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Using Cluster Analysis as a Methodology for prototyping Livestock Production Systems Systems : A Case Study of the Haryana State, India

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Abstract

There is an increasing importance of smallholder livestock production systems with milk as the major commodity in mixed farming systems. More than 90 percent of milk production is generated in mixed-farming systems. With the majority of livestock products such as milk coming from these smallholder labour intensive low input milk production systems, it is necessary to characterize and analyse these systems for future impact analysis and to determine the strategies for improvement. Under smallholder conditions, milk tends to be a more important output than meat. Though a lot of studies have been done to characterize the farming systems in different agro-climatic zones in India, not much has been done to characterize and represent the milk production systems systems. The present study identifies the milk production systems in the state of Haryana using cluster analysis. The milk production systems were further quantified and its parameters determined in terms of economic returns.

Key words: Livestock, farming systems, cluster analysis, small-holder, tropics

Introduction

With the increase in demand for livestock products in densely populated areas in India, agriculture and farming systems in these areas needs a closer scrutiny. The direct impact of the increase in demand may be on the degradation of arable production areas due to the greater dependency of livestock on planted crop byproducts and fodder and the ensuring livelihood security of the millions of small and landless farmers in India. **This is directly or indirectly affecting the natural potential of genetic base, the sustainability of natural resource use and its over exploitation. This is evident from cases of low productivity of milch stock in India, the low income of farmers , the increase in inequity distribution, the greater incidences of decreasing crop yield and increasing resistance of pests to pesticides. This is leading to the continuing vicious cycle of low income , low yield, and low living standards. These livestock systems are less endowed with**

land and livestock per unit and less intensified. While more intensive production systems are facing environmental problems, the less intensive systems have problems of low productivity and low economic criteria. However with reduction in subsidies and more of market free these small holder livestock systems will play an increasing role in livestock production.

There is an increasing importance of smallholder livestock production systems with milk as the major commodity in mixed farming systems. The small share of grazing systems (less than 10 percent) is certainly surprising. More than 90 percent of milk production is generated in mixed-farming systems and the largest share (53.9 percent) of total meat production is generated in mixed-farming systems , followed by landless systems (36.8 percent). Among land-based systems, specialized grazing systems only contribute 23.5 percent of the ruminant meat output and 7.9 percent of all milk output; the vast majority is provided by mixed systems. It is expected that the importance of mixed systems as suppliers of livestock products will continue to grow in the future.

More than 90 percent of the world stock of buffaloes is concentrated in Asia, with more than 25% coming from the states of Punjab and Haryana in India alone.

Hence these small holder mixed farming systems need to be classified commodity wise in order to determine the alternative development strategies and reduction of population pressure on resource base. With the majority of livestock products such as milk coming from these smallholder labour intensive low input milk production systems, it is necessary to characterize and analyse these systems for future impact analysis and to determine the strategies for improvement. Under smallholder conditions, milk tends to be a more important output than meat. Though a lot of studies have been done to characterize the farming systems in different agro-climatic zones in India, not much has been done to characterize and represent the milk production systems systems.

Livestock production systems are considered to be a subset of farming systems. A review of the literature (Ruthenberg, 1980; Jahnke, 1982; FAO, 1980; De Boer, 1992; FAO, 1994) revealed that most farming systems classifications are not backed by quantitative criteria, which would enable cases to be clearly allocated to one class.

These classifications are closer to typologies. **No attempts at developing a classification of world livestock systems by using quantitative statistical methodologies (cluster analysis and related methodologies) could be located in the literature. This probably relates to the lack of appropriate data sets for such approaches on a global scale.**

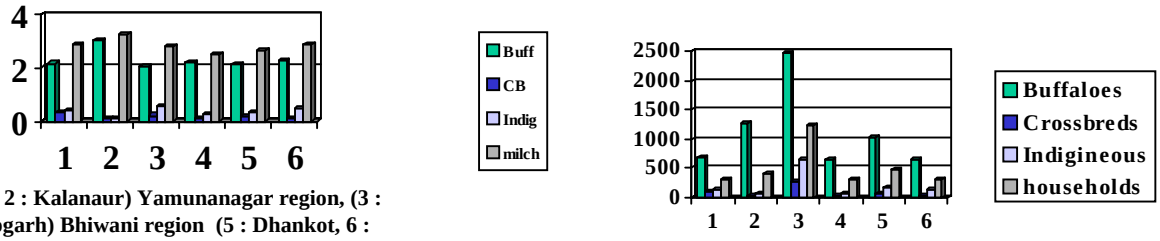
The literature on classifying farming systems at regional and local level are many. Staal et al. (1998) characterised 365 dairy systems in the Central highlands of Kenya (Kiambu). By means of a cluster analysis, patterns among dairy households in terms of level of intensification, household resources and access to services and markets were distinguished. Shepherd and Soule (1997) used participatory techniques to classify mixed farming systems in the Vihiga district in Western Kenya. based on their resource endowments and constraints faced by farmers. Nicholson and Thornton (1998) characterized farm systems with respect to the adoption of livestock as a farm component. To allow comparison of different farming systems, not only in terms of resources availability, but also in terms of farm management objectives, prototyping techniques can be used to include and compare data collected in the above mentioned and other studies. Prototyping has been used by Vereijken (1992) to characterize ecological farming systems. The methodology of prototyping can be divided into two parts: (i) designing prototypes, and (ii) testing prototypes. Aim of this study is to set up a prototyping procedure and to apply this procedure in the major milk producing state of Haryana in India.

Livestock Farming Systems in India are mainly classified as the ***Arid and semi-arid tropics and subtropics rain-fed system (MRA), the Humid and subhumid tropics and subtropics mixed system (MIH) and the Arid and semi-arid tropics and subtropics mixed system (MIA). The arid rain-fed system is the majority in India*** where livestock have a range of simultaneous roles in this system, including animal traction, production of manure and use as a cash reserve, in addition to the production of meat and milk. Fuelwood is often scarce as a result of deforestation and range degradation, leading to the ever-increasing role of animals as providers of manure for fuel, in addition to means of transport. Wherever increase in Irrigation facilities in the arid and semi-arid zones e.g., eastern Haryana, year round intensive crop production is made possible in the Arid and semi-arid tropics and subtropics mixed system. ***the Humid and subhumid tropics and subtropics mixed system***

(MIH) is characterized by intensive crop production esp. water intensive crops such as paddy twice a year due to increasing population pressure and demand for food crops.

Description of Study Area

The state of Haryana, which is very important for milk production in the country was selected for the selection, classification and characterization of dairy farming systems in the area. The state of Haryana is in the arid and semi-arid zone divided into two main water use zone based on water availability for irrigation : The irrigated fresh



(1 : Govindpura , 2 : Kalanaur) Yamunanagar region, (3 : Aaluwas, 4 : Rupgarh) Bhiwani region (5 : Dhankot, 6 : Secunderapurbara) Gurgaon region

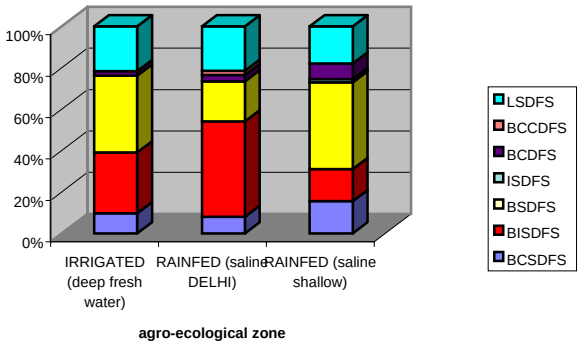
Fig 1. **livestock means per farm household and village wise**

water zone and the saline rainfed and partially rainfed zone. The districts of Yamunanagar from the freshwater irrigated zone, and the districts of Gurgaon near to commercial city Delhi and Bhiwani from the rainfed saline water zone were selected for the study. Two villages were selected purposively from each of the districts with the criteria of one being close to city and other far from city. The bench mark survey of all the households were done.Initial analysis revealed that the most dominant milch animals in the study area was of buffaloes and the average size of milch animals in all of the study area was 2.5 to 3 animals (figure 1). The cluster analysis of the households in the villages was done district wise from each of the zones on the following variables:- number of milch animals of different types (indigineous cattle, crossbred , buffalo), milk production and sale, operational land holdings and cropping pattern.

Initial results from cluster analysis revealed about five to six clusters of dairy farming systems from each of the three agro-climatic regions (figure 2). These clusters were named first depending on the type of milch animal reared and the proportion of

contribution to family cash income. The dominant systems found in the study area was the buffalo based subsistence dairy farming systems. The only system with commercial nature was the MixedBuffalo based and Landless Buffalo Crossbred based commercial dairy farming systems in the rainfed zone and the landless buffalo based commercial dairy farming systems in the irrigated zone.

Fig. 2 Dairy Farming Systems in Haryana



LSDFS : Landless Subsistance
BCCDFS : Buffalo Crossbred Commercial
BCDFS: Buffalo Commercial
ISDFS : Indigineous Subsistence
BSDFS : Buffalo Based Subsistence
BISDFS : Buffalo Indigineous Subsistence
BCSDFS : Buffalo Crossbred Subsistence
DFS : Dairy Farming Systems

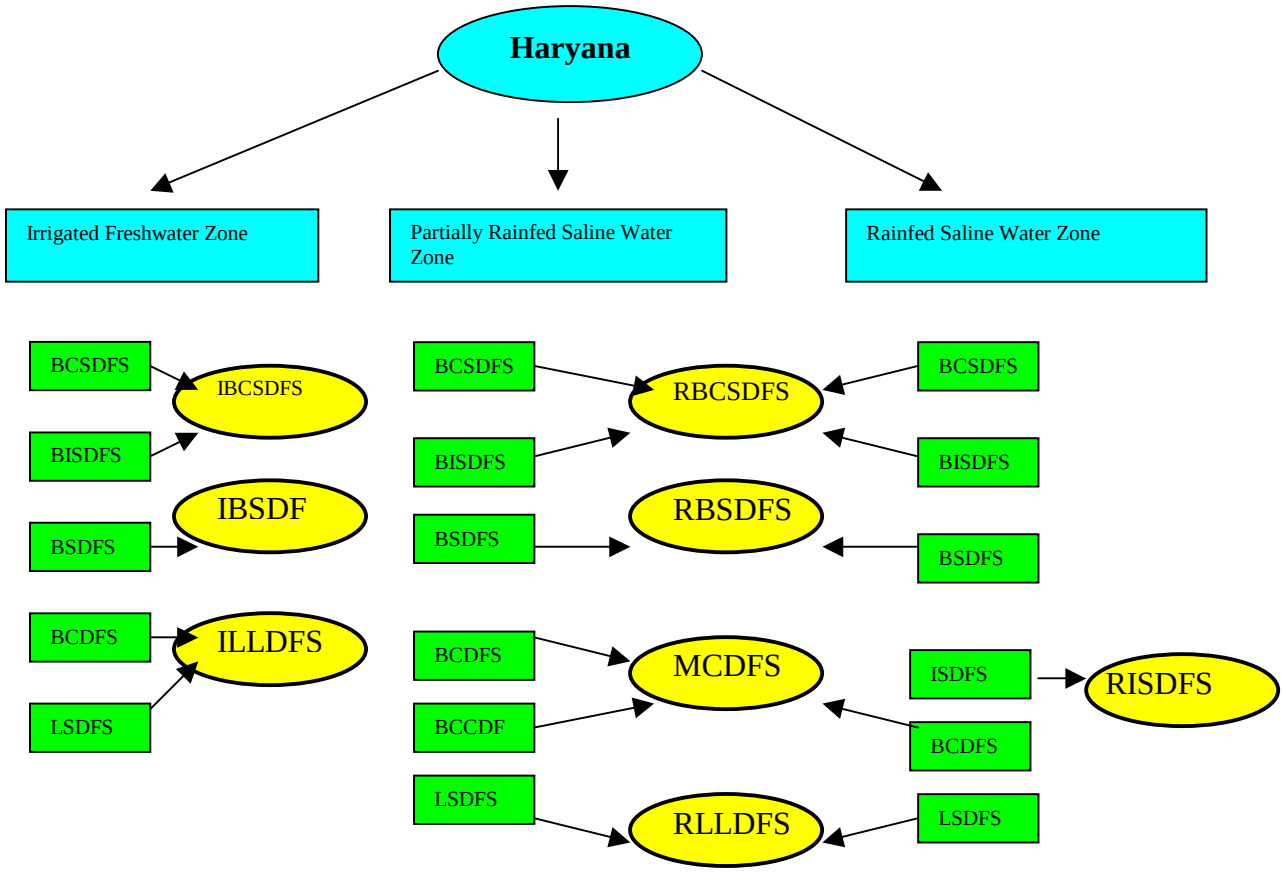
The analysis of each of the systems separately for each of the zones was done to understand the structural composition of the systems . It could be seen from the analysis that in the irrigated zones the Buffalo Crossbred Subsistence Dairy Farming Systems had the larger mean land size followed by the Buffalo Indigineous Cattle based Subsistence Dairy Farming Systems and the Buffalo based Subsistence Dairy Farming Systems. However the reason for keeping crossbred or indigineous cattle by these systems needs further investigation which is supposed to keep even milk production and preferences of cow milk for home consumption in some cases. This zone also had the Landless Buffalo based Commercial Dairy Farming Systems (BCDFS).

The analysis of the dairy farming systems in the partially rainfed zone of Haryana showed the buffalo based subsistence dairy farming systems with the maximum mean land area per household. Also there were the commercial buffalo based mixed dairy farming systems with dairying as the main activity and cropping the secondary one. The landless Buffalo Crossbred Commercial Dairy Farming Systems were also present in this zone with the reason of the proximity to the commercial market of Delhi. However such systems had very low proportion of the households.

The structural composition analysis of the Rainfed zone showed that the Buffalo based subsistence Dairy Farming Systems has the largest mean land holdings. Also the land composition of the other mixed systems were of the same level. The Buffalo based Commercial Dairy Farming Systems were of the mixed type.

To characterize these milk production systems on the basis of economic factors, an analysis on the returns of crop and dairy activities was done for each of these systems in the three different zones. The graphs in figure 4 and 5 clearly reveals that the crop returns was more from the irrigated freshwater zone from the three mixed farming systems in this zone. The mean returns from the mixed commercial dairy farming systems in the partially rainfed zone was however lower showing its secondary importance to dairying in these systems. The mean returns from the Buffalo based and the indigineous subsistence dairy farming systems were at the average levels.

Figure 3**. Schematic Representation of Dairy Farming Systems Classification**



These systems were finally named as

- Irrigated Buffalo cattle based subsistence dairy farming systems (IBCSDFS)
- Irrigated Buffalo based subsistence dairy farming systems (IBSDFS)
- Mixed Rainfed Buffalo cattle based subsistence dairy farming systems (RBCSD

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BCSDFS : Buffalo Crossbred Subsistence

- Mixed Rainfed Buffalo based subsistence dairy farming systems (RBSDFS)
- Mixed Rainfed Indigineous Cattle based subsistence dairy farming systems (RISDFS)
- Mixed Commercial Dairy Farming Systems (MCDFS)
- Irrigated Landless Dairy Farming Systems (ILLDFS)
- Mixed Rainfed Landless Dairy Farming Systems (RLLDFS)

The characteristics of these systems in term of mean crop and dairy returns were represented graphically in figure 4 and figure 5.

Figure 4. Mean Crop and dairy returns of Mixed farming Systems of Haryana

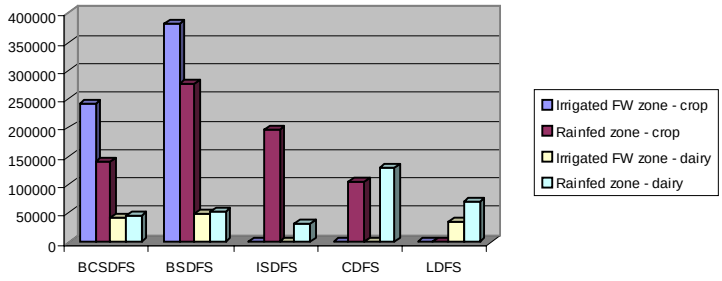
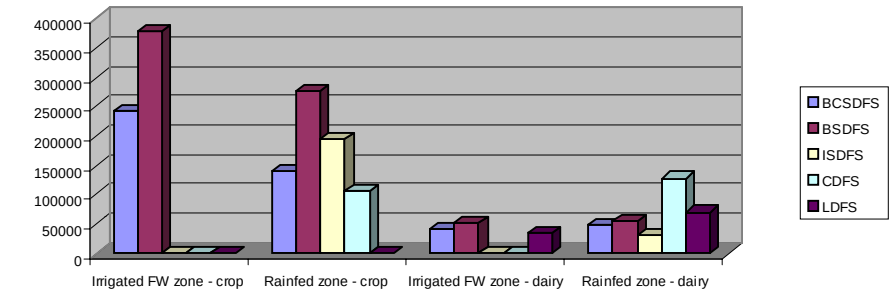


Figure 5. Mean Crop and Dairy Returns of Dairy Farming Systems in AEZs of Haryana



The future strategy of classifying milk production systems also needs to take into consideration the quality of milk produced , the production technology used, the long run supply response of milk and the socio-economic parameters of the farm households.

Thus quantative characterisation of milk production systems is one of the stepping stones to understanding the complex nature of farming systems in an area or a agro-ecological zone. It is very much necessary to identify and quantify the characteristics of the various farming systems in order to develop strategies for improvement or development of a region.

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