting.

Constraints in crop-livestock production system

The non-availability of quality feed resources and efficient nutritional management is the principal constraint to dairy production as enunciated by the assessment of livestock research priorities carried out by Devendra *et al.,* (1997). For crop-animal systems in rainfed agro-ecological zones of nine countries in South East Asia

High cost of feed and fodder has been reported as another major constraint faced by the dairy farmers (Thorat *et al.*, 1994, Rajendran & Prabaharan, 1998). Inadequate supply of fodder and feed to the animals, lack of knowledge regarding preparation of silage and scientific feeding of animals were the other constraints. Other major constraints in milk production were low price of milk, inadequate input, low productivity problem. Milk production could be increased by adopting scientific feeding and breeding management. Another study in Barmer district of Rajasthan by Chaudhary and Intodia (2000) revealed that poor irrigation facilities for growing green fodder, high cost of concentrate, transportation of feed and fodder and non-availability of improved seeds were the most serious constraints of livestock owners.

Keshava and Mandape (2001) analysed the problems in a prospects of dairy farming in Muzaffar district of North Bihar. They found that dairy farming in the area was characterized by inadequate herd size, low milk productivity and poor feeding practices. The major problems faced by farmers in dairy farming were proneness of animals to diseases, costly cattle feeds and unavailability of veterinary facilities and regular milk market. Shortage of feeds and fodders during dry season, traditional methods of feeding, scattered and low land holding and poor extension services, were other constraints (Singh *et al.*, 2004).

Cross-bred breeding programme did not become popular due to low demand for milk of cross-bred cows. The constraints experienced by farmers related to low conception rate in artificial insemination, proper and balance feeding, high cost of medicine, cost of resources, location of veterinary dispensaries and knowledge etc. greatly influence the success of dairy production (Singh and Fulzele, 2006). Fragmentation and sub-division of landholdings, scarcity of labour, low yield of crops, less reliable markets, scarcity of owned-fund, depleting natural resources, non-availability of good quality seeds and sheds for poultry, etc. were identified as the major constraints to promote integrated farming system (Singh *et al.*, 2009). Inadequate availability and poor quality of feed and fodder; high incidence of diseases; and inadequate knowledge on appropriate management of livestock were major problems being faced by the smallholder farmers (Misra *et al.*, 2007).

The major constraint faced by the farmers of the Shivalik foothill villages of Punjab in livestock farming was non availability of green fodder all through the year (Kaur and Sidhu, 2010) and they were underfed. (Kaushal *et al.*, 2011). In case of Tamilnadu the constraints faced in rearing crossbred

cows as reported by Kathiravan and Selvam, (2011), in the order of their importance were, excessive feed cost, followed by inadequate price for milk and huge investment. Low productivity in local cow was the major constraint followed by excessive feed cost, inadequate price for milk. Lack of fodder and grazing facilities was the prime constraint in buffalo farming followed by labour shortage and infertility problem. The foremost constraint faced by overwhelming majority in sheep and goat production was lack of fodder and grazing facilities in the state.

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