

Livestock in the livelihoods of the underprivileged communities in India: A review



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Abstract

In India underprivileged families account for about one-fourth of the population and contribute a major part of livestock production. Livestock are central to their livelihoods and culture. An extensive review of formal and grey literature addressed the premise that a good understanding by the research and development community of the role of livestock in the livelihoods of the underprivileged and their production and marketing systems are needed to guide effective research and development (R&D) aiming to alleviate poverty. The review covered cattle, buffalo, goat, sheep, pig and poultry and their output, input, risk, asset and social functions when kept by India's underprivileged families. It examined the factors affecting where and how the livestock were managed. It is concluded that to improve the livelihoods of the underprivileged families through livestock, inter-disciplinary action-oriented research should target communities in contrasting agro-ecozones in central, eastern and north-eastern India with priority given to small-stock, specifically goats, pigs and backyard poultry. The review notes that there is paucity of information and of projects on underprivileged communities and small-stock, particularly in the suggested target regions. It is recommended that the research should start by ensuring a shared understanding between research-for-development teams and the underprivileged communities of the preferences of the communities for specific types of livestock, their perceptions (particularly of the women) about the roles and functions of the livestock in livelihood strategies, and what, from their perspective, constitutes improvement. Subsequently, action-oriented participatory research would identify and address constraints to, and opportunities for, improving livestock-based productivity and profitability and the non-market functions of livestock. The recommended approach will require a change in paradigm from the conventional reductionist, animal-level research to people-centred, participatory and holistic methods in iterative research-for-development programmes that are inter-disciplinary, multi-institutional and, ideally, multi-locational to facilitate cross-site lesson learning. Given the increasing demand for livestock products, this is an opportune time for animal scientists to make an impact on the livelihoods of the underprivileged by adopting this change in the research paradigm.

EXECUTIVE SUMMARY

Introduction

India has a large livestock population, regarded by some as an asset provided in plenty by nature, and by others as a burden. Since 1971, when 'poverty eradication' became the main theme of development planning, livestock development has been recognised by the Indian Government as an important tool for poverty alleviation while funding support was provided for development and research programmes. However, the focus of the programmes has been on improving production of livestock commodities for income generation, applying the western model and assuming that ideal conditions would be provided. As a result, the programmes have had mixed results and many reports on the impact of livestock development programmes concluded that 'there is no clear evidence to show impact on poverty' and that 'adoption of technology by the resource poor has been negligible'. The major reasons indicated for this failure are 'lack of poverty focus in the projects; institutional frameworks being incompatible with systems and conditions in which poor farmers stay, and inability to select appropriate interventions and approaches to reach poor farmers in an effective manner' (LID 1998, 1999). Analysts also pointed out paucity of precise information on the roles that livestock play in the livelihoods of underprivileged and resource poor families. The analysts recommend that a critical first step should be to take up studies on this aspect under different agro-ecological and socio-economic situations.

An extensive review of formal and grey literature from the last decade or so was undertaken to address the premise that a good understanding, by research and development planners, of the role of livestock in the livelihoods of the resource poor, their production systems and their perception in this regard is essential to have the desired impacts on poverty. The need for such studies is all the more warranted in view of the reports showing that the resource poor can benefit from the rising demand for livestock products (Delgado et al. 1999) and that developing smallholder livestock production has better impact on livelihood of the resource poor compared to developing commercial enterprises (Mellor 2004). However, Thomas and Rangnekar (2004) pointed out that resource poor farmers have to overcome technical, economic and social constraints to take benefit of increasing demand of livestock products and compete with commercial producers and that there are indications that this can be done in developing countries.

The findings from the review are summarised here while information gaps that should be addressed for a clearer understanding of the issues are discussed. The livestock species considered in the review are cattle, buffaloes, goats, sheep, pigs and poultry.

The underlying hypothesis of the review is therefore that: a good understanding, by research and development planners of the role of livestock in the livelihoods of the resource poor, by studying their production systems, constraints and perceptions, would help in planning livestock development in a manner that would enable the underprivileged to benefit from increasing demand for livestock products and to come out of poverty.

Livestock keeping and underprivileged families

In India 70 to 80% of the total livestock produce is contributed by the underprivileged families (Kurup 2004) and livestock are central to their livelihoods and culture. Hence, to improve the livelihoods of the underprivileged families we need to understand their way of life, livestock production systems and their perceptions about the roles of livestock in their livelihoods.

The underprivileged

These are described and classified using different criteria. From the economic perspective, they are classified using land holding, viz. landless, marginal farmers and smallholder farmers (family income is not considered since most fall below the poverty line, refer Appendix 1). From a social perspective, there are three main categories of the underprivileged families described by the Government, i.e. scheduled/backward castes, scheduled tribes and pastoralists and within each category there are many social groups in the country. The population of underprivileged families varies considerably between and within states. For example, the percentage of the population represented by underprivileged families ranges from 19 to 32% in Andhra Pradesh; 8 to 49% in Gujarat; 25 to 65% in Orissa and 14 to 65% in Rajasthan (see Appendices 2 to 5) and information for these states is discussed in detail in the main review.

Livestock ownership

While the majority of livestock are owned by underprivileged families, reliable statistics are not available on the number of livestock owned by a family (neither for rural nor urban populations); an exception is a report from Rajasthan showing that >80% of rural families in arid and semi-arid districts own one or more livestock species. The species and therefore the size of animals owned seem to be positively related to the socio-economic status and land holding of the families, viz. most of the underprivileged families own small ruminants, while large animals are commonly owned by better-off families. Rajasthan and Andhra Pradesh are exceptions, where the numbers of small ruminants are greater with smallholder farmers. However, this picture changes when agricultural and infrastructural development as well as institutional support is available to the underprivileged families.

Specialisation in livestock breeding and variation in livestock keeping amongst the underprivileged families

In India, the majority of the underprivileged families keep livestock; however, it is only a few social groups who are recognised as specialists in selection and breeding of livestock. Through experience, these social groups have acquired the knowledge and skills of selecting animals (males and females) for certain characters and for the production of bulls for sale and providing breeding services. They have made major contributions in maintaining biodiversity amongst Indian livestock. Majority of these specialist livestock breeders are pastoralists. Other underprivileged groups are generally not known to specialise in livestock breeding. However, there are exceptions like tribals from Northern Himalayan ranges (Gaddis and Van Gujjars) and the Nes-rabaris of Gir forest in Gujarat, who specialise in breeding of sheep, goats and buffaloes. Their way of life is like that of nomadic pastoralists for whom livestock is the main source of livelihood.

Amongst the underprivileged families there is variation, probably due to social factors, in the choice of livestock species. For example, while the majority of tribal families in India own backyard poultry (mainly chicken and duck), pig keeping is common with tribals from Eastern and North-Eastern States but not with those from Western states, where goat keeping is more common. Besides the tribals of the North-East, pig keeping in the rest of India is mainly with scheduled and backward

classes, while goat keeping is common amongst Muslims and backward classes. There is variation between social groups amongst pastoralists regarding main livestock species kept. For example, Bharwads in Rajasthan and Gujarat Dhangars in parts of Maharashtra keep sheep and goats, while the Rabaris/Raikas, in North-West India specialise in cattle and camel breeding. Social groups from backward classes, like Nats in Uttar Pradesh and Waghri in Gujarat, specialise in breeding of buffaloes and farmers in these areas wait for their visit to breed their own animals. There are very few studies on ways of the animal selection and management practices (under unfavourable and extreme conditions) of these social groups. Such studies would generate valuable information on indigenous knowledge and have the potential to make indigenous breed development programmes more effective.

Buffalo and goat—preferred animals of the resource poor

Over the last decade or so, the populations of buffaloes and goats in most states are increasing more rapidly than other species and they are considered the ‘animals of the future for the country’ (note that the increase in the chicken population is mainly within the commercial sector in which the underprivileged families are not involved). The preference of the underprivileged families for buffaloes and goats is intriguing since both are said to have many negative techno-economic characters. Until recently, the buffalo was described as an animal of irrigated and assured rainfall areas where good quality fodder is available, while semi-arid and arid areas were considered cattle tracts (of breeds like Tharparkar, Rathi, Kankrej and Haryana). Yet even in these areas buffalo is overtaking cattle. In the technical literature, many performance problems are reported for buffaloes, viz. high calf mortality, late maturity, long dry periods and poor thermo-regulation, while the only favourable character reported is their production of high fat milk (preferred by most Indians). Goats are reported to have high kids’ mortality, susceptibility to diseases like PPR, enterotoxaemia and parasitic infestation. Moreover, goats have had hardly any development support since they are branded as responsible for de-vegetation and desertification (although a debatable issue). Goats seem to be preferred by the resource poor (also by many resource-rich farmers), but still apparently not by research and development planners. Participatory studies in a few districts in Western India (unpublished) show that buffaloes are preferred not only because their milk can be sold easily and fetches a good price (even in areas where co-operatives are not well established), but also because they are easy to maintain. Adult buffaloes have hardly any health problems and they can thrive on coarse feed (unlike crossbred dairy cattle); they can also be sold easily when unproductive or during droughts (unlike cattle for which sale is a taboo) and hence they are not a burden. Goats are preferred by underprivileged families due to low initial investment, low external inputs and good market demand. However, most families were reluctant to increase flock sizes due to the limitation of time (labour) and other resources (e.g. grazing land). In-depth studies are needed to better understand the reasons of the underprivileged families for preferring buffaloes and goats, their practices for, and perceptions about, improving animal productivity and the contributions of the livestock to their livelihoods.

Three hypotheses are therefore suggested:

- a) the underprivileged can best be benefited through livestock production by focusing R&D efforts on improving productivity of small animals and buffaloes in smallholder systems and keeping in view the choice or preference for livestock of some communities;
- b) in many areas, compared to other livestock, goat production is more beneficial for

- the underprivileged and, given adequate support services including credit and marketing, can significantly improve the livelihoods of the underprivileged; and
- c) understanding the breeding and management systems of traditional livestock breeders in ecologically fragile arid/semi-arid and hill areas, would enable appropriate approaches to be developed to improve livestock productivity and to maintain livestock biodiversity.

Roles and functions of livestock in the livelihoods of the underprivileged families

Most of the reports on this subject relate to generation of income and employment amongst rural families in general and very few specifically on the underprivileged families and on evaluating different roles played by livestock. Extremely few studies are reported from Central, Eastern and North-Eastern regions although these regions have high proportions of underprivileged families. The roles and functions of livestock can be classified broadly into four major categories (based on reports and observations) as shown in Box 1.

Box 1. Roles, functions and contributions of livestock

1. Output function: related to producing food and non-food products.
2. Input function: related to providing inputs for crop production, transport etc.
3. Risk coverage or asset function: related to raising moneys in times of need.
4. Socio-cultural functions: related to social status, culture etc.

The output function

This is the most commonly studied and reported function of livestock. It relates to the production of food and non-food products (milk, meat, wool, hair and eggs) used for home consumption as well as for sale and generate employment and income for the family. While using food products like milk from cattle and buffaloes is well studied, there is dearth of information on non-food products and products from small animals. Home consumption of food products is affected by factors like food habits, economic status of the family, market conditions, crop performance and drought. During droughts, almost 90% of milk and all surplus/unproductive animals may be sold, being the only commodities available for sale. Home consumption of eggs and poultry meat from backyard poultry is very limited (mostly used for sick members or for entertaining guests). Tribal families are more interested in sale of birds rather than eggs. Surplus goat milk for sale is available only with pastoralists or big farmers while most underprivileged families consume all the milk produced. The availability of good quality and fresh food products for the family, at low cost, makes even a low producing cow or goat or fowl an important asset for the women from underprivileged families and there is need to understand this function when assessing the productivity of livestock.

The income and employment generated from the production of food and non-food products are well studied for large dairy animals and to some extent for small ruminants (in a few states); however, there are very few reports on pigs and backyard poultry. In mixed crop–livestock systems, dairy production contributes 20 to 50% of family income; the extent of the contribution is

influenced by factors like type of animal, market condition, economic status of the family and crop condition. The share of income from milk in the total income of underprivileged family is as high as 75 to 80% during drought. Dairy production is labour intensive and the employment generated is relatively high. Labour is invariably provided by family members with low opportunity cost. Small ruminants are a major source of income for the underprivileged families and their contribution ranges between 17 to 24% of family income.

Additional aspects worth noting about output functions of livestock are:

1. Very few comprehensive studies on contribution of all livestock owned by a family.
2. Indigenous livestock is reported to make a negative financial contribution to family income, yet the majority of families continue to keep them and consider them important. Farmers' perceptions of benefit from livestock (key non-market functions) are probably not well understood and not assessed in the published Indian studies.
3. Data on the economics of livestock are often incomplete or are inadequately analysed and hence comprehensive understanding of these livelihood systems is not possible.
4. Reports and data are very scanty for Central, Eastern and North-Eastern India.

The input function

Livestock provide inputs for crop production, transport of produce and people and fuel needs of the families. While some studies have assessed the input functions of large ruminants (though only in a few states), there are hardly any studies specifically on underprivileged families and on inputs provided by small stock (sheep, goats, pigs, backyard poultry). Large ruminants provide two major inputs for crop production, viz. draft power and organic manure from their excreta. Precise data on use of dung as manure and for other uses like fuel and for plastering of walls and flooring of houses are not available. Estimates indicate that 40 to 60% of dung is used as manure and the rest as fuel. The extent of use for different purposes depends on land holding, herd size, economic status of the family and alternate material available as fuel and fertiliser. Valuing cattle and buffalo dung as manure is done only on the basis of its NPK value and the beneficial effect on properties of soils is ignored. Using dung as fuel is criticised by many, but has some positive aspects such as saving fuel wood and oil, low cost, traditional preference for cooking, convenience and low dependency on fuel suppliers. Surplus dung cakes are sold and are a good source of income for women from underprivileged families (income is mostly used for purchase of jewellery). Biogas system is an efficient alternative for use of dung as manure and fuel; however, its adoption is limited to a few pockets of the country. Very few resource poor families have adopted biogas, despite the subsidies provided by the Government, due to some constraints (initial investment, small herds, maintenance needs). The excreta from small ruminants is widely recognised as good quality manure and is used through an innovative and well-knit system of penning animals in harvested fields during migration by pastoralists. The system enables pastoralists to get fodder and resting place for their animals as well as the opportunity to sell animals and the farmers' fields get fertilised. However, this system is breaking down with changes in farming systems (cropping intensification, adoption of cash crops). There is lack of comprehensive studies on contribution of animal excreta for soil enrichment and meeting fuel needs of the underprivileged families.

A few decades ago draft power for crop production and transport (of produce and people in remote rural areas) was the major function of large ruminants and particularly cattle, as is evident from the

fact that majority of Indian cattle breeds are draft type. The share of animal power in farming and hence the demand for bullocks and their population has now gone down substantially except in states like Andhra, Orissa and Rajasthan, indicating their continuing use. Only a small percentage of underprivileged families keep bullocks and mostly depend on others for meeting draft needs. While there is preference for bullocks for transporting material in most parts of the country, buffalo males are preferred in western Uttar Pradesh. The reasons for this variation have not been studied. The use of animals for draft purposes results in saving of fossil fuel and thus saving of precious foreign exchange. Social benefit–cost analyses show that the estimated value of contribution of livestock through use of crop by-products, draft power and dung for manure and fuel far exceeds the value of livestock products (Mishra and Dixit 2004).

Risk coverage or asset function

Participatory studies on reasons for keeping livestock show that ‘asset building’, in the form of animal/bird, is one of the top four objectives along with income generation, meeting family needs and tradition. For resource poor families, any kind of animal is an asset since it can be easily encashed in times of need. There are several examples of resource poor farmers using income, from sale of animals, for improving their farms, irrigation facility, houses, as well as for meeting marriage expenses or paying school fees of the children etc. During drought, sale of animals is a major source of income for resource poor farmers to sustain the family. However, there are very few studies to assess the contribution of animals and birds as assets in times of need and giving due credit for it while working out economics of livestock production.

Social function

This is an aspect usually ignored or undervalued even though it is now well known that livestock have strong socio-cultural linkage. For most rural families and particularly for women, livestock are a part of the family. Their importance in Indian rural society is evident from the fact that livestock are still indicators of social status, many festivals and fairs are based on livestock, and many songs related to livestock are sung by women while cleaning, feeding or grazing and milking the animals. Possessing an animal of their choice gives women considerable satisfaction. The choice of an animal, kept by a family, and management practices are influenced by socio-cultural factors. These factors have to be borne in mind while studying production systems and suggesting interventions for increasing productivity and profitability with underprivileged families.

These roles and functions of livestock therefore suggest four hypotheses:

- a) Generating and analysing economic data on the multiple roles of livestock will give a better understanding of their contribution to the livelihood systems of the underprivileged and will provide information from which to design more effective livestock development programmes
- b) An outcome of livestock development will be generating employment and income through increasing demand for livestock-related services
- c) Another outcome from livestock development would be producing energy and organic fertiliser from livestock waste—an area hitherto neglected but gaining importance for environmental reasons and due to increasing oil prices and depleting soil fertility; and

- d) Improving productivity of livestock with the underprivileged would further reduce malnutrition in their families besides improving income.

Livestock production systems of the underprivileged families

There are very few studies planned exclusively to understand livestock production systems (even farming systems in general) of the underprivileged rural families. For review purposes (Appendix 1), most information was extracted from general studies, from key informants and from personal observations. The livestock production systems of the underprivileged families are different from those of resource-rich farmers since they aim at optimising use of the limited available resources (material and labour) and minimising external inputs and avert risks, as against maximising profit by the resource rich. Thus 'diversification and internalisation' are the main features of their production systems. Based on the review of available reports and extensive observations in five sample states, some shared characteristics of the livestock production systems of the rural underprivileged families are presented in Box 2.

Box 2. Features of livestock production systems of rural underprivileged families

1. Mixed farming system and diversified crop and livestock activities are common.
2. Low external input–low output and highly internalised system making maximum use of available resources like crop residues, feed, labour, animal waste etc.
3. Extensive grazing with limited supplementary feeding in semi-arid/arid areas and limited grazing/semi-stall feeding in other areas.
4. Local breeds of livestock/poultry preferred over 'improved' stock as part of risk management, except in areas where there is organisational support.
5. Traditional systems of livestock management and feeding are preferred and adoption of scientific recommendations or technologies is very low.
6. Livestock output is low but represents major share of daily cash income to family.
7. Women play a major role in livestock production and sale of produce.

Diversification

Crop–livestock production diversification is one way of optimising outputs from limited land and reducing risks. Reports from some rainfed, semi-arid districts of central Rajasthan indicate that some farmers have as many as 27 crop and 7 livestock activities (milk, meat, wool/hair, eggs, animal sale, transport, and farm work). Diversification is more common in areas with erratic rainfall and frequent crop failures. Farmers from such areas, based on their innate wisdom, use a mix of crops (with different moisture requirements) and livestock so that subsistence is assured even if rains fail or disease occurs. Moreover, livestock production is less severely affected by drought than crop production and it becomes the main source of income during years of poor rainfall. Diversification

in livestock, as traditionally practised by the resource poor, is not studied and such research would provide good leads for innovative and effective approaches to improving the livelihoods of resource-poor families (through livestock) in a sustainable manner.

Factors influencing production systems

Production systems are a result of the interplay between agro-ecology, stage of overall development of the area, farming situation, market demand, organisational support, resources of the farmers and social factors and thus systems appropriate for specific situations are adopted by farmers in general. An important characteristic of the underprivileged families is 'preference for assured subsistence over risky productivity' and hence changes in production systems and adoption of technologies or improved animals are slow (till farmers are convinced that change is not risky and is beneficial). Some of the factors influencing livestock production systems adopted by the underprivileged families are discussed next to elucidate the points mentioned above.

- (a) Agricultural and overall development of the area: In developed areas the livestock production systems of the underprivileged families are more productive than in other areas. For example, in tribal belt of Rajasthan, Gujarat and Maharashtra, the efforts of the district co-operative milk union and Bharatiya Agro Industries Foundation (BAIF, a major livestock NGO) have considerably improved dairy and crop production systems of thousands of tribal families (Hegde 2005), while tribal families from other parts of the country continue subsistence farming. Landless livestock owners have developed innovative systems to secure green fodder for their animals from farmers' fields as part of labour wages or in exchange for dung. Most animals (including goats) are stall-fed or grazed in a limited area or in harvested fields. Animal owners get organisational support and services, well established in these areas, (livestock services, processing and marketing of produce, credit etc.). Access to reliable input and output markets aided by the motivation from observing the results achieved by progressive farmers in these productive areas are the key to success.
- (b) Agro-ecology and farming systems: There is large variation amongst livestock production systems between various regions of the country. For example in the Himalayan ranges, livestock production can be said to be forest-based, it being the main source of fodder (through grazing and cut and carry system). However, in the Indo-gangetic plains crop residues are the major source of fodder for livestock and majority of animals are stall-fed or only partially grazed and there is hardly any migration. Another example of influence of agro-ecology on farming systems is the variation observed in livestock production systems, predominant animal types, cropping pattern and dominant social groups by drawing a transect from North-west to South-east Rajasthan. One can see a shift from livestock of defined breeds to non-descript animals, from pastoralist dominated society to tribal dominated society and from dry farming to assured rainfall system. A similar relationship can be seen between agro-ecology, social structure and crop–livestock production in most other states. Appendices 2 to 5 provide information for different agro-ecozones of Andhra Pradesh, Gujarat, Orissa and Rajasthan. However, there are very few well-planned studies on production systems in different agro-ecological regions and drought related livestock management practices. Studies from arid, semi-arid and

mountain areas, that are ecologically fragile, sparsely populated and inaccessible to markets, show the need for an approach different from conventional approach. The holistic and resource-based 'niche approach' that considers farmers' needs is strongly recommended. Considering the variability that exists in the country, such studies are essential for the planning of development programmes suitable to the conditions prevailing in an area.

- (c) Women in livestock production: The role of women in livestock production varies amongst underprivileged groups and between regions. In tribal communities, women play a major role in livestock production as well as in the sale of produce, while pastoral women are generally involved in looking after the new born and sick animals. Amongst most of the other backward communities, women have a greater role with small animals and backyard poultry, while men manage large animals (Rangnekar 1992). Studies also indicate that there is poor awareness regarding ways of improving livestock productivity to improve livelihoods—a consequence of weak public extension support for livestock (Rangnekar 1998). Studies on gender roles in livestock production, which are few and scattered, mostly cover work sharing. Such studies need to be widely undertaken, should be comprehensive and be able to capture knowledge and experience of women about feeding and management of animals and their perceptions about choice of animals and adoption of technologies. Such studies would help identify appropriate interventions for improving livestock productivity. There is need to strengthen extension and it is crucial that women's involvement in livestock research and development (R&D) is promoted.

Within this context of livestock production systems, three hypotheses are suggested:

- a) Under rainfed conditions diversified crop–livestock production systems in which livestock and crops 'niche well' together, are the best way to improve sustainably the livelihoods of the underprivileged
- b) Improving the knowledge and skills of women about how improving the productivity of livestock and the greater involvement of women in livestock research and development would bring in a short time quantitative and qualitative improvements in the livestock production of the underprivileged and
- c) More productive livestock production systems can be adopted by the underprivileged working in developed areas and wherever they have access to organisational support.

Impact of livestock development programmes on underprivileged families

Recent statistics show that on average 25% of households belong to the underprivileged category (Appendix 1). Analysis of data from India by some economists clearly showed that agricultural and rural growth reduces poverty drastically while industrial growth has very little effect on poverty (Mellor 2004) and that smallholder livestock production has a special role in this regard since the majority of the poor are involved in livestock production and it is labour intensive. Other factors favouring smallholder livestock development are sustained growth in demand for livestock products and low value of 'Gini Coefficient' (0.16 against 0.65 for crop production) indicating that income distribution through livestock is more equitable than from crops.

Evaluation of livestock development projects by some research, or financial/banking organisations indicated that wherever an integrated, situation-specific and participatory approach was taken and backward and forward linkages (services, inputs and marketing) were established, the impacts are positive. However, such approaches require systematic planning including needs assessment, organisational sensitivity to the needs of the underprivileged families and a long-term commitment. Most livestock development programmes and their research counterparts lack concept of the 'sustainable livelihoods' which is relatively new and is based on conceptual framework for sustainable development evolved by the Department for International Development (DFID, Carney 1998). It takes into consideration 'five types of capital assets' on which rural communities/ individuals build their livelihoods, i.e. natural, social, human, physical and financial capitals. The framework approach makes the user take a holistic and participatory approach and to think beyond 'techno-economic aspects'. Well-planned livestock development programmes have the potential to ensure development of all the five capital assets: however, there are only a few projects in India implemented by some NGOs and co-operatives where 'sustainable livelihood' approach is taken.

These experiences from livestock development programmes suggest three hypotheses:

1. Livestock development is most likely to be effective as 'a pathway out of poverty for underprivileged rural families' and enable them to compete with commercial producers provided:
 - a) organisations planning and implementing livestock development programmes are sensitive towards the needs, resources, production systems and perceptions of the families;
 - b) livestock development is a part of 'integrated development programme' that incorporates natural resource management and development of producers organisations to provide credit and services (backward and forward linkages) and help to improve efficiency and quality of livestock produce;
 - c) technologies, recommendations and services are developed on the basis of 'needs assessment' and are pre-tested for being beneficial to the resource poor farmer;
 - d) livestock extension is strengthened and targeted to the underprivileged families particularly the women.
2. Livestock production by resource-poor farmers can be more economic provided they have access to adequate techno-economic support; and
3. Integrated livestock development can improve all five 'capital assets' within the sustainable livelihoods framework.

Conclusions and recommendations

Based on the findings of the review, it is proposed that inter-disciplinary action-oriented livestock research to improve the livelihoods of the underprivileged families in India should target the following:

- Livestock production systems of underprivileged communities in contrasting agro-ecozones in Central, Eastern and North-Eastern India with priority given to small-stock, specifically pigs, goats and backyard poultry;
- Research should address the livestock-livelihood issues of the different social groups of the underprivileged categories (as given by Government);

- Research should start by ensuring a shared understanding between the research-for-development teams and their clients—the underprivileged communities—of the preferences of the communities for specific types of livestock, their perceptions (particularly of the women) about the roles and functions of the livestock in livelihood strategies, and what, from their perspective, constitutes improvement;
- Subsequently action-oriented participatory research with individuals, households, communities and villages will identify, characterise and prioritise constraints and interventions for improved production and marketing; and
- Action plans should then be agreed and implemented based on the outcomes of the iterative interactions amongst the social groups and the technical teams regarding the ways to increase livestock productivity and profitability and to improve the non-market functions of livestock at household, community and village levels.

Obviously this approach will require a change in paradigm from the conventional reductionist, animal-level research to people-centred, participatory and holistic methods. It will be iterative research-for-development programme that is inter-disciplinary, multi-institutional and, ideally, multi-locational (for cross-site lesson learning). It is recommended that the core research-for-development teams (with a minimum of two women members) will include animal production and health scientists, a sociologist, an anthropologist and an agricultural economist and that the team will draw on water, crop and soil scientists and human health specialists (as and when need arises).

It is proposed that either the National Centre for Agricultural Economics and Policy Research (NCAP) or the Indian Veterinary Research Institute (IVRI) should act as the local co-ordinating agency and integrate into the iterative research-for-development process state agricultural universities, specialist research centres and NGOs (experienced in livestock development) from respective regions.

If these recommendations are accepted and acted upon, important outputs of the programme will be the strengthening of the capacities of the collaborating organisations to undertake participatory, inter-disciplinary research in support of sustainable livestock-based development, with the concurrent strengthening of extension capacities and greater involvement of women.

REVIEW OF REPORTS
ON LIVESTOCK IN THE LIVELIHOODS
OF THE UNDERPRIVILEGED COMMUNITIES IN INDIA

1. Introduction

'Sustainable livelihood', a relatively new concept in rural development and more so with livestock development is considered in this review based on the conceptual framework developed by DFID. The concept is based on five types of capital assets on which rural communities/individuals build their livelihoods (Carney 1998). These capital assets are natural capital, social capital, human capital, physical capital and financial capital. The major advantage and usefulness of the framework approach is that it forces the user to take a holistic and participatory approach, lacking in most of the livestock development and research programmes.

Role of livestock in generating employment and income was recognised quite some time back and livestock development was included as one of the major interventions for rural development by the Government of India in 1971. In view of the social commitment of the Government, special provisions have been made in most of the five-year development plans to assist the rural poor and socially backward to come out of poverty. Besides general rural development programmes for the economically weaker sections of the society, there are special programmes for those from lower socio-economic strata, i.e. tribals, scheduled caste etc.

However, the earlier development programmes were pushed by economists and pulled by technologists and social acceptance or suitability was not given due weight. There was too much emphasis on technology transfer and on increasing production, making available or producing high potential livestock for the families. This approach did have some positive impact on employment and income of the rural poor but it was rather limited and technology adoption was very poor. With each five-year plan there has been some change in the approach to development and the programmes became more integrated and participatory and steps at empowerment of the people were included.

While the review of literature by Holden et al. (1997) showed that livestock are important for the majority of the poor, there are some evaluation reports that conclude to the contrary. These reports state that a review of donor experience encompassing around 800 projects by most of the funding agencies revealed little evidence of a sustainable impact on the poor and that most technical/ service-oriented projects in the livestock sector have failed to offer any significant sustainable improvement in the livelihood of the poor (LID 1998 and 1999). The two major reasons of failure pointed out in these reports are lack of poverty focus in the projects and institutional framework being incompatible with systems and conditions in which poor farmers stay. The institutions implementing the projects are probably unable to select appropriate interventions and to reach them in an effective manner. The reports recommend the need to consider a new paradigm for donor livestock interventions and that one of the first efforts should be to assess the nature of importance of livestock to the poor in different agro-ecological and socio-economic situations and to ensure linkages through appropriate institutional arrangements.

Rangnekar (2003), while discussing buffalo production from sustainable livelihood perspective, has described multiple roles of dairy animals ranging from being source of regular income, being an asset, to a source of draft power and manure, providing nutritional security to their social value. Rangnekar (2003) also drew attention towards the fact that buffalo production deals with most of the development issues like gender, equity, environment friendliness and social acceptance. A favourable development is that demand for livestock products is growing rapidly

in developing countries like India. The demand for milk and meat is projected to double by 2020 and this rise in demand for livestock products is unlikely to subside in foreseeable future, in view of rapid urbanisation and economic growth in the country (Delgado et al. 1999; Rao et al. 2004). These developments, according to Thomas and Rangnekar (2004), offer market opportunities for the resource poor farmers and small producers to improve their livelihoods through livestock production. They, however, pointed out that to enable the resource poor to take benefit of market demand, a favourable policy environment will have to be provided and technical and socio-economic constraints addressed. They draw attention to some of the threats like degrading natural resources, involution, industrial systems development and international trade policies. However, their opinion is that, with some improvement in production efficiency and organisational support, mixed crop–livestock farming will remain the main source of livestock products, despite the threats.

Citing results of data analysis from India by Revellion and Datt (2002), Mellor (2004) clearly showed that agricultural and rural growth reduces poverty drastically while industrial growth has very little effect. Mellor (2004) further states that smallholder livestock production has a special role in this regard since more poor are involved in it and livestock production is labour intensive. Another factor in favour of smallholder livestock production is the low value of ‘Gini Coefficient’ (0.16 against 0.65 for crop production as reported by Sharma and Poleman 1993), indicating that income distribution is very equitable. Hence, increasing income of smallholder livestock producers has an immediate and direct impact on poverty. Mellor (2004) recommends that (a) if the smallholder livestock producer is to grow it must constantly reduce cost of production and (b) governments should diagnose the critical needs of smallholder and ensure these are met and public goods complement private activities.

This review is an effort to compile and collate information from reports that have directly or indirectly examined contribution of livestock to livelihood of the resource poor and indicate constraints in deriving desired benefit. An attempt is made to point out gaps in information and suggest areas that need to be studied on priority to improve understanding of the concept and the situation related to livelihood.

2. Review methodology

- a) Published and unpublished reports, based on research studies, R&D project reports, case studies, proceedings of seminars and workshops on related subjects and project evaluation reports, as could be accessed within the time frame, were reviewed.
- b) Reviewed reports that describe livestock production systems and role of livestock in livelihoods of the socio-economically underprivileged families. Criteria for categorising as socio-economically underprivileged are:
 - i) those below poverty line with total family income below Indian Rupee (INR) 24 thousand/year (referred to as BPL families). Note that in January 2006, US\$ 1 is about Indian Rupee (INR) 45.16
 - ii) those classified as landless, marginal, small and large farmers (see Table 1)
 - iii) those belonging to lower social strata like tribals, scheduled caste and other backward classes.
- c) Reviewed reports (as were available) on evaluation of livestock development programmes for the underprivileged. Attempt was made to review reports on special development programmes for the underprivileged, supported by bank finance at lower interest

rate to improve their socio-economic status. These reports provide information on benefit to underprivileged families, viability of the project, indicate limitations of the projects and suggest improvement measures.

- d) Other aspects reviewed are:
 - i. participatory studies on livestock production and development, with observations on farmer's perceptions about role of livestock in livelihood
 - ii. gender and livestock production.
- e) Livestock species considered for the review are: cattle, buffalo, sheep, goat, pig and poultry (mainly backyard, traditional)
- f) Information gathered is grouped according to topics/subjects (those on farming system; small ruminants, dairy animals and pigs and poultry) and sub-grouped for different states within each topic.
- g) Summary of information and gaps are indicated for each chapter.
- h) Sources of information: Major sources of information for this report are:
 - i) Published information on related subjects were gathered from Commonwealth Agricultural Bureaus (CAB), CDs
 - ii) Reports from animal science research institutes like Indian Veterinary Research Institute (IVRI), Central Sheep and Wool Research Institute (CSWRI) and Central Research Institute on Goat
 - iii) Reports/case studies from the Bharatiya Agro Industries Foundation (BAIF), a non-governmental organisation (NGO) involved in agriculture-based poverty alleviation programmes
 - iv) *Ex post* evaluation reports of livestock development projects of National Bank for Agricultural and Rural Development (NABARD) for their projects for socio-economically lower strata
 - v) Proceedings of workshops and seminars on livestock economy and livelihood related aspects
 - vi) Discussions/consultations held with key persons involved in planning/ implementing and analysing rural development projects
 - vii) Working papers and proceedings of workshops of the South-Asia Hub of Pro-poor Livestock Policy Initiative of the Food and Agriculture Organization of the United Nations (FAO) located in Ahmedabad
 - viii) Reports from agricultural universities involved in studies on livelihood aspects.
- i) Reports were reviewed keeping in mind the concept of livelihood described by DFID and the local situation.

Table 1. Categories of farmers in India on basis of landholding (ha).

Farmer category	Normal area		Semi-arid area		Arid area	
	Irrigated	Non-irrigated	Irrigated	Non-irrigated	Irrigated	Non-irrigated
Marginal	0.5	1.0	0.75	1.5	1.5	3.5
Small	1.0	2.0	1.5	4.0	3.5	7.0
Semi-medium	>2.0	>4.0	4.0	7.0	7.0	10.0
Medium	4.0	6.0	6.0	8.0	8.0	>10.0
Large	1.0	2.0	1.5	7.0	10.0	>20.0

3 Livestock production systems

Livestock production systems can be described in various ways depending on the objective of the study and use of information. According to Seré and Steinfeld (1995), there are 11 livestock production systems belonging to 3 major groups, viz. grazing system, mixed crop–livestock system and industrial system. Relative importance of the system varies with overall development status of a country or region. Industrial system is the major and important system in developed countries while mixed crop–livestock system prevails in developing countries. Six out of the eleven livestock production systems fall under mixed crop–livestock systems. Production systems that prevail in an area also reflect resource status and get more complex in rainfed and semi-arid areas. Misri (1999) classified livestock production systems into peri-urban, urban, rural and transhumant. Rao et al. (2004) made an interesting attempt of constructing typology of mixed crop–livestock production systems for South Asia with the objective of identifying regions having similar constraints to development. Rao et al. (2004) developed typology for rainfed districts in India and characterised for key socio-economic and agro-ecological variables. Rao et al. (2004) indicated that a combination of agro-ecological and socio-economic variables together are able to correctly classify 87 to 90% of the districts, indicating that nearly 175 to 182 out of 202 districts were accurately predicted to fall into their respective zones. They developed an 18-zone typology using cluster analysis technique and systems were identified which have different agricultural activities. In most of the zones crop activities were dominant but livestock activities are among top 2 to 4 activities. Cattle and buffalo production are the second most important activity in four zones. Crop activities on an average contribute 75 to 80% of the total value of agriculture production; however, there are 4 zones where livestock contributes more than 30%. Cattle and buffalo are the main contributors to livestock sector and their average share is 40% each, although their relative importance varies across the zones.

Production systems develop in response to interplay of agro-ecological, socio-economic and technological factors. In resource poor areas, crop–livestock mixed farming system enables farmers to minimise external inputs by internalising the system and using a variety of crops and livestock. Thus the mixed crop–livestock farming serves as means of risk aversion since resource poor farmers prefer assured subsistence over risky high productivity. This perception of resource poor farmers is related to feeling (and probably based on some experience as well) of risk due to lack of support and linkages. And hence study of prevailing production systems, constraints to improvement and farmer perception in this regard is crucial to plan development and technological intervention.

A few economists have studied economic aspects of livestock and their contribution at national and family level and have suggested measures to improve their contribution. Vaidyanathan (1988) published a comprehensive report on the bovine economy of India based on about 10 years of study and discussed various aspects of economics of bovine production and points related to livelihood are:

- i. bovines are mainly maintained for animal power and milk (cattle for bullocks and buffalo for milk)
- ii. buffaloes are mainly maintained for milk production but more buffaloes are reared by resource rich farmers and in feed surplus areas, compared to cows
- iii. there is a strong link between milk production and feed availability
- iv. Milk production can generate employment and income for smallholder and landless

farmers, however, they need financial and institutional support and better access to feed resources and livestock services.

Subsequently, Vaidyanathan (1989) published a review of research on livestock economics and some of his relevant observations were:

- there is inadequacy of hard data on economics related aspects
- available data have been inadequately treated to understand changes in production trend, contribution to family, national economy etc.
- requirement of bullocks is decreasing in some areas and is maintained in others and are still a major source of draft power
- adoption of crossbred cattle is limited to areas where requirement of bullocks has stabilised and linkages are well established
- buffalo appears to be the animal of the future and its population is increasing in almost all the states
- resource poor families can benefit from livestock development although they need support.

Recognising importance of livestock in rural economy, the Indian Society of Agriculture Economists (ISAE) organised special sessions/seminars on the livestock economy in 1987, 1995, 1996 and 2004. The topics commonly discussed in these conferences were related to livestock economics, changes in livestock production and population, contribution of livestock to family income and employment. However, none of these convention seminars have discussed livestock production from livelihood perspective in totality.

Nair (1995) summarising discussions of the 1995 convention mentioned that the main issues covered were: changes in size and composition of bovine population, milk production, small ruminant production, demand, consumption and trade in livestock products and livestock and environment. Dairying dominated discussions in all these seminars probably because it makes major contribution to the rural economy. The papers were mostly based on field studies with sampled farmers involved in mixed farming and on evaluation of development programmes like Integrated Rural Development Programme (IRDP) and Operation Flood. The papers pointed out drawbacks of the development programmes such as quality of animals provided, limited coverage of co-operatives and their services. There were a few papers drawing attention towards importance of small ruminants as source of employment and income and report that small ruminants contribute 17 to 24% of the family income. The report summarised issues identified for discussions in future conferences and some of the issues related to livelihood are: (a) ability of the resource poor to sustain livestock production and face competition from resource rich, (b) constraints in adopting technology by smallholder farmers and improve their income, (c) ways to overcome feed and fodder deficits to sustain growth of livestock production, (d) developing meat sector and taking benefit of export potential, and (e) improving data base on livestock related aspects.

Saxena and Sardana (1997) reported that livelihoods of resource poor rural families gets hardly any mention in the report except: (a) availability of required data through census and sample survey reports, (b) issues related to milk production, its demand and marketing, (c) functioning of dairy co-operatives, (d) feed–fodder availability, and (e) small ruminant and poultry production, their role as source of milk and meat and possibility of developing this resource.

The 64th annual conference of ISAE was held recently at Coimbatore in which India's livestock economy was one of the three topics discussed. Sharma (2004) covered a wide range of subjects extending from contribution of livestock, growth and compositional changes in livestock, demand and supply of livestock products to impact of trade liberalisation and Government programmes and policies. Sharma (2004) mentioned that livestock sector has shown higher growth compared to other sub-sectors of agriculture and makes major contribution to family income of poor families. Its contribution to agricultural gross domestic product (GDP) has increased from 23% in 1990s to 25.5% in 2001–02. However, Sharma (2004) cautioned that smallholder farmers, who are the major contributors to livestock products, may not stand competition from imported products from developed countries. Sharma (2004) suggested the need for the Government to continue to protect interests of livestock producers and processors. The need for appropriate policy about livestock breeding and delivery of services and steps to improve feed–fodder situation are strongly recommended for sustaining growth of livestock sector. Summarising the proceedings of the conference, Vasishtha (2004) pointed out that most of the papers contributed were from Northern, Western and Southern states and only 5% of the papers were from East and North-eastern states, indicating the need to promote research in these states. There are very few papers dealing with livelihood related aspects and most of the papers discussed dairy related aspects. A few papers from hill states expressed the need for AMUL like co-operatives to ensure desired benefit to small producer; however, they did not discuss necessary and sufficient conditions needed for it.

Pandey (2000) presented an overview of livestock economy and discussed reports on contribution of different species in different regions of the country and with different classes of households. He pointed out that livestock not only generate income and employment but also stabilise family income and meet equity considerations. He makes special mention of small ruminant and pig production for their contribution towards improving employment and income of the families of lower socio-economic strata. He pointed out the need for improving production efficiency of small animals for the benefit of underprivileged families.

Economics of dairy production was studied by the National Centre for Agricultural Economics and Policy Research (NCAEPR), New Delhi, in regions with sorghum- and groundnut-based cropping systems with the objective of understanding the systems and their constraints. Jha (2000) reported results of study taken up in sorghum production systems (SPS) in Mahboobnagar of Andhra and Solapur of Maharashtra. He reported that farmers keep both cows and buffaloes and face several technical and socio-economic constraints and hence dairying has remained a subsistence activity. Cross-sectional primary data from 169 farmers were analysed and the results indicate huge yield gaps in cows as well as buffaloes. Main technical constraints observed are lower conception rates, scarcity of fodder, poor quality of feeds and diseases like Foot-and-mouth (FMD), mastitis and theileriosis. Estimates of losses due to low conception, FMD and HS were INR 2,234.41, 1,296.33 and 680.45 million, respectively. Considering the extent of losses, Jha (2000) recommended special efforts to control these problems. Among socio-economic constraints, lack of proper infrastructure and institutional support and market price are the major ones. An integrated approach to improve the conditions is strongly recommended.

Another study on dairying by the NCAEPR was carried out in rainfed area with groundnut-based cropping system in Junagadh. Roy et al. (2000) reporting the results indicated that dairying is based on cows as well as buffaloes and has become a major source of food and income for the rural people due to frequent crop failures. It is observed that milk production increased for sometime

but stagnated even at low base. The study showed considerable yield gaps and has tried to identify researchable issues by identifying and prioritising constraints. The major constraints to improvement in productivity are mineral deficiencies, FMD, low conception rate, parasitic infestation and mortality.

Studies have also pointed out that livestock production is responding to technology and further growth demands making appropriate technology and efficient services available to smallholder farmer.

Keeping in view information and recommendations available at national/aggregate level referred to in the above review, an attempt is made to discuss reports/information available on contribution of livestock to livelihood of resource poor farmers at state levels, in the major agro-ecological zones, for major production systems and social groups.

4. Livestock in the livelihoods of mountain areas

The Himalayan Mountains offer unique environment and system, so different from the rest of India that it demands separate and special consideration not only due to its ecology but also its special social and farming systems. Taking an overview of the conditions prevailing in Himalayan region, Banskota and Jodha (1993) strongly recommended an approach that enables learning lessons from prevailing traditional agricultural systems, identifying niches, encouraging people's participation and developing resource-based management systems. Thus for these areas an alternate approach is needed. Study meeting of Asian Productivity Organisation concluded that input-based Green Revolution would not be appropriate for semi-arid and highland agriculture in Asia (Anon 1993).

The Himalayan range covers about 11% of land mass of the country and is divided horizontally and vertically into three regions. Horizontal regions are: (i) Outer Himalayas with average height of 3000 meters above sea level (masl), (ii) Greater Himalayas with an average height of 5200 masl and (iii) the high peaks with heights above 8000 masl. Vertically the range is divided into (i) Western (Jammu and Kashmir and Himachal states) (ii) Central Himalayas (Uttanchal) and (iii) Eastern Hiamlayas (Sikkim and Arunachal states). Original inhabitants of these regions are Laddakis and Lahaul Spitians; Gurungs; Lepchas, Bhutias and Monpas, respectively, and are well known as gritty and adroit highlanders who have not only survived the extremes of the region but have an attachment for it. Farming systems in the Himalayan region have some common features although regional differences exist and these are summarised in Box 3.

Box 3. Features of farming systems in hill areas

1. The areas represent typically fragile resource zones
2. Low input-output crop-livestock production systems prevail in the region
3. Mixed cropping and livestock keeping is common
4. Farming systems differ between regions and valleys and highlands
5. Women play major role in crop-livestock production and post-production activities
6. Migration and shifting cultivation practices seen in every region.

Source: Rangnekar and Rawal (1998).

In most of the hill states rapid changes in farming systems are taking place and cash crops are becoming more popular as also buffaloes and small ruminants and these changes are reflection of change in market demand (due to tourist traffic) and deterioration of fodder resources (Jodha 1993; Singh 1993).

The Northern Himalayan Ranges cover states of Jammu and Kashmir and Himachal Pradesh. Tomar and Lall (1992) and Ganai et al. (2004) offered information on livestock production systems in Jammu and Kashmir. Their studies, carried out in a few districts, show that livestock production has an important role in the livelihood of rural families of all categories, although they have not recorded income from the livestock. Ganai et al. (2004) reported that almost every family keeps cattle as well as sheep and goat (more sheep than goats) and rice and maize are the main food crops and oats the main fodder crop. They also report that most farmers own bullock and cows. About half of the cows are crossbreeds kept for milk production and it was observed that half of the milk is consumed by the family and the rest sold. Sheep and goat contribute to family through wool and meat production. Rice straw, maize stover and bund grass are the main roughages for cattle, while sheep and goat are fed tree leaves besides being grazed. Concentrates mixtures made from rice bran, maize grain and mustard cake are fed to producing animals. The authors recommend improvement in feed resources and feeding practices to improve productivity of livestock and thereby improve farmer income.

Bhati et al. (2000) analysed farming systems in Himachal Pradesh to study four aspects, viz. (i) transformation of livestock in different agro-climatic zones of Himachal Pradesh, (ii) relationship between livestock and landholding and role of livestock in diversification, (iii) income and reduction in its distribution inequality, and (iv) input–output relationship between livestock and other sub-systems of farming. Bhati et al. (2000) emphasised that livestock production should be studied with holistic approach by linking with all other components of farming. The authors report that commercialisation of crops and lack of road links in the villages has resulted in increase in number of pack animals, reduction in total number of cattle and increase in number of improved dairy animals and improvement in their feeding and management. The number of sheep decreased and that of goats has increased in hill region due to decrease in grazing area. In low hills the number of cows is decreasing and that of buffaloes is increasing due to better returns from buffaloes. There is need to help farmers to further improve productivity of livestock particularly goats and dairy animals (buffaloes).

Gaddis are amongst well known livestock keeping tribes for whom livestock keeping is a way of life. Chauhan and Moorti (1991) studied sources of livelihood amongst Gaddi tribes of Himachal Pradesh. Influence of sheep farming on income and employment levels of the tribal families from Chamba district of the state was examined. Results of study indicated that sheep contribute 43 to 66% of the total family income, considering all types of farms. Employment levels at all categories of farms follow a cyclical trend with labour requirements being higher in April–May and October–November due to migration.

Studies on the economics of livestock production in Himachal Pradesh show that livestock are good source of income to farmers of all categories. Most of the reports relate to dairy animals; however, there are conflicting reports regarding relative contribution of different type of dairy animals. Sharma and Singh (1994) reported that farmers get highest returns from graded Murrah buffaloes followed by crossbred cows while others reported to the contrary. However, Tripathi (1995) reported that all farmers involved in dairy production incur losses. He had analysed economics of

milk production from different parts of Himachal Pradesh, although milk production in the state has improved considerably in the last few years in view of growing market demand.

Studies on resource use efficiency for dairy production in Northern Himalayan Region showed that availability of good quality fodder and concentrate has considerable influence on milk production and accounted for 70 to 80% of variation in milk production from different categories of farms. Availability of quality fodder and concentrate and improving breeding efficiency could improve milk output and efficiency of production (Singh 1992; Singh and Paul 1992).

The Central Himalayan Ranges cover the newly formed state of Uttaranchal (formerly a part of Uttar Pradesh) and have a variety of agro-climatic conditions and social groups. Rangnekar and Rawal (1998) reviewed reports on role of livestock in Uttaranchal and discussed crop–livestock production systems in Kumaon region of the state. There is variation in cropping system between valleys, mid hills and high hills of the region as indicated in Table 2.

Table 2. *Cropping pattern in Kumaon Region.*

Season	Valleys	Mid hills	High hills
Rainy	Rice–soybean	Rice–maize–millets–pulses	Millets–soybeans–vegetables
Winter	Wheat–potato–vegetables	Wheat–barley–lentils	Wheat

Source: Adopted from Singh (1993).

Mixed cropping is common and farmers prefer dual-purpose varieties (for grain and fodder). However, there is increasing adoption of cash crops like fruits, flowers and vegetables in view of development of tourism. Cattle keeping is common; however, these are small sized and commonly referred to as Hill Cattle. Like other states, buffaloes for milk and goats for milk and meat are becoming popular. Rapid increase in the population of improved poultry is seen probably again due to market demand as a result of growing tourist industry. Rangnekar and Rawal (1998) have described BAIF approach in evolving integrated rural development programme with livestock as base. Starting with learner approach to understand prevailing systems and farmer’s perception and priorities, appropriate intervention plan is recommended. Priorities indicated by the farmers from one of the districts show priority for development of water and fodder resources, improving crop productivity and improving health control measures for livestock. Keeping in view the needs and priorities of the state, they recommend developing an integrated programme for improving natural resources along with improving crop and livestock productivity.

Veer-Singh et al. (2001) characterised smallholder dairy farms in typical mixed crop–livestock mountain farming systems in the hills of Uttaranchal. An inventory was made from 12 villages, chosen to represent different altitudes and existence or otherwise of dairy co-operative society, in four community development blocks in two milk sheds of Almora and Nainital. While mixed crop–livestock farming was common, use of dairy–manure with buffalo and dairy–manure–draft with cattle were the main types of large animal sub-systems. Majority of smallholder dairy farms operate under small- and medium-scale production and inputs are internally mobilised with common property resources and crop land being the two main sources of feed for animals. In contrast, market-oriented dairy farms in the villages with dairy co-operative societies purchase feed for their animals. Dairying emerges as one of the most important dimension of diversified mountain agriculture to reduce risks and derive economic benefits. However, feed–fodder resources emerge as the main constraint considering the fact that requirement of villages far exceeds availability of feed and fodder. Singh et al. (2001) studied dynamics of livestock population, composition and milk production in hill state of Uttaranchal for the period 1961 to 1999. Analysis of data

from census reports on species wise population showed that there is overwhelming increase in population of buffaloes (55%) and of goats (50%) while there is decline in population of cattle and sheep. Milk production in Uttarakhand hills has shown impressive increase of 71% in the period 1979–1999–2000. The authors indicated that most of the livestock production is by smallholders since they predominate in the state and that spurt in tourists has offered good market for livestock products. They pointed out that there is shift towards market-oriented production and recommended well-planned institutional and technological intervention.

According to Pal (1998), the *Eastern Himalayan region* mainly covers two states—Sikkim and Arunachal. Pal (1998) described livestock production in these two states of Eastern Himalayan region and indicated that cattle, buffalo, yak, sheep and goat are the main livestock species and that their relative concentration varies between outer Himalayas and high reaches. Rangnekar (1995) described the prevailing farming system with detailed account of livestock production system in Sikkim. Rangnekar (1995) indicated strong relationship with social aspects, besides ecology. Yak and sheep are the main livestock species in high reaches and the husbandry practices are migratory. These animals are driven into high hills for grazing in summer and return after October. Cattle and goat are the common livestock in outer areas of Sikkim and buffaloes are kept in valleys. Backyard poultry keeping is common with most families and pigs are reared by 40 to 50% of farmers. According to Rangnekar (1995), goat keeping system in Sikkim is different from other parts of the country since these are housed and fed in bamboo enclosures constructed above the ground.

Rangnekar (1995) further stated that women have a major role in crop and livestock production in Sikkim and observed two peculiar systems. One of the systems is called ADHIYA meaning ‘equal sharing’ adopted by goat and poultry keepers. A farmer not having enough space to keep goat or birds gave these to others and the income is shared. The other traditional system is PEWA followed by some communities. In this system goat and chicken are purchased and reserved in the name of daughters. Whenever the daughters get married they take these goats and poultry with them and may sell whenever there is exigency. These systems signify social link of livestock. Livestock are kept mainly to meet family needs and surplus is sold in the market. However, in this state also demand for livestock products is growing fast and there is scope for the farmers to derive benefit from it. The situation in Arunachal Pradesh is to some extent comparable to Sikkim except that besides cattle, yak, sheep and goat other species of importance are mithun and pigs and buffaloes are not common. Goat and pigs have place of importance as preferred sources of meat. Pal (1998) pointed out that livestock in these states has not received attention and there is need to study the systems so as to decide appropriate development and technological interventions.

The reports referred to above recommend the need for clearer understanding of interaction of social–economic–ecological factors and livestock farming and choose technological and institutional interventions that niche well in the region.

5. Livestock in the livelihoods of families in the plains of northern India: The case of Rajasthan

Much of Rajasthan is arid or semi-arid and livestock production has a special place from economic as well as social viewpoint. Livestock made substantial contribution to domestic product of the state and livestock keeping is a way of life for many social groups in rural Rajasthan. This state

presents a scenario wherein interesting inter-relationship between ecology, social structure, cropping and livestock keeping can be seen. A transect study of Rajasthan from North–West to South–East would reveal that as ecological conditions change from arid to semi-arid to sub-humid and humid so would the cropping from pearl millet–maize to paddy–wheat rotation. Socially, north-western Rajasthan is dominated by pastoral–agro-pastoral communities while the south-eastern is dominated by tribal farmers. North-west Rajasthan is dominated by cattle, sheep, goat and camel of defined breeds while in south-east Rajasthan most livestock are non-descript. A major change in the last decade or so is shift in livestock composition in favour of buffalo and extension of canal into some of the northern districts has changed cropping pattern and farming system.

The transhumance system

In north-western Rajasthan, extensive and transhumant system of livestock keeping predominates. The system has been studied and described by different scientists (IDS 1985; Bharara 1992, Koller-Rollefson 1994; Rangnekar 1994). Livestock keepers migrate every year, soon after rains, in search of fodder as well as sale of livestock and livestock products to resource rich areas of south-eastern Rajasthan and adjoining states. Migration resulted in evolution of well-knit system, involving farmers from resource rich areas and pastoralists from dry areas and an interesting system emerged complimentary to both the groups. Migration is so well planned that not only the villages on their migratory route are decided in advance but also the farmers on whose fields the families would camp with their animals. The farmers are well aware of the benefits of herding animals on their fields considering the fact that farmers provide fodder and even food for the families and in some cases even pay money and book the herds/flocks in advance. However, the system is breaking down and conflicts arising between pastoralists and farmers at many places mainly due to irrigation and intensification of cropping and shrinking of common property resources.

Pant and Sharma (1995) reported results of a study on role of livestock in farm economy in semi-arid region of Rajasthan by conducting surveys of different groups of farmers. They reported that amongst all groups of farms surveyed, goats were the main animal species kept by the farmers and accounted for 63, 68 and 50% of all animals kept by the small, medium and large farmers, respectively. They showed that on average, livestock contribute more than 25% of family income of small and large farms and 19% for medium farms and provide 45 to 50% of employment. Contribution from livestock decreased with size of landholding.

Small ruminant production

Studies carried out on feeding of goats and constraints faced by goat keepers reported by Conroy and Rangnekar (1999, 2000) showed that feeding systems and constraints vary according to the resources of the keepers and conditions in the area. The studies were carried out in parts of Rajasthan and West Gujarat under BAIF/NRI project and the results showed that feeding systems are influenced by social factors also (besides resource base of the goat keeper). The study also showed that, contrary to the general belief that goat production is with zero input, most keepers provide supplementary feeding to pregnant and high milk producing goats. Goat keepers have their own way of coping with scarcity conditions and they adjust the numbers according to resource availability, and migration is resorted to as the last measure (except for nomadic groups). Stopping breeding is another way of coping with scarcity. Degradation of CPRs is one of the major

constraints besides health problems (especially with the newly born). Other major constraints are absence of organised marketing system and credit facility resulting in dependence on middle men for sale of animals and getting credit in times of need.

Livestock in mixed farming

Ray (2001) studied bovine composition, milk production at household level and its interface with formal and informal milk market, functioning of dairy related rural institutions with the objective of understanding problems and prospects of dairy industry in Rajasthan. He reported that there is perceptible change in composition of bovine population of the state within last decade or so. There is clear indication of preference for buffaloes by the farmers, and increase in total milk production in the state is largely contributed by increase in dairy animal population and very little due to increase in productivity. An interesting observation is that average milk yield of buffaloes is comparable to that of crossbred cattle, indicating that potential of crossbreds is not exploited. Adoption of artificial insemination and crossbreds is poor in Rajasthan. Ray (2001) reported that maintenance cost of dairy animals is higher in villages with irrigation as compared to dry villages due to differences in feeding practices and availability of grazing land. He further stated that although milk production activity is not loss making, but high maintenance cost does not indicate good health of milk economy. With degradation of grazing lands, feeding costs are likely to increase further. The farmers were found to retain 35 to 40% of milk for home consumption and primary objective of milk production seems to be for meeting family needs. The study reveals that co-operatives do not play major roles in milk marketing, and thus informal sector has major share in milk marketing. In conclusion, he stated that if rural poor are to benefit there is need to improve productivity of dairy animals, feed resources and efficiency of dairy co-operative societies.

Singh and Pande (2000) studied changes in interrelation between crop and livestock enterprises and household income in Sri Ganganagar and Jaisalmer districts of Rajasthan for the period 1967/68 to 1999/2000. While there was negative growth in ovine population in Sri Ganganagar district, there was 315% growth in ovines in Jaisalmer district (goat 363 and Sheep 286%). Positive growth in dairy enterprise was noticed in both districts and share of income from milk to family income rose up to 30%. Singh and Pande (2000) observed that investment in livestock has increased considerably and there is increasing interdependence between household income and crop and livestock. Singh and Pande (2000) recommended that development policy for crop and livestock development should not be uniform but should consider local situations and all related aspects.

Sharma and Sharma (2004) reported results of a study carried out in semi-arid parts of Rajasthan to estimate income and employment generation from crop and livestock production with different land holdings. The study was based on data collected from 60 farmers belonging to 4 villages adopted by the Agricultural Research Station since the year 2000. The farmers were classified into four categories based on land holding, viz. marginal, small (up to 2 ha); medium (2 to 4 ha) and large (4 ha and above). Amongst livestock the farmers kept cows, buffaloes and goats. Data were gathered from five farmers randomly chosen from each group and analysed for total cost of production, farm business and family labour income. Results show that average income from farm business (crops) and family labour was INR 47,198 and 32,448, respectively, and the incomes increased with landholding. Average farm business and family labour incomes from dairy farming were INR 27,669 and 27,059 respectively. The contribution of crop farming to the family income

was 64.8% and that of dairy farming 35.2%. However, dairy enterprise provided more employment (338 mandays) compared to crop farming (219 mandays) and per worker employment generated from crop and dairy farming was 80 and 123 mandays respectively. Sharma and Sharma (2004) concluded that dairy farming plays a key role in generating employment and income.

A study of diversification in crop, livestock and other activities (farm and non-farm) along with gross income of 465 farm households was undertaken in nine agro-climatic regions of Rajasthan and sampled small, medium and large farmers. Reporting the results of the study, Singh and Verghese (2004) stated that average size of the family ranged between 6 to 9 members and landholding between 1.93 to 5.05 ha, with an average of 3.71 ha. Data on crop diversification showed that it was moderate in 6 regions and no diversification was reported in 3 regions, probably due to semi-desert conditions in one case and dominance of tribal farmers in the other. However, interesting finding is prevalence of high degree of diversification in livestock activities amongst majority of households. It was reported that 75% of the households had 2 to 3 livestock activities and 3% had 5 or more livestock activities and only 3% did not have any livestock component on their farms. Analysis of data for gross income from different components showed that average household gross income, for the whole sample, is 51.58% from crops, 20.65% through livestock, 10.60% through hiring out of resources and 17.17% through non-farm activities. The study also indicated that the income from crops, in relative and absolute terms, increased with farm size; however, livestock income increased with farm size in absolute terms, while its relative contribution decreased. Share of non-farm income was more for smallholder farm households. Thus the study reiterates importance of livestock production for Rajasthan and particularly for smallholders.

Small ruminant production in Rajasthan has been studied extensively in view of its importance for the state. Sagar and Ahuja (1990) carried out studies on goat production systems in some districts of Rajasthan and reported that for smallholder farmers goat production contributes substantially towards their income while it is the sole source of employment and income for pastoralists. Results of performance recording taken up under Indo-Swiss project in a number of villages of some districts of Rajasthan were analysed and reported by Groot et al. (1993). The results show that Sirohi breed of goats has potential for high productivity through improved management and can serve as a dual-purpose goat (meat and milk) and contribute substantially to family income.

Rawat et al. (1993) reported results of a survey study on economic status of sheep farmers of Tonk district, a semi-arid area of Rajasthan. Survey was undertaken in six villages of the district and covered three categories of farmers, viz. marginal (<1 ha), small (1–2 ha) and other farmers (>2 ha). Most of these sheep farmers possessed goats and a few owned cattle or buffaloes. Data was analysed to work out gross income, net income and benefit–cost ratio and the results show that best benefit–cost ratio was found with smallholder farmers. The combination of having mostly sheep, a few goats and a few bovines on a 1–2 ha land generated maximum returns per sheep farmer in the semi-arid area.

Kumar (2000) reported results of study conducted in three districts of Rajasthan (Ajmer, Tonk and Jaipur) to identify problems faced by sheep growers. The report draws attention to the fact that Rajasthan state has 25% of India's sheep population, produces 40% wool and 30% mutton; however, there is need for considerable research and development effort to improve sheep productivity. Information was gathered by interviewing farmers from 10 villages of each of the three districts to identify problems and a ranking exercise undertaken to understand their importance as perceived by sheep rearers. The problems identified as most serious by the sheep rearers are:

lack of grazing area, presence of *Prosopis juliflora*, scarcity of green fodder, lack of medicines and veterinary doctors. The report mentions that most sheep farmers use traditional knowledge and medicine for treatment of their animals and there is need for integration of traditional and modern systems for maintaining health of the animals. The results of study indicated need for an integrated approach covering feeding, health control and marketing aspects. There is good scope to substantially improve family income through such approach.

Tribal production system

A series of studies carried out by Rangnekar (1992), Rangnekar and Rangnekar (1996 and 1999) on livestock and poultry production by tribal women in Rajasthan and Gujarat indicated that their animal and poultry management systems and perceptions and priorities are different from non-tribal farmers. Their production system is low input–low output system. Most tribal families own livestock (small or large animal), many of them have a mix of species and most of these are non-descript. Backyard poultry keeping is also very common amongst tribals. However, many families now own improved animals as a result of special development programmes of the Government. While most animals are grazed, probably in view of proximity of forests, it is a common practice to keep the animals in the house at night. Supplementary feed is offered only to productive animals and usually it is home made mixture. Amongst tribal families, the contribution of men folk in livestock production is minimal and the women are responsible for production as well as marketing activities. Thus the women are overburdened and have to manage the activities within resource and time constraints (majority of tribal families are resource poor and organisational support is lacking). However, in some areas of the country successful efforts have been made by governmental organisations (GOs) and non-governmental organisations (NGOs) to develop village level organisations and provide services while in many areas they have still remained away from mainstream. Although livestock and backyard poultry make major contribution to family income and nutrition, the majority of women are not aware of the possibility of improving their productivity and thus the family income. However, majority of women were not willing to keep more number of animals or birds in view of limitation of time and resources. They are also not willing to keep improved animals or birds with high production potential as these are considered risky. The tribal women prefer assured subsistence to risky high productivity.

Rangnekar and Rangnekar (1996, 1999) studied traditional poultry production system in the tribal belt of the country along the borders of Gujarat, Rajasthan and Madhya Pradesh. The results of studies showed that traditional/backyard poultry not only has an important role as source of small cash to the family but is important from the view point of family nutrition. Comparing traditional and modern commercial system of poultry production from development perspective, Rangnekar and Rangnekar (1996, 1999) indicated that the former scores over the latter in many respects. Some of the main favourable aspects of traditional poultry production system are: low initial investment, better sustainability, no dependency on outside agencies and direct benefit to women. The studies show that traditional poultry is mostly in the hands of women and they have control over the use of its products and income and thus the family has better chances of benefiting from its development. Rangnekar and Rangnekar (1996, 1999) pointed out that backyard poultry has a social value also for these families and its importance is evident from the fact that most of the tribal families keep a few local birds in their backyard. The reports also pointed out some constraints faced by the families like losses due to disease and predation and in some areas lack of marketing support.

They draw attention towards need for research to make available heat stable vaccine and proper housing to control chick mortality, develop suitable feeding system and to develop village level organisations for market support.

6 Livestock in the livelihoods of families in the Eastern states

North-Eastern states

There are only a few studies on contribution of livestock to livelihood/family income from North-Eastern states and that too from two states. According to Prasad (1993) Eastern Himalayan range covers all the eight states and recommends development of integrated crop–livestock farming considering the ecosystem and resources available. According to Prasad (1993) livestock production niches well with socio-economic and agro-ecosystems of the region and livestock-based farming system has great relevance for the region. According to him, livestock-based farming can also improve family income substantially. Prasad (1993) pointed out that good quality forage could be a constraint to improving productivity; however, there is vast potential to fit forage crops in the agricultural systems of the Eastern Himalayan region. He identified a number of potential niches for forage production in the hills for cropped and non-cropped lands. Some of the major recommendations include: growing grasses and trees along terrace risers/bunds and farm bunds; developing horti-pastoral system; growing high density maize and rice beans and thinning them to get fodder and allow grain production and developing silvipastures on waste lands etc. He also recommended introducing production of farm-yard manure and biogas system for proper use of waste.

Yak and mithun, referred to as the ships of the highlands, are a good example of integration of agro-ecology, subsistence livelihood, culture and livestock rearing. These animals are of special importance in the hills, at an altitude above 2,000 masl, considered almost sacred in view of their ability to survive those harsh conditions and multiple use.

Reports from Meghalaya

Goswami (2002) reported results of an exercise to develop optimum farm plans in eastern hill state of Meghalaya. Farming systems in valley cultivation and terrace cultivation covering horticulture, plantation crops, livestock and fodder crops were studied. Data from 40 farmers involved in farming since 10 years was studied at the existing and improved levels of resources (capital and labour). Analysis of data showed that systematic farm planning can improve productivity even under existing resource conditions and improvement in resources can substantially improve the farm income.

Reports from Assam and Arunachal

Saikia (2000) carried out study in three villages of Jorhat district of Assam and the results showed that while number of livestock and poultry has increased the number of draft animals has gone down. The study showed that use of draft animals is for a total of 116 days, of which 56 days use is

for crop production and 51 days for transportation and other uses. Livestock and poultry contribute 22% of family income on average. Thus livestock are an important source of supplementary income and employment as well as source of draft. Bhowmick and Sarma (2000) drew attention to the importance of livestock in the farming system and its strong social and cultural linkage for the rural society of Assam. Livestock keeping is a way of life in this region and an important source of supplementary income and employment for the rural families; however, their productivity is low and hence the income generated is also low. Bhowmick and Sarma (2000) strongly suggested improvement in productivity of livestock for income enhancement, along with development of resource base of the farmers and marketing facility.

Rao (2000) described agro-climatic conditions in Arunachal Pradesh and provided information on population of major livestock species in the state. He pointed out that besides cattle the state has sizeable population of yak, mithun and pigs, the three other species that are important in the economy and nutrition of the families. Mithun is found only in the North-Eastern states of the country, and has socio-economic and cultural importance. Rao (2000) stated that while efforts are being made to improve livestock production and to set up dairy co-operatives, there is need to take holistic approach and develop feed resources, livestock services and improve awareness of the farmers.

Pig production

There are very few reports on pig production and their contribution to livelihoods of the rural families probably because their contribution to national GDP is very low, pigs are still considered scavenging animals and that the underprivileged are involved in pig production. Pig keeping is important in eastern states of the country and particularly for the tribal communities.

Sethi (2004) in a recent report drew attention to the scope of developing pig production in the hill region of Arunachal Pradesh. She reported that in the state pig meat is most preferred, its rearing most common and every tribal family rears pigs; however, there is acute shortage of pork in the state and its price is high. The report concluded by indicating that there is scope to develop pig production as a viable enterprise as the demand for pork is high in the region. It is suggested that the pig rearing methods have to be improved by introducing appropriate technologies and farmers' organised for marketing.

7 Livestock economics related studies on contribution of livestock to livelihoods with a farming systems perspective

Although a farming systems approach to livestock research and development has been recommended since many years, its adoption has been very limited.

Reports from Andhra Pradesh

Results of a whole farm modelling exercise, based on time series cross-section data from villages of dry-land tract of Peninsular India are reported by Bhende and Venkataram (1994). The results

showed that diversification of farming into livestock rearing augments farm income and reduces income risks in dry-land areas where crop production is unstable. Risk efficient plans are derived using a quadratic risk-programming model.

Reports from Haryana

Singh and Gangwar (1989) reported results of studies on economics of milk production from farmers from dry, semi-dry and wet areas of Haryana. They compared economics of cow and buffalo production and reported negative returns from cows from all the three regions and positive returns from buffaloes, probably due to better yields and higher price for buffaloes. Milk yield of cows as well as buffaloes was highest in semi-dry areas of the state compared to other areas. Based on the results of the study Singh and Gangwar (1989) recommended that milk production is preferred in dry and semi-dry zones of the state for its income stabilisation effect.

Sheokand et al. (2000) reported results of a study conducted in Haryana state to compare economics of three farming systems (arable, buffalo rearing and mixed farming) in a rice-wheat cropping sequence. The study involved 300 farmers belonging to 5 landholding categories (landless, marginal, small, medium and large). Analysis of income expenditure of each of the three farming systems showed net returns of INR 6,326; 3,904 and 10,966 per hectare, respectively. The net return over gross expenditure for the three systems was found to be 22.3; 24.1 and 25%, respectively. The authors concluded that gross and net returns over investment as well as employment generation are higher for mixed farming compared to other farming systems.

Watershed programme is a major intervention taken up in rainfed areas of the country since last 15 to 20 years and mixed results are reported from different parts of the country. Arya et al. (1994) studied impact of integrated watershed programme on the farming system and village economy in Shivalik foot hills. The results show that villages derive 54% of total income from livestock, 33% from crops and the rest from off-farm activities. Arya et al. (1994) reported that during the seven years period of study the number of cows and buffaloes increased while that of small ruminants decreased. While availability of fodder and concentrates increased substantially, the gap between demand and supply did not narrow due to change in livestock composition (increase in number of large animals). Villagers earned about 25% of their total income from migrating animals and that helped in reducing inequalities between families. Effective participation of people in the programme for increasing productivity on a sustainable basis is recommended.

Reports from Gujarat and Maharashtra

Patil et al. (1993) reported results of a modelling exercise made to design new farming systems with crop and dairy, for conditions representative of rainfed farming around Baroda in Central Gujarat. Linear programming was used to optimise the number, type and production level of cows that could be maintained on feed from different cropping patterns. Use of urea treated straw or stover or supplementary concentrate for feeding dairy cows was tested and found to increase milk production, especially in more productive cows. Patil et al. (1993) concluded that the mixed farming system is more rewarding than crops or cash crops alone, provided the animal productivity is adjusted to feed resources.

Kapse and Patil (1995) reviewed livestock development programme in scarcity zone of western Maharashtra (Ahmednagar and Solapur districts) by analysing data for the period 1978–87. They reported increase in population of livestock and poultry and replacement of uneconomic animals by more productive animals by the farmers. The changes, however, did not result in improvement in income and employment due to lack of support in marketing and services.

Shiyani and Singh (2004) analysed crop–livestock enterprises existing in different zones of Gujarat state from the viewpoint of livelihood sustainability by estimating profitability of major crop–livestock production systems in Gujarat state. They enumerated a total of 2,793 households from 25 villages, covering all the agro-climatic zones of the state and identified 49 crop–livestock production systems. Primary data were gathered by surveying 1,200 farmers to study economics of the whole farm. The results of the study show that buffalo + paddy + fallow + summer paddy + sugar-cane production system gave maximum net profit of INR 26,904 in Zone 1 whereas buffalo + crossbred cow + sugar-cane emerged as the most profitable system (INR 64,298) among all the systems in the state. However, in rainfed Saurashtra region buffalo + groundnut + fallow + fallow and buffalo + groundnut + wheat + fallow were found to be most profitable. Shiyani and Singh (2004) concluded that concerted extension efforts and appropriate technological support is needed to popularise most profitable system and to further improve it.

Reports from Madhya Pradesh

Rathi et al. (2000) reported results of a study carried out in a block of Jabalpur district of Madhya Pradesh to examine income generation in a mixed farming situation. Data were gathered from randomly selected 45 farmers who indulged in milk and crop production activities. The study reveals that crop cum livestock farming was the most suited strategy for risk aversion by the farmers. Average number of milk animals owned by sampled farmers ranged from 3.7 to 10.9 animals per farmer. Farmers with large herds were found to be the most efficient in resources use. However, major income was from sale of milk irrespective of farm size and share of farm income from milk increased with unit size and share was highest with large group (18.6%) and lowest in small group (16.4%). Rathi et al. (2000) concluded that research effort need to be put in to improve productivity and thereby increase income of the farmers.

Reports from Orissa

Behera and Mahapatra (1999) reported employment and income generation from a pond-based integrated farming system project at Orissa University of Agriculture and Technology at Bhubaneswar. The system consisted of pisciculture, agro-forestry, poultry, mushroom, coconut, apiculture and biogas systems. Cropping system included vegetables and fruit crops along with spices and coconut used in a three-storey system. Apiculture provided highest returns, followed by pisciculture while poultry and mushroom enterprises gave low returns. Highest employment (of 180 mandays per year) was generated by mushroom cultivation. Integrated farming system generated a net income of INR 58,360 and employment of 573 mandays per year on 1.25 ha of land.

Tiwari et al. (1999) carried out investigations to determine an economically viable and sustainable mixed farming model for tribal farmers with an average land holding of 1.5 ha. Six different viable combinations, viz. (i) arable, (ii) mixed farming with two crossbred cows, (iii) mixed farming with two buffaloes, (iv) mixed farming with two crossbred cows and fish, (v) mixed farming with two

buffaloes and fish, and (vi) mixed farming with two crossbred cows + 15 goats + 10 poultry + 10 ducks + fish were developed to find the best combination. The last combination (no. vi) was found to be the best with net income of INR 44,911 per year compared to others and arable farming alone provided net income of INR 24,091 per year.

Reports from Tamil Nadu

Saleth (1997) conducted study on a sample of 218 households selected from four villages representing different agro-climatic conditions in the district. Data gathered from these families were analysed to: (1) study economic and non-economic factors behind variations in crop–livestock diversification; (2) assess the effects of diversification on overall performance of enterprises; (3) evaluate the relative occupational diversification of farm groups both in the employment and income domains and (4) indicate certain design and policy requirements for an effective diversification strategy for smallholders and the landless. Saleth (1997) concluded that the income and employment of the poor rural groups can be considerably improved by changing the size and composition of livestock enterprises in favour of dairy animals. Besides livestock production, rural non-farm occupation can also play a key role in providing employment and income.

Arunachalam and Thiagrajan (2002) reported results of a field survey of 300 livestock farmers in 5 regions of Tamil Nadu to understand the buffalo farming structure and income for the farming families. The study revealed 23 combinations of crop–livestock, involving 7 species of livestock in the region. It was observed that combination of buffalo and poultry predominate in North and Cauvery delta region and buffalo and goat in the West and South regions of the state. However, in the high rainfall region, draft bullock and poultry along with buffalo predominate. A large number of farmers were found to prefer three types of combinations of species with buffaloes. Study also showed that farmers in the west region, with buffalo, cow, poultry, goat and draft bullock combination, earned an income of INR 3,885, while farmers from southern region, having combination of buffalo and poultry earned least income of INR 1,024.

Reports from Uttar Pradesh

Shukla et al. (1994) analysed data from a sample of 60 marginal farmers from Rampur district of Uttar Pradesh using linear programming technique to examine potential for increasing income and employment. They tested options of incorporating two levels of dairy production with crop production. The study revealed that scope for increasing employment and income from crop farming alone is severely limited for small land-holders. They further reported that dairy production comes out as a very potent and easily operational way of increasing employment and income, along with crop production. They pointed out the need for strengthening credit facility and services to improve the potential and make it effective in removing poverty. Data from 10 marginal farmers from 6 villages were further analysed by Shukla et al. (1995a), using Linear Fractional Programming technique for farm planning to maximise profitability. They developed two optimal plans with optimum mix of crop–livestock and off farm wage employment that can substantially improve the income base and efficiency of capital use. They concluded that a combination of good buffaloes and crop production provides highest returns and maximum employment; however, milk price critically influences the outcome.

Singh and Sharma (1988a) reported results of analysing data from 67 farmers from two districts of mid-western region of Uttar Pradesh to examine possibilities of improving income and employment. Five farming systems were identified with these farmers and data from these farms were subjected to linear programming and optimal systems developed introducing borrowing, improved technology under two situations, i.e. restricting livestock numbers and not restricting livestock numbers. Analysis indicates that the optimal systems, without restriction of livestock numbers, increased income by 11% and employment by 28%.

Summary of findings

There are very few studies on contribution of livestock to the livelihoods of the underprivileged. Reports from only 11 states could be gathered:

1. These reports relate only to generation of income and employment and hardly any address family nutrition, asset development, change in knowledge and awareness etc.
2. There are many more reports on generation of employment and income from dairy production compared to those on small animals and backyard poultry.
3. Studies showed that crop–livestock mixed farming can increase income to the extent of 20 to 30% and employment by 40 to 50% from smallholder farms. Livestock generates more employment than crop production.
4. Mixed crop–livestock farming system prevails in India, however, within this system a number of combinations exist and attempts have been to define typologies based on agricultural and socio-economic aspects.
5. Some studies report existence of a variety of production systems in rainfed area with as many as 27 crop–livestock combinations, using 7 livestock species.
6. Reports indicate that dominant or preferred livestock species differ with farming systems:
 - a) In mountain farming systems smallholders are common and dairy production is the most preferred/suited.
 - b) In rainfed semi-arid conditions small ruminants predominate.
 - c) In higher rainfall areas of eastern India mixed farming with a combination of paddy, vegetable, dairy, fish, goat, poultry and duck are common.
7. Very few studies are planned to understand production systems of the resource poor and the underprivileged rural families.
8. Demand for livestock products is growing fast in developing countries and there is scope for improving income of livestock farmers.
9. Farmers from higher strata derive more benefit from livestock than resource poor farmers in absolute terms, however, in relative terms contribution of livestock to family income of resource poor is high.
10. Resource poor/underprivileged farmers can also get good benefit from growing demand of livestock products provided they get support for credit and marketing (institutional support), and access to livestock services (including extension).
11. Reports from Kerala studies on livestock sector provide a good lesson for flexibility in approach according to changing situation (farming system or market). Analysis by economists showed that dairying developed at good pace during the period 1965 to 1995 and then it has stagnated. Reports since last few years indicated rise in cost of milk production due to problems of availability and cost of feed and labour cost. Changing

farming system is indicated as the main causal factor and milk production may not remain attractive and developing meat production alongside milk is suggested as an alternative.

12. Major constraints faced by the resource poor farmers pointed out through the studies are:
 - a. feed resources and use
 - b. animal health problems
 - c. accessibility of livestock services
 - d. credit and marketing services.

8 Studies assessing contribution of livestock to livelihoods and evaluation reports of livestock development projects

Distribution of livestock is more egalitarian than that of land and has the potential to contribute to poverty reduction (Birthal and Rao 2002).

Reports from Uttar Pradesh

Two evaluation reports of development projects in parts of Uttar Pradesh that were available for review indicated that livestock production, particularly dairy production, can generate additional employment and income for smallholder farmers. Kushwah et al. (1986) reported results of a survey study conducted in Ghazipur district of Uttar-Pradesh to assess impact of a development project of Small Farmer Development Agency (SFDA). They reported that contribution of livestock to farm income was more for marginal farmer families (30%) compared to other categories (20%).

Ex post evaluation of Mini Dairy Project in Uttar Pradesh was commissioned by National Bank for Agriculture and Rural Development (NABARD 1997) and financial viability analysis was undertaken. The project provided credit facility for purchase of two crossbred cows, two buffaloes or four buffaloes in two blocks of Allahabad district. A total of 112 families were surveyed and the results showed that both crossbred and buffalo units were viable and returns were higher for buffalo units. However, repayment of loan was unsatisfactory since 60% of the households were defaulters. The report makes three main recommendations for improving benefit to smallholders (i) supply better quality animals (ii) provide a second set of animals (iii) ensure service support and feed–fodder availability.

Reports from Gujarat

Two reports on evaluation of development projects were reviewed and their findings summarised below. Sharma (1991) carried out a study to assess changes in income level of the recipient households, to examine equity aspects and to look into factors affecting the income level of households from livestock schemes under Integrated Rural Development Programme (IRDP) in Ahmedabad district of Gujarat. Income levels of the households were assessed at two points in time, viz. 1985–86 and 1988–89 over the base year of 1982–83. Main target groups in this IRDP were the underprivileged with annual income between INR 3,500–4,800 and belonging to backward class, women-headed families, small and marginal farmers and landless families

(poverty line was raised to INR 11 thousand during the period 1985–90). Sharma (1991) reported that there was improvement in income levels of all the groups in the long run. Out of 182 in the lowest income group 125 could cross the lowest income category and 30% moved out of poverty line; however, 25% remained below poverty line. Analysis of income distribution (Gini coefficient and developing Lorenz curves) showed a trend of inequality. Studies of employment showed that households could get employment in the range of 121 to 240 mandays and livestock production was the main subsidiary activity. Families from villages with better infrastructure benefited most and Sharma (1991) recommended multi-pronged approach for an impact on economic status of the rural families.

NABARD (1994) undertook *ex post* evaluation of a project in Valsar district in which credit facility was provided for purchase of bullocks, bullock carts, crossbred cows and oil engines to families below poverty line. Report is based on survey of 80 farmers from 2 blocks of the district belonging to tribal and non-tribal families. Estimated net income accrued by the families averaged INR 4,866 from crossbred cow, INR 2,988 from local cow and INR 3,160 from buffaloes. The families who purchased bullocks had low income and could not cross poverty line. The report emphasised the need to strengthen linkages, ensure better quality services for improving benefit to the families.

Reports from Haryana and Punjab

Results of detailed economic evaluation of Intensive Cattle Development Project in Karnal District of Haryana reported by Singh and Sharma (1988b) indicated a favourable benefit:cost ratio of 1.48, high internal rate of return and a payback period of eight years. They concluded that investment made through the project was economically sound and justifiable taking into consideration improvement in productivity of dairy animals.

Reports from Kerala

Kerala is one of the few states where livestock development projects have been periodically analysed; however, most of these studies relate to dairy production. An exception is that of Yeshwant (1990) who reported that contribution of livestock to agriculture in Kerala is second only to coconut (in that period). He pointed out that cattle are most important amongst livestock followed by poultry and then goat and sheep (Kerala is known for plantation crops like coconut, arecanut, cashew and now rubber). He further indicated that livestock development would be very useful in improving and stabilising income of the farmers and emphasised the need for improved breeds and feed. Yeshwant (1990) drew attention towards the need and potential of exploiting meat production to improve returns from livestock through goat and cattle (Kerala is one of the few states where cow slaughter is permitted). Livestock economy and cattle development related studies were reviewed, data analysed and findings published in two useful publications by George and Nair (1990) and George et al. (1990). The reviews showed that livestock are an important source of employment and income. However, much of the space in these publications is devoted to dairy production probably because dairying has a major share in livestock production. Both the reports drew attention towards stagnation of dairy production and constraints in its progress, like shortage and high cost of feed and low reproductive efficiency. These reports also indicate limited scope for developing feed resources through fodder production in view of prevailing plantation-cropping

system in the state which has made land scarce. Both reports strongly suggest developing poultry and small ruminant production, as these are likely to niche well in the changing farming system.

Report of Krishnan (1997) on evaluation of an Integrated Development Project through survey of 20 families below poverty line and 20 above poverty line indicated positive impact of dairy production on income and employment. While the report showed higher increase in gross income for families above poverty line compared to families below poverty line (49 and 60%, respectively), the employment generation was not much different (97 and 99 hours). However, repayment of loan was not proper with only 37.5% families repaying loan in full and 35% partially (credit facility was provided by South Malabar Grameen Bank). The authors concluded that scale of financing, type of animals supplied, milk price and livestock services have to be improved for better results.

Reports from Tamil Nadu and Pondicherry

Three evaluation reports of development projects from Tamil Nadu available for review indicated that livestock production improved income and employment of poor families and the findings are briefly discussed. Anees (1989) analysed data from two blocks from Madurai district where dairy development was taken up as part of Integrated Rural Development Programme (IRDP) for poverty alleviation. He reported that the dairy schemes not only brought the families from these two blocks out of poverty but also provided profitable economic enterprise over time. Anees (1989) discussed methodological issues for assessing impact of such projects. He recommended that annual return is a crucial factor and that returns from one vocation be compared with those from other vocations open for the families.

Kannapiran (1992) reported results of a survey study in some blocks of Chengleput district of Tamil Nadu to assess impact of Integrated Rural Development Programme (IRDP) on poverty. The project objective was to improve income and provide employment opportunities through funding support. The survey covered 100 families from landless, marginal and smallholder farm households. Mixed crop–livestock farming was found to have beneficial effect on income and employment.

Prabhakaran et al. (1994) examined economic viability of goat, dairy cattle and sheep in the ASEEFA PLAN International Uthiramerur India project in the state of Tamil Nadu. Analysis of data from 548 participants of the project showed that goat generated higher annual income than dairy cattle and sheep and show best economic viability.

In an independent study, Dasir et al. (1995) assessed contribution of livestock to income of rural households in the Union territory of Pondicherry in South India. Data were collected from 72 households of 12 villages and analysis showed that goat, milch animals and bullocks are preferred in that order by farmers. Investment in livestock accounted for 24 to 33% of the total value of assets and livestock contributed 7.7 to 10.5% of the total annual income of the farmers.

Reports from Maharashtra

Two evaluation reports were reviewed and their findings on income and employment generation differ. Cost:benefit analysis of cattle crossbreeding programme implemented by an NGO, the BAIF Development Research Foundation and the State Government of Maharashtra was undertaken by the Indian Institute of Cost and Management Studies and Research. Their report (Anon 1985) showed that crossbred cows generate 5.2 hours of employment per day as against 3.2 hours by

local cow and is a good source of employment for women who carry out 29% of dairy production work. It was observed that the time spent on dairy animals varies with stage of lactation and that the role of women declines with economic status of the family. The evaluation showed that crossbred cows are economic, making a positive contribution to the extent of INR 0.46 to 0.96 per litre of milk while local cows make negative contribution. Between various crossbreds Holstein crosses are most productive. Production function and response function analysis of milk production showed curvilinear relationship with feeds, its quality and quantity with increasing returns to concentrates and decreasing return to roughages. Feeding accounts for 75% of the cost of production.

Kapse and Patil (1995) reviewed livestock development programme in scarcity prone region of western Maharashtra (Ahmednagar and Solapur districts) by analysing data for the period of 1978 to 1987. They reported increase in livestock population and replacement of uneconomic animals by more productive animals by the farmers. However, these changes have not resulted in increase in employment and income due to lack of supporting services, e.g. processing, marketing, breeding, health etc. They pointed out that there is lack of stable and viable technology for improving feeding and management of livestock.

Reports on women and livestock production

It is a well-known fact that income in the hands of women would be mostly used for the benefit of the family. It is generally believed that women have more control on income from livestock compared to income from other sources. A series of studies by Rangnekar (1992 and 1993) on women in livestock and poultry production indicated that women have more control over income from small stock as compared to large animals. These studies also pointed out that women gave equal weight to non-monetary benefits from livestock as to monetary benefits (milk/meat at low/no cost, status, social value etc.). Rangnekar (1992) recommended that for getting desired benefit from livestock development women's involvement is crucial and planning research and development should take into consideration their perceptions and preferences. Report of Waldie and Ramkumar (2003) based on studies with landless women in dairying in southern states of India projected a vivid picture of the role of dairy animals in women's livelihood. They drew attention to the fact that dairying offers a viable option for landless women for a decent and secure livelihood in rural areas and there is need to recognise their constraints and provide required support (including that of appropriate technology).

9 Contribution of small ruminants to livelihoods

Small ruminant research and development has not received much attention although its usefulness to the poor is recognised since long. Devendra (1992, personal communication) described the major role played by goats in the livelihood of vulnerable section of the rural society of developing countries. He pointed out that goat population in developing countries accounts for 94% of the total goat population of the world and that they are found in all agro-ecological environments. He further mentioned that their importance is indicated by various functional contributions (meat, milk, fibre, skin), socio-economic relevance and stability to farming systems. Analysis of results of studies in various developing countries on the nature of economic contribution by goats showed that the major contribution of goats is through sale of animals (22–26%) followed by sale of milk (20%) and manure (1–5%). He pointed out that social relevance of goats lies in the fact that most

vulnerable sections of society, including women and children, are involved in goat keeping. He recommended comprehensive approach to improve contribution by goats through official support, breed improvement, post-production support and extension and service delivery support. Devendra (1992, personal communication) concluded that such approach only can result in impact-oriented benefits and can directly reduce poverty.

Secondary and primary data were analysed by Kumar and Pant (2003) to examine variation in growth and density of goat population and economics of goat production, using different cost categories. A linear regression model was fitted to look into impact of variables like percentage of people below poverty line, grazing and wastelands, irrigation, bovine density etc. The findings showed that goats not only make significant contribution to Indian economy but are also associated with socio-cultural fabric of millions of rural poor. Goat is an invaluable source of milk and of income through animal sale and is an easily disposable asset in exigency. While goats contribute 7.6% of the GDP from livestock, at the micro level estimated income is INR 28 thousand and INR 6,101 from large and small (with 6 goats) flocks, respectively. Emergence of intensive/commercial goat production system in some parts of the country was pointed out and they recommended that this should be encouraged. Strategic and integrated research and development is strongly recommended to improve productivity and help the resource poor to derive greater benefit from goat production. Integration of production and processing along with breed improvement, improvement of feed resources and health control is suggested.

Reports from Andhra Pradesh

An interesting study was carried out in Andhra Pradesh by Reddy et al. (1990) to assess costs and returns to goat rearing in rural areas. Data from 60 goat farmers having small (20 goats), medium (21 to 40) and large flocks (>40 goats) was analysed taking into account fixed and variable costs and gross returns. The authors report that main investment in goat farming is largely personal unlike other livestock enterprises where feeding accounts for 70 to 80% of total production costs. Results show that variation in production costs between the three flock sizes is very little; however, the net returns are highest with medium flocks. Reddy et al. (1990) concluded that flocks between 21 to 40 are most viable and with marketing support it can be a good source of self-employment and income for the rural poor.

Chowdhary et al. (1995) studied efficiency of various input factors influencing sheep production in Anantpur District of Andhra Pradesh. They pointed out the need for developing marketing support, starting with facilities for grading of wool and establishing market yards and also recommended back up of professionals and institutional finance for the benefit of smallholders and marginal farmers. Their findings from the study showed that flock size made the highest contribution to gross returns and hence availability of easy credit and extension support is necessary. Inefficient use of human labour has negative influence on returns. Animal health is the second major factor influencing returns from sheep production and improving accessibility and effectiveness of veterinary services is strongly recommended.

Vishwaraj (1997) reported results of a detailed study on small ruminant production in Andhra Pradesh, which was taken up by Swiss Development Cooperation. He indicated that as against the situation in Maharashtra sheep production is more popular in Andhra Pradesh compared to goat production. Based on the finding of the study, Vishwaraj (1997) recommended development of dual

type of sheep (for carpet wool and meat), for most parts of Andhra Pradesh, and crossbred for fine wool for selected pockets of the state. Analysing the small ruminant production situation in the state, he pointed out the need to strengthen services (breeding, health, extension and training) and development of village commons to augment feed resources.

NABARD arranged *ex post* evaluation of a sheep scheme taken up by Small Farmer Development Agency (SFDA) in Nalgonda district of Andhra Pradesh. Data were collected from 77 families of shepherd community to work out net income and financial rate of return for the evaluation report (NABARD 1982). The results show that the scheme generated an additional income of INR 2,196 per year for each family after adjusting imputed cost of family labour. The financial rate of return ranged between 25 to 33%, after adjusting for family labour, and is very favourable indicating that the scheme is viable for smallholder and landless families. The report suggests that there is scope to improve performance of sheep units by improving services, feed–fodder resources, availability of crossbred rams and checking mortality.

Reports from Bihar

Pandey et al. (1999) reported results of a study on economics of goat rearing carried out in Chotanagpur region of Bihar (currently part of Jharkhand state). The study involved 65 tribal and 53 non-tribal goat owners. The results showed that capital investment per goat by tribal and non-tribal farmer was INR 404 and INR 518, respectively. The total cost and gross income per goat decreased with increase in flock size. The major investment in goat rearing was labour and very little on feeding as the goats were mainly grazed. Non-tribals spent more on rearing of goats compared to tribals and the gross incomes per goat were INR 430 and INR 266, respectively.

Reports from Maharashtra

Rath (1992) reported results of a detailed and critical analysis of small ruminant production in the state of Maharashtra for Sheep and Goat Commission of the state. The report pointed out clear preference for goats in the state as reflected by high growth in their population and wide distribution. Goat is a major species in about 95% of the villages of the state while sheep prevail only in 1 to 2% of the villages. Rath (1992) reported that goat keeping is more profitable than sheep in the state. He reported that farmers on average keep five goats and will have gross income of INR 1,480 in the first year and INR 1,930 from second year onwards. He pointed out that the existing type of sheep is neither a good meat producer nor a good wool producer and hence most sheep development schemes have failed. However, the report stated that it is only the traditional sheep keepers, like Dhanagars, who inherit large flocks that can stay in business. He further drew attention to the faulty nature of goat schemes formulated for the benefit of the underprivileged families. The development schemes insist on purchase of a minimum of 11 to 12 goats and most families cannot maintain so many animals and thus are not able to take benefit of these schemes.

Gokhale et al. (2002) reported results of survey study conducted in five districts of Western Maharashtra to understand status of goat breeders and their goat management practices. Survey results show that small ruminants constituted 22% of the animal holding of goat keepers and large dairy animals constituted only 2%. Literacy level amongst goat keepers was 59% and age and literacy had no relationship with the number of animals reared by a household. It was noticed that

only 9% goat owners provided constructed housing for goats while 47% provided thatched housing and 36% kept goats in a compound with thorny border.

Reports from Tamil Nadu

Prabhakaran and Thirunavukkarasu (1992) studied goat farming in three districts of Tamil Nadu, involving 120 farmers from three randomly chosen villages, to assess income and employment potential. The results of the study showed that goat rearing is the most sought after enterprise amongst landless and marginal farmers in the study areas. The main reasons indicated for this preference are: minimum investment, good returns and minimum risk. Analysis of data for income and employment generation for farmers of different categories showed that net income from goat keeping was comparable for farmers from all the 3 districts and ranged between INR 1,827 to 1,908. There was variation in net income between different categories of farmers (landless, marginal, small, medium and large) and large farmers earned highest net income. However, contribution of goat production to family income was high amongst underprivileged rural community (landless) ranging between 32 to 42% of their total income and between 25 to 30% for marginal farmers. Estimation of employment generation showed that goat keeping generates 200 mandays of employment per year. Prabhakaran and Thirunavukkarasu (1992) recommended that goat production should be promoted to extend benefit to the underprivileged and the women.

Arunachalam et al. (2002) interviewed 60 farmers from different parts of Tamil Nadu to study different sheep farming structures and income per cattle unit. They reported having observed a variety of combinations of livestock species with the farmers and many farmers prefer to keep more than one species of livestock, with some keeping three species (most common being sheep, buffalo and bullock). Study also showed that income per cattle unit was highest in high rainfall region (INR 3,474), followed by western region (INR 2,890) and low in dry North West region (INR 809).

Reports from Uttar Pradesh

Kushwah et al. (1995) analysed census data and made intensive inquiries in Etawah district about Jamanpari goats as this is the most widely used breed of goats for upgrading local goats in India and neighbouring countries. They reported that population of Jamanpari goats has declined sharply in the last 20 years as also the interest of farmers in maintaining this animal. Kushwah et al. (1995) reported that inquiries made with goat keepers show that high cost of feeding these goats is one of the major reasons for loss of interest. The farmers mentioned that due to shrinking of grazing lands they are required to purchase feeds and fodder and these have become costly. The farmers also mentioned that Jamanpari being a big animal, they need more feed and in view of degrading pastures makes them difficult to get feed supplies. Kushwah et al. (1995) drew attention towards depletion of germplasm of Jamanpari and strongly recommended taking measures to save this important breed of goats.

Deoghare (1997) studied resources, employment and income pattern amongst goat farmers, from Mathura district of Uttar Pradesh, by conducting survey of 451 families. The results show that main occupation of the families was crop production (69%) followed by goat rearing (20%), dairying (10%) and sheep production (1%). Study results show that the contribution to net income/household per year is about 27% from livestock and 73% from crop production. Deoghare (1997) estimated average labour employment/household per year from different livestock sub-systems

and reported that contribution from crops, buffalo, goats and sheep is about 42, 33, 23 and 2%, respectively. This was followed by another study in the same area by Deoghare and Khan (1998) on economics of rearing Barbari goats with farmers having small, medium and large sized flocks. They reported that the cost of rearing goat decreased with flock size, being INR 490 with small, INR 480 with medium and INR 477 with large flocks. However, net annual income per goat was highest with small flocks compared to medium and large flocks. The overall margin over cost 'A' (feeding, hired labour, recurring expenses and depreciation), cost 'B' (cost A plus interest on fixed capital) and 'C' (cost B plus imputed cost of family labour) was INR 705, INR 597 and INR 346, respectively.

Singh (2001) undertook study of socio-economic aspects and production systems of goat keeping families belonging to landless and marginal farmer category. The objective was to help the state and district bodies to plan development interventions according to resource of these families. Flock size was categorised according to the number of goats, i.e. small (up to 5), medium (6 to 10) and large (>10). Results of study show that literacy was lowest with landless (17%) and is higher with medium farmers (21%). The families keep local as well as Barbari breed of goats and the ratio of these two breeds differed with flock sizes. Goats in small flocks were kept mainly for meeting family needs of milk while objective of medium and large flocks is to augment family income.

Summary of observations from reports on small ruminants

- i. Reports indicated that sheep and goats are preferred by the underprivileged families (those from lower socio-economic strata). However, relative preference/usefulness of these animals differs between states, i.e. goats reported to be more profitable than sheep in Maharashtra and the reverse is true in Andhra Pradesh. Goats are seen in almost all villages of Maharashtra.
- ii. In rainfed semi-arid areas goats are reported to be preferred by resource poor farmers over other livestock species.
- iii. Major reasons for preference of small ruminants by families from lower socio-economic strata and women are: low initial investment, low maintenance cost (main cost is labour and feeding cost is low), easy to manage for women, source of small cash for women; easy liquidity and rising market demand, cheap/free source of milk for the family, excellent ability to adopt under varying agro-climatic conditions—even under extreme conditions.
- iv. Goats contribute 15–27% of family income of smallholders.
- v. Commercial goat production is developing in some pockets of the country.
- vi. Constraints/problems for smallholder farmers and landless are: low productivity of most goats, health problems, high mortality in new borne, poor accessibility of health services, lack of organisational support and extension services and marketing and dependence on middle men for marketing, feed–fodder resources and absence of appropriate development programmes.

10 Pig and traditional poultry production and livelihoods

Pig production

Recent surveys show that there is flourishing trade in pigs in Eastern Uttar Pradesh, mostly with local pigs, and there are regular markets held in several towns of Eastern Uttar Pradesh where pigs are sold and taken to adjoining cities, indicating scope for development.

Jain (1992) reported on economics of pig rearing based on a field study in tribal area of Bihar (now a part of new Jharkhand state). He reported that average cost of pigs, calculated on basis of data gathered from tribal families is INR 90 for male and INR 107 for females. Cost of feeding pigs at this age is INR 1.20 and the costs decreased with flock size. Of the total cost of pig production, feeding accounted for 60% and labour 30%. Returns from pig production to a tribal family were 3 to 4 times the cost of production.

A study to examine existing status of pig production, socio-economic constraints in its adoption and economics of pig production was carried out in Haryana state. Data were collected from 16 landless and 14 landholding pig farmers. The major constraints were found to be (1) lack of proper marketing infrastructure, (2) institutional credit facility, (3) cost and availability of good quality feed and (4) animal health services causing heavy losses. A major variation in feeding and management practice was the use of hotel waste for feeding pigs and affected the economics significantly.

Results of study indicated that share of feed cost in total working cost ranges from 45 to 67% with farmers using hotel waste and 52 to 66% for those not using hotel waste. Annual net return per pig ranged between INR 908 to 1,136 for farmers using hotel waste and between INR 713 to 920 for those not using hotel waste.

Pandey (2000) mentioned that while the density of pigs is highest in Eastern region (6/km²) some of the union territories like Chandigarh and Goa and states like Nagaland and Tripura have much higher density (18 to 35/km²). According to Pandey (2000), feeding patterns have highest influence on returns from pig production and mentioned that use of hotel waste in peri-urban areas of Haryana is a useful practice.

Traditional poultry production

Backyard, traditional poultry keeping system has been ignored by researchers and development planners until recently, like most other traditional systems, probably because it is considered backward and its contribution to family income and state and national GDP is not known or considered very low. However, it is now drawing attention in view of a few studies made and reports published of late.

Khan (1999) presented a review of work on indigenous poultry and pointed out that there are 26 local breeds and most of these are not characterised and a few of these have become extinct. According to Khan (1999), two types of indigenous fowls are found in India—one a heavier bird that is good for meat and the other lighter with a potential for egg production. Average production of indigenous poultry is between 60 to 90 eggs and their production can be improved up to 130 to 140 eggs per year through selection and proper feeding (Khan 1999). Similar observations were

reported by Kumtakar (1999) on backyard traditional poultry production systems with tribals of eastern Madhya Pradesh. His studies showed that backyard poultry contributes between 11 to 20% of cash income of the families and losses due to diseases and predation are some of the major constraints. More recent studies by Conroy et al. (2003, unpublished) in villages around Trichy in Tamil Nadu and around Udaipur in Rajasthan showed that predation probably causes more losses in family poultry than diseases and easy to adopt measures (housing) have to be developed in consultation with the poultry keepers.

Dolberg (2004) reviewed information on backyard poultry in Bangladesh and India from the viewpoint of its contribution in alleviating poverty. He emphasised that the objective of development of traditional smallholder poultry is not primarily to increase egg and poultry meat production but to initiate the process of 'getting out of poverty trap'. Thus the contribution to family nutrition, particularly of women and children, enhancing capabilities of women to cope with threats commonly faced by the poor, building assets etc. are important. He discussed results of efforts of DANIDA and IFAD in developing village systems and improving income of the families and pointed out constraints and problems faced by the families involved in this system. Concluding about the situation in India, regarding use of poultry as a tool and starting point for poverty alleviation, he stated that it is important to consider (i) identifying organisations that can facilitate the process combining social and technical competencies; (ii) promoting required research to overcome constraints faced by resource-poor families and generate appropriate technologies (iii) adopting livestock policies that create conducive environment for applying the concept of smallholder poultry production as a tool for poverty alleviation (this would equally apply for livestock in general). He cited examples of development initiatives taken in Orissa and Kerala where poultry and livestock development are proposed to be used as engine for social and economic development.

Summary of observations on pig and traditional poultry production

Although only a limited number of reports are available on pig and traditional poultry production, there is some evidence to indicate that they make useful contribution to employment and income of resource-poor families.

The importance of pig production in Eastern states and Union territories is well-established and available reports show that there is good demand for pork in these areas and through research and development support it can be developed into a viable enterprise. However, there is dearth of information on pig production systems and proper understanding of the systems and constraints is essential for desired results. There are indications that pig production can be very useful in poverty alleviation in Eastern states, given desired support in improving productivity and marketing.

The case of traditional backyard poultry is similar to that of pig production; however, there is more information available in this case as compared to pig production. Encouraging experience of Bangladesh has generated interest in many parts of the country and studies and development projects are initiated. However, there are bottlenecks like high losses due to disease and predation. To control those bottlenecks, appropriate technical and implementation solutions have to be found. Similarly, suitable breeding and feeding interventions have to be found to improve productivity.

Studies, like those reported in this review, have to be initiated in other parts of the country for evolving appropriate approaches.

11 Dairying and livelihoods

Operation Flood was the biggest livestock development programme so far undertaken in India (probably in the whole of developing world). Many international and national agencies supported it, studied, analysed and evaluated it and outcome of the Operation Flood programme has been extensively debated. Most evaluation reports were related to increase in collection, processing and marketing of milk and viability of co-operatives. Very few studies have looked into the impact of Operation Flood on livelihood of producers.

One of the extensive studies on impact of Operation Flood covering all the four regions of the country is by Shukla and Brahmankar (1999). The study is based on surveys involving 2,868 members of the village co-operative societies. The results of the study showed that dairying contributes 27% of the total family income, on an average, and the share is highest in the eastern region. Cost of production per litre of milk was lowest for crossbred (INR 5.4), followed by buffaloes (INR 7.69) and highest for indigenous cattle (INR 7.96). The report indicated that while majority of the member producers are smallholders only 15% members belong to lower social strata and landless category. The report pointed out two major constraints for improving productivity of the dairy animals, e.g. (1) services for health care and breeding and (2) cost of feed and fodder.

Reports from Andhra Pradesh

Comprehensive studies to understand regional variation of bovine sector in Andhra Pradesh were undertaken by Subrahmanyam et al. (1995) and Subrahmanyam et al. (1999). They carried out comprehensive studies on bovine production in all the three regions of Andhra Pradesh and analysed economics aspects in detail. One of the studies compared dairy production in Coastal Andhra and Telangana as these two regions represent prosperous and irrigated and underdeveloped and rainfed agriculture, respectively. The results of this study provided a good picture of relationship between bovine sector and agriculture development. In Coastal Andhra 35.8% and in Telangana 28.7% rural households own bovines, probably due to bovine maintenance being non-remunerative in Telangana. The participation of landless, marginal and scheduled caste in bovine production is low in Telangana, as there is priority for draft power and demand for milk is low and hence there is low emphasis for dairying. This low emphasis on dairying is reflected in sex ratio, low buffalo population besides low crossbred population, low adoption of crossbreeding and virtual absence of fodder cultivation; as compared to agriculturally developed Coastal Andhra. Home consumption of milk is 30% of total production per household in Coastal Andhra as against 42% in Telangana, however, absolute quantities consumed do not differ much (average per capita consumption per day in Coastal Andhra is 161 g as against 159 g in Telangana). The study, however, pointed out that the impact of introducing milk producer's co-operatives differs between the regions. With establishing co-operatives, milk consumption in Coastal Andhra increased, this intervention decreased consumption in Telangana. This finding confirmed that along with market intervention there is need to increase productivity to prevent adverse impact on family nutrition.

The other study by Subrahmanyam et al. (1995) examined economics of dairy production in all the three regions and the findings indicated that intensive dairy areas (Coastal Andhra) produce milk more efficiently. Contribution of bovines to family income also varies considerably between zones of Andhra; it is lowest in South Telangana (10.8%) and highest in Southern zone (18%).

Income generation from dairy schemes, taken up under Integrated Rural Development Programme (IRDP), was studied in Ranga Reddy district of Andhra Pradesh (Venkatadri 1998). Data were gathered from blocks with higher concentration of dairy animals and influence of variables like socio-personal attributes, information utilisation, project intervention and cognitive orientation were studied. The results show that project intervention variables are most critical for technology adoption and that in turn influences income generation amongst resource poor families. Venkatadri (1998) strongly recommended strengthening extension, reducing input costs, improving feed–fodder resources and availability of better producing animals to enable resource poor to get desired benefits.

Reports from Gujarat

A study was conducted in 1997 on the impact of crossbreeding in mixed farming systems in three ecological zones of Gujarat state. Income and employment generated was compared between households with and without crossbreds. Results of survey reported by Patil and Udo (1997) showed that household with crossbreds had higher livestock gross margins compared to households without crossbreds.

Shiyani (1993) carried out studies in Saurashtra region of Gujarat, on economics of dairy enterprise by different categories of farmers and compared results between members and non-members of co-operatives. His results show that dairying was profitable for all classes of farmers and with cows as well as buffaloes and it provided substantial income in form of family labour. However, the income was more from buffaloes compared to cows and landless and smallholder farmers earned higher profit than medium and large farmers.

Reports from Haryana

Sardana and Panghal (1984) surveyed small and marginal farmers from Bhivani district of Haryana state to study income and employment generation from mixed crop–livestock farming. They processed the data using linear programming technique and the results show that through improved technology of dairy production and relaxed capital constraint the income and employment generation from mixed farming can be considerably increased.

Singh (2001) undertook economic analysis of dairy production, from indigenous and crossbred cows, in Karnal district involving farmers from five categories (landless, marginal, small, medium and large). The results showed that dairy production from all types of animals is profitable, however, crossbreds are more profitable. Net profit was found to vary considerably between different categories of farmers as also the income earned from family labour. In the case of indigenous cows, the net profit and family income is highest amongst medium farmers and lowest with landless; while in case of crossbreds it is the large farmer who earn most followed by landless. There is need for further study to explain this phenomenon and whether results are similar from other areas.

Reports from Karnataka

An NGO Sampark (1997) assessed economic and social impact of establishment of village dairy co-operatives, in parts of Karnataka, through survey and participatory discussions with different category of farmers in sampled villages. Quantitative as well qualitative approach was adopted to analyse the information. The results of study showed that families involved in dairying had significantly higher income than non-dairying families. The proportion of income from dairying to total family income was highest in landless and decreased with landholding.

Dixit (1999) while studying bovine economy in Mandya district compared income from local cows, crossbred cows and buffaloes. The results showed that it is only the crossbred cow which earns some profit through milk and family labour, while others make negative contribution.

Reports from Kerala

In view of some studies reporting that dairy co-operatives have failed to reach socio-economically backward sections of rural society, Narayana (2002) carried out a study in Malabar region of North Kerala to investigate status. He undertook studies to examine three questions (i) whether SC/ST have not taken to dairying and are excluded from membership of dairy societies; (ii) whether landless and those with very small land holding are not able to take up dairying and (iii) whether the burden of dairying falls heavily on women. Data were gathered through survey of randomly chosen 50 farmer families each out of members of co-operative societies from three districts in Malabar. The results showed that, like Gujarat, majority of families from lower socio-economic strata and very low land holding are not able to participate in dairying and they are in minority in co-operative dairy society. However, he indicated that illiteracy or lack of awareness is not the causal factor for non-participation in dairy related activities and feed resource may be a factor. The studies showed that participation of women in dairying is great, irrespective of whether they are housewives or working women. The author pointed out the need for a different kind of intervention to look into problems of the economically weaker and landless families.

Reports from Maharashtra

Apte (1989) analysed reports gathered from micro-level studies carried out in three districts of Maharashtra to understand the role of dairying as source of employment and supplementary income for small and medium farmers and landless. Farmers were so chosen that they represented a mix of crossbred and local cows and buffalo owning families. Study results showed that one dairy cow and its followers generated 2 to 3 hours of work per day and an additional cow generated 30 to 40 minutes of additional work. These estimates do not include time spent for grazing of animals. Some of the interesting observations are: (i) work with dairy animals is done in spare time and does not clash with the routine work required to be done by the farmers, i.e. household and farm work and hence the work generated by dairy animals does not get noticed during the cropping season and gets noticed only during off season, (ii) it is difficult to accurately estimate time spent for dairy production, since there is a lot of seasonal variation (farmer's ways of time management), and (iii) most estimates are based on single interviews (Apte 1989).

Autkar et al. (1995) worked out costs and returns from dairy production in rainfed area of Vidharbha region of Maharashtra. Secondary data for the year 1989–90, from different categories of farmers, were used to work out costs and returns from dairy production. The results of analysis indicated that net returns per milch animal per year were INR 52, 409 and 264, with input:output ratio of 1.31, 1.20 and 1.12 for small, medium and large holdings, respectively. They concluded that dairy production in Vidharbha region is at sub-optimal level and there is need for improvement. Autkar et al. (1995) recommended improvement of breed, health and nutritional status of dairy animals through improved services and use of appropriate technologies.

Goswami and Rao (1992) reported results of analysis of economics of milk production carried through a survey involving 60 farmers of different categories. The study involved 22 marginal (<1 ha); 17 small (1–2 ha); 12 semi-medium (2–4 ha); 5 medium (4–10 ha); and 4 large (>10 ha) farmers. The results indicated that feeding accounts for major expenditure on milk production in all five categories of farmers. The total cost of production/cow and lactation yield/cow increased with land holding, so also the net income/lactation, which ranged between INR 653 to 1,921. Contribution of livestock towards net income of the family ranged from 34 to 36% of the total net income of the family. Further analysis of data (CD and CV of milk yields and net income) showed that medium and large farmers had higher risk associated with milk production than smaller categories of farmers.

Reports from Tamil Nadu and Podicherry

Kumar (1997) and Kumarvel (1998) carried out economic analysis of dairy production from different dairy animals in some districts of Tamil Nadu. The results of both these studies are very different. Kumar (1997) reported marginal profit of INR 697/year from local cow and higher profit from crossbreds (INR 3,697/year) while Kumarvel (1998) reported highest profit from buffaloes (INR 4,595/year), marginal profit of INR 686/year from crossbreds and negative contribution from local cows. Market price of milk and milk yield are the main factors for this variation in findings.

Reports from Uttar Pradesh (including Uttaranchal)

Milk production and profitability from different dairy animals, viz. local and crossbred cows and local and improved buffaloes has been studied by some economists and the results reported are variable and inconsistent.

Shah and Sharma (1994) undertook a study in Bulandshahar district of Uttar Pradesh. Taking into account various fixed and variable costs and income from milk, they reported that farmers get highest returns from improved buffaloes. Studies in Faizabad district of Uttar Pradesh showed that crossbred cows are more profitable than buffaloes and have lower maintenance costs. However, they cautioned that effective services need to be ensured for good returns from crossbreds.

However findings of Chandra and Agarwal (2000), which compared cost of milk production from crossbred cows and buffaloes for four categories of farmers from Farukhabad district of Uttar Pradesh, are in favour of buffaloes. Using multi-stage stratified random sampling design of 100 households representing landless, smallholder (0.1–2 ha.); medium (2.1–4 ha) and large (>4 ha) landholding milk producers were surveyed. Average gross cost per milch animal per day was found to be INR 48.39 and INR 50.95 and net returns were INR 5.30 and INR 9.34 for crossbred and

buffalo, respectively, indicating better returns from buffaloes. It's concluded that net returns per milch animal were highest for medium farmers and low or negative for landless milk producers; while with buffaloes it was highest for large farmers and lowest for smallholders (Chandra and Agarwal 2000).

Reports pertaining to studies on impact of organisational support on milk production, income and employment generation through dairy production are available from two districts of Uttar Pradesh. Shukla et al. (1995b) studied impact of Operation Flood Programme in two blocks of Kanpur district of Uttar Pradesh by conducting survey in programme and non-programme villages. The results show that milk production and consumption in programme villages was 8.78 and 2.23 litres, respectively, compared to 6.25 and 1.92 litres, respectively, in non-programme villages. Employment generation was also higher in programme areas compared to non-programme areas (440 and 289 days, respectively).

Similar results are reported from Etah district in Uttar Pradesh by Singh et al. (2001) who compared income of dairy producer members of Brooke Bond Lipton India Ltd. (BBUL) with that of non-members. Singh et al. (2001) reported that the net annual income of the members was INR 6,125 as against INR 2,059 of non-members and attributed this to the marketing support and services provided by BBUL to the producers.

Summary of observations related to dairy

- i) Dairy production accounts for about 80% of livestock produce.
- ii) Resource rich benefited more from dairy development projects compared to resource poor and those from lower social strata as they face economic, social and technological constraints.
- iii) Improving dairy production can help the underprivileged to come out of poverty; however, they need institutional (credit, marketing and services) and technological support (linkages).
- iv) There are conflicting reports about benefit from crossbred cattle and buffaloes and reasons are not very clear and need in-depth study.
- v) Many reports show that dairy production from indigenous cattle is not profitable; however, a large number of rural families keep indigenous cattle and this showed that there is need for understanding the situation more clearly.

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APPENDICES

Appendix 1. Characteristics of crop–livestock regions in India (1999–2000).

Characteristics	North	South	West	East	North-East
Human population (million)	231	220	279	222	38
People below national poverty line (%)	25	18	25	38	22
Major agricultural activity	Wheat, paddy, buffalo, cattle	Paddy, coarse cereals, fruits, cattle, buffalo	Wheat, coarse cereals, pulses, cattle, buffalo	Paddy, wheat, vegetables, cattle	Paddy, vegetables, fruits, cattle
% irrigated area in arable land: 2001	63.5	28.2	22.3	35.0	10.4
% crop value in agriculture	71.6	78.3	76.4	76.9	80.6
% livestock value in agriculture	28.4	21.7	23.6	23.1	19.4
Density/1000 human population: 1997					
Bovines	308	238	374	315	361
Ovines	121	197	243	228	119
Poultry	188	668	238	349	920

Note: LU = Livestock unit.

North — Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab and Uttar Pradesh.

South — Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

West — Gujarat, Madhya Pradesh, Maharashtra and Rajasthan

East — Bihar, Orissa and West Bengal.

North-East — Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura.

Sources: Government of India (1999–2000), Government of India (2004), Rao et al. (2004).

Appendix 2. Relationship between agro-ecology, socio-economic groups, crops and livestock in Andhra Pradesh.

Agro-climatic zones ¹	Districts ¹	Major crops ¹	Major livestock ¹	Major socio-economic groups ³	People in marginalised communities ² (in million)
1. Krishna Godavari	West Godavari, Krishna, Guntur, parts of East Godavari, Khammam, Nalgonda and Prakasam	Paddy, black and green gram, groundnut, cotton, tobacco, sugar-cane, mango	Buffalo, cattle, sheep	High and low caste farmers, landless (56%)	4.9 (27)
2. North Coastal	Srikakulam, Vishakhapatnam, parts of East Godavari, Vizayanagaram	Paddy, pearl millet, groundnut, sugar-cane, pulses, blackgram	Buffalo, cattle and sheep	High and low caste farmers and landless (47%)	1.7 (20)
3. Southern	Nellore, Chittoor, Cuddapah, parts of Prakasam and Anantpur	Paddy, groundnut, sorghum, pulses—red-gram	Cattle, buffalo and sheep	High and low caste farmers, landless (26%)	2.3 (21)
4. Northern Telangana	Adilabad, Medak, Karimnagar, Nizamabad, Warangal, Khammam	Sorghum, rice, maize, cotton, redgram	Cattle, buffalo, goat and sheep	High and low caste farmers and pastoralists and landless (25%)	3.9 (28)
5. Southern Telangana	Hyderabad, Rangareddy, Mahboobnagar, Nalgonda	Sorghum, paddy, castor, cotton, pearl millet, groundnut	Cattle, buffalo, goat and sheep	High and low caste farmers and landless (19%)	2.5 (21)
6. Scarce rainfall	Kurnool, Anantpur, parts of Prakasam, Mahboobnagar and Cuddapah	Groundnut, sorghum, cotton, sunflower	Cattle, buffalo, sheep and goat	High and low caste farmers, pastoralists and landless (24%)	1.9 (19)
7. High altitude and tribal	Northern parts of Vizyanagaram, Vishakhapatnam, Srikakulam, East Godavari, Khammam	Rice, pearl millet, groundnut, finger millet, tuber crops	Cattle, goat, sheep	Tribals, low and high caste farmers	0.8 (32)

Note: Figures in parentheses represent percentages of total population.

Sources: 1. Ghosh (1991), 2 & 3. Census of India (2001).

Marginalised communities refer to scheduled caste and scheduled tribes. For the districts that fall in more than one zone, population was apportioned based on their area in a particular zone.

Appendix 3. Relationship between agro-ecology, socio-economic groups, crops and livestock in Gujarat.

Agro-climatic zones ¹	Districts ¹	Major crops ¹	Major livestock ¹	Major socio-economic groups ³	People in marginalised communities ² (in million)
1. South Gujarat heavy rainfall	Dang, Valsad and part of Surat	Paddy, millets, pulses, sugar-cane, groundnut and fruits	Buffalo, cattle, goat—most non-descript	Tribals and high and low caste farmers	2.0 (49)
2. South Gujarat	Surat and Bharuch	Paddy, pulses, sorghum, sugar-cane, fruits and cotton	Buffalo, cattle, goat—mixed population	High and low caste farmers and tribals	1.3 (24)
3. Middle Gujarat	Pandhmahal, Baroda, Kheda and part of Ahmedabad	Sorghum, pulses, cotton, pearl millet, maize, tobacco	Buffalo, cattle, goat—mixed population	High and low cast farmers and tribals	4.4 (30)
4. North Gujarat	Banaskantha, Sabarkantha, Gandhinagar, Mehsana and part of Ahmedabad	Pearl millet, sorghum, cotton, castor, pulses and mustard	Cattle, buffalo, camel, goat, sheep	Pastoralists, high and low caste farmers	0.7 (11)
5. North West	Kutch, Rajkot, Surendranagar and parts of Mehsana, Banaskantha and Ahmedabad	Pearl millet, sorghum, cotton, pulses, castor	Cattle, camel, sheep and goat	Pastoralists, high and low caste farmers	0.7 (15)
6. North Saurashtra	Jamnagar, Bhavnagar, Rajkot and Amreli	Groundnut, cotton, pearl millet, sorghum, sesam	Cattle, goat, sheep and buffalo	High and low caste farmers and pastoralists	0.5 (8)
7. South Saurashtra	Junagadh, parts of Bhavanagar, Amreli and Rajkot	Groundnut, cotton, pearl millet, sorghum, sesam	Buffalo, cattle, goat, sheep	High and low caste farmers and pastoralists	0.4 (10)
8. Bhal Coastal	Parts of Bharuch, Ahmedabad, Kheda and Bhavnagar	Pearl millet, cotton, barley, wheat	Cattle, buffalo, goat, sheep	Pastoralists, high and low caste farmers	0.35 (35)

Note: Figures in parentheses represent percentages of total population.

Sources: 1. Ghosh (1991), 2 & 3. Census of India (2001).

Marginalised communities refer to scheduled caste and scheduled tribes. For the districts that fall in more than one zone, population was apportioned based on their area in a particular zone.

Appendix 4. Relationship between agro-ecology, socio-economic groups, crops and livestock in Rajasthan.

Agro-climatic zones ¹	Districts ¹	Major crops ¹	Major livestock ¹	Major socio-economic groups ³	People in marginalised communities ² (in million)
1. Arid Western	Jaisalmer, Barmer, Bikaner, Jodhpur	Pearl millet, pulses, wheat, mustard, rapeseed	Camel, sheep, goat and cattle descript breeds	High-caste farmers, pastoralists	1.2 (18)
2. Irrigated N.W. Plain	Sri-Ganganagar, Bikaner, Jaisalmaer	Wheat, mustard, cotton, gram, groundnut	Buffalo, cattle, camel, sheep descript breeds	High-caste farmers, pastoralists	1.1 (31)
3. Transitional Plain	Churu, Ajmer, Zhujunu, Sikar, Nagaur	Pearl millet, pulses, gram and wheat	Sheep, goat, cattle, buffalo and camel — mixed type	High and low caste farmers, pastoralists	1.3 (14)
4. Transitional Luni Basin	Pali, Jalore, Sirhi, Jodhpur	Pearl millet, pulses, wheat, mustard, rapeseed	Cattle, sheep, goat, camel, mixed type	High and low caste farmers and pastoralists	1.7 (24)
5. Semi-arid Eastern Plain	Jaipur Ajmer, Tonk	Pearl mllet, wheat, mustard, pulses, vegetables	Cattle, buffalo, sheep, goat — mixed type		2.5 (26)
6. Flood Prone Eastern Plain	Bharatpur, Dholpur, S.Madhopur	Pearl millet, barley, wheat, maize, mustard, pulses	Buffalo, cattle, sheep, goat of mixed type		1.7 (31)
7. Sub-humid Southern Plain and Hill	Bhilwara, Udaipur, Chittaud	Maize, wheat, sorghum, groundnut, mustard, pulses	Cattle, sheep, goat, buffalo mostly non-descript	High and low caste farmers, tribals	2.3 (37)
8. Humid Southern Plain	Banswada, Udaipur, Dungarpur, Chittaud	Maize, paddy, sorghum, sheat, pulses	Cattle, sheep, goat mostly non-descript	Tribals, high and low caste farmers	2.4 (65)
9. Humid South-Eastern Plain	Bundi, Kota, Jhalawad	Sorghum, wheat, pulses, paddy, sugar-cane	Cattle, sheep, goat mostly non-descript	High and low caste farmers, tribals	1.4 (29)

Note: Figures in parentheses represent percentages of total population.

Sources: 1. Ghosh (1991), 2. Scheduled caste and scheduled tribes census (2001), 3. Census of India (2001).

For districts that fall in more than one zone, population was apportioned based on their area in a particular zone.

Appendix 5. Relationship between agro-ecology, socio-economic groups, crops and livestock in Orissa.

Agro-climatic zones ¹	Districts ¹	Major crops ¹	Major livestock ¹	Major socio-economic groups ³	People in marginalised communities ² (in million)
1. North-Western Plateau	Sundergarh, parts of Sambalpur	Rice, pulses, millets and oilseeds			2.0 (60)
2. North-Central Plateau	Mayurbhanj, parts of Keonjhar	Rice, pulses, oilseeds and millets			3.4 (62)
3. North-Eastern Coastal Plain	Balasore, Jaipur, Keonjhar/Anandpur	Rice, vegetables, pulses, oilseeds and horticultural crops (coconut and betel leaf)	Cattle, goat, sheep, buffalo, poultry and pig; fisheries—marine and fresh water	Farmers (56%), agricultural labourers (27%), 1–5 ha constitute 87% of holdings	3.8 (29)
4. East and South-Eastern Coastal Plain	Balasore, Puri, Cuttack and parts of Ganjam	Rice, oilseeds, pulses, vegetables, wheat and horticultural crops (mango, cashewnut, coconut)	Cattle, goat, sheep, buffalo, poultry and pig		9.2 (25)
5. North-Eastern Ghat	Phulbani, Aska, Paralakhmundi and Rayagada	Rice, pulses, vegetables, oilseeds and millets			1.8 (67)
6. Eastern Ghat highland	Koraput and Nawaranpur	Paddy, ragi, maize, vegetables, niger; cinger and turmeric (in kitchen gardens by tribals and mango, Jack fruits)	Poultry, cattle, goat, sheep, buffalo and pig		2.7 (67)
7. South-Eastern Ghat	Jaipur	Rice, sesam, millets, mango, lime, guava	Cattle, goat, sheep and pig		1.5 (33)
8. Western undulating	Kalahandi and parts of Koraput	Rice, pulses, millets and oilseeds			1.9 (47)
9. West-Central Table Land	Parts of Sambalpur and Bolangir	Rice, pulses, oilseeds, wheat and sugarcane			4.7 (43)
10. Mid-Central Table Land	Dhenkhanal, Angul and parts of Jaipur	Rice, pulses, oilseeds, cotton and vegetables			2.2 (32)

Note: Figures in parentheses represent percentages of total population.

Sources: 1. Ghosh (1991), 2 & 3. Census of India (2001).

Marginalised communities refer to scheduled caste and scheduled tribes: For the districts that fall in more than one zone, population was apportioned based on their area in a particular zone.