Gender roles and child nutrition in livestock production systems in developing countries: A critical review

Socio-economics and Policy Research Working Paper 27

F.K. Tangka, M.A. Jabbar and B.I. Shapiro

International Livestock Research Institute
P.O. Box 30709, Nairobi, Kenya

Working Papers Editorial Committee

LPAP working papers contain results of research done by ILRI scientists, consultants and collaborators. The author(s) alone is (are) responsible for the contents.

Authors' affiliations

Ms F.K. Tangka, Food and Resource Economics Department, University of Florida, Gainesville, Florida, USA
Dr M.A. Jabbar, International Livestock Research Institute, Addis Ababa, Ethiopia
Dr B.I. Shapiro, Natural Resource Management Program, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Bamako, Mali

ISBN 92–9146–076–1

Correct citation: Tangka F.K., Jabbar M.A. and Shapiro B.I. 2000. *Gender roles and child nutrition in livestock production systems in developing countries: A critical review.* Socio-economics and Policy Research Working Paper 27. ILRI (International Livestock Research Institute), Nairobi, Kenya. 64 pp.

Table of Contents

Acknowledgements

The authors acknowledge the financial grant to undertake this review from the International Centre for Research on Women through the CGIAR Gender Programme, now incorporated into the System-wide Programme on Participatory Research and Gender Analysis (SPPRGA), co-ordinated by the Centro Internacional de Agricultura Tropical (CIAT). The comments of Professor Robert Emerson, University of Florida, Dr Nancy McCarthy (ILRI/IFPRI) and Dr Maria Fernandez, Co-ordinator, SPPRGA, on earlier drafts are appreciated. We also thank Ms Anne Marie Nyamu for editing the manuscript. The authors alone are responsible for the content.

Executive summary

The study of gender issues in agricultural production has become an important subject of inquiry, ever since questions were raised on whether women and men benefited equally from economic development. The focus of the debate and empirical research has primarily been on the role of women in crop production to the virtual exclusion of the role of gender in general (women, men and children) in livestock farming. This review is based on the limited amount of available literature which shows that specific participation of women, men and children in animal husbandry is significant and varies from region to region according to the traditional gender division of labour, other variables, the farming systems and the demographic and environmental factors. The objectives of this review are to:

- examine the gender division of labour, access to resources and benefits from smallholder ruminant livestock production systems
- evaluate the effects of ruminant livestock production on the nutritional status of children
- present two case studies that critically examine how gender analysis was included in smallholder ruminant livestock research projects.

Ruminant livestock are important in maintaining the livelihoods of their keepers by providing food, traction power, manure, raw material, cash, security, social and cultural identity, medium of exchange and means of savings and investments. The smallholder ruminant livestock production systems considered in this review, and which are common in developing countries, are nomadic pastoral, agropastoral and mixed crop–livestock farming.

There is a distinct, but not very strict, age and sex division of work in pastoral (nomadic and sedentary) systems. This division of work is influenced by socio-cultural and economic factors, what the animal is used for and how valuable the animal is. Men are largely the decision makers for livestock production and are in charge of general herd management. Women carry out dairy-related activities, manage vulnerable animals (calves, small ruminants, and sick, injured and pregnant animals). Children undertake most of the routine work such as herding. Men own most of the livestock and sell live animals and meat. Women own a small proportion of the animals and are milk managers in the pastoral systems.

Gender division of labour in mixed systems varies from region to region according to culture, religion and socio-economic variables. Both men and women take part in the harvesting and transportation of feed, chaffing of fodder, feeding of animals, milking, cleaning of sheds and sale of milk. Processing of milk is done solely by women while children of both sexes tether and herd animals. As in animal husbandry activities, crop cultivation tasks are shared among household members and vary across regions.

The welfare effect of technological change at the household level is of concern to many researchers and policy makers involved in ruminant livestock development. For example, intensified dairying has been shown to potentially raise milk production and household incomes, but the welfare consequences on different household members may not be the same. The effects vary over time and across regions. In many places, women are involved in marketing milk and other dairy products in informal markets but they share the proceeds of the sales with other members of the family to meet family expenses. Similarly men may be required by law to register with formal marketing institutions such as co-operatives and may be responsible for collecting revenues for milk deliveries, but they may not spend the entire

revenue on their own.

Performing certain tasks may not be equal to control. The issues surrounding ownership of livestock, control over resources, income and expenditures and their implications for gender roles, equity and household welfare are not well understood and need to be more intensively researched.

Ruminant animals are important sources of livelihood for millions of smallholder farmers in developing countries, but their productivity remains low. This can be explained by both biological and constraints. Constraints such as shortage and high cost of improved breeds and commercial feed, lack of market access and unstable livestock and livestock product prices, and access to veterinary services and drugs are gender neutral. Obstacles such as the lack of capital and access to institutional credit; competing use of time, and lack of technical skills and access to extension service may affect women more than men and further limit women's participation and efficiency in ruminant livestock production. Research leading to the identification and resolution of such constraints will enhance women's participation in livestock production.

Ruminant livestock ownership directly and indirectly affects the nutritional status of children in developing countries. The significant correlation between the quantity of milk consumed by children and the nutritional anthropometric variables corroborates the importance of protein food sources from animal origin to child growth. Better quality diets, such as those from animal origin, are important in fostering growth in toddlers. Nutritional status of children with low consumption of dairy products has been shown to improve with the intake of ruminant animal product. However, drinking non-human milk before the age of 6 months and the presence of ruminant animals close to the household without proper veterinary care and good hygiene poses serious risk of disease to children. The limited evidence available indicates that the potential impact of any livestock technology on gender roles and household welfare, particularly human nutrition, should be carefully incorporated in the design, testing and diffusion processes of research projects.

Overall, research on gender and ruminant livestock is limited, especially gender disaggregated data on work sharing, access to resources and benefits. Total labour allocation, relative burdens and intra-household decision making processes need to be examined to fully understand the implications of technological change in ruminant livestock production systems at individual and household levels. All of these need to be undertaken using appropriate conceptual and theoretical constructs that fit the varying socio-cultural situations prevailing in the developing world. The studies reviewed in this document rarely used any conceptual/analytical framework; rather they describe or quantify certain elements in an isolated manner.

We suggest that future studies on gender in livestock technology research should consider using an appropriate conceptual framework to understand the inter-linkages between technology and its users and beneficiaries. The theoretical underpinnings of such a framework may be based on the new household economics and related models, e.g. the unitary and collective models. Both models treat the farm household as a unit of production and consumption. They differ in that the unitary model treats the household as a single entity with one set of preferences represented by a household utility function, while the household is considered by the collective model as a collective entity allowing heterogeneity in preferences among its decision makers. The tenets of collective models may not be applicable in many developing countries, where men and women may not always own different resources. Division of responsibilities and tasks, and ownership of livestock and collection of revenues from sale of different farm products by different family members (husbands, wives and children) may not, in most cases, reflect differences in control of resources, income or other outcomes. Also there may be flows of resources and incomes between members of different

sexes in the household, but such flows may not represent or signify control and exchange (e.g. intra-household labour market) relationships, but rather sharing of responsibilities and incomes to assist individuals in meeting their socially assigned responsibilities, which contribute towards the attainment of family goals and welfare. Consequently, the simpler unitary model may still be an appropriate framework for gender analysis in the context of most developing countries. Within this framework, there may still exist gender inequities in terms of work burden and benefits. These need to be understood and addressed to make development more equitable.

1 Introduction

1.1 Background

It is nearly three decades since (1970) called into question if women and men benefited equally from economic development. Since then, gender issues in agriculture have become an important subject of inquiry. Gender is a socio-economic variable used to analyse roles, responsibilities, constraints, opportunities and incentives of people involved in agriculture (Poats 1991). However, the focus of the debate and empirical research has primarily been on the role of women in crop production to the virtual exclusion of their roles and those of men and children in livestock farming. For example, Ashby (1999) examines the dimension of poverty and the relationship between gender and poverty of rural people in developing countries. Although mention is made of the different roles, rights and resources men and women have in society as important determinants to the nature and scope of poverty, emphasis is laid only on women, with minimal attention given to men and children, and the focus is almost exclusively on the individual rather than on individuals as members of a family. Whereas women undertake major responsibilities in agricultural production (most of which go unrecognised in employment records—especially for subsistence, in addition to performing household chores and reproductive activities and deserves the necessary attention) focusing on women only may not be the appropriate approach towards improving the welfare of the poor families, in developing countries.

The few studies that have been undertaken to examine the gender division of labour and responsibilities in ruminant production systems in developing countries show that men, women and children participate in varying degrees in animal husbandry. Some of the ruminant livestock production activities include: herding, milking, processing of milk, selling milk and dairy products, care of calves, pregnant and injured animals, collection and transportation of animal feed, feeding and watering animals, cleaning of animal sheds and processing of cow dung for use as fuel. Raising ruminants requires a labour contribution from all family members. The specific participation of women, men and children in animal husbandry varies across regions depending on the farming systems and socio-economic factors such as religion, culture, development gradient etc. Gender roles are further influenced by the environmental and demographic characteristics and the type of animals kept. These variations make it impossible to generalise about gender roles in ruminant livestock production systems in developing countries. Gender dimensions in ruminant livestock production systems have to be considered within particular production systems, socio-economic and socio-cultural environments.

Development is a process that allows people to improve their livelihoods. Livestock development is therefore concerned with enabling farmers to use livestock as a means of improving the well-being of their families. Livestock development planners generally focus on how to increase production for the market. This can be achieved only if development activities and policies assist smallholder livestock keepers, who make production decisions, meet their

own primary objectives, which may not always be production for the market. Livestock policies made and projects initiated on the basis of inappropriate assumptions about the aims of the livestock keepers and how resources and benefits are allocated within the household, may result in limited success. The effects of livestock development on the well-being of different family members, particularly women and children, are being debated in the development literature (1986; Quisumbing 1998) and are of great concern to policy makers and researchers.

Intra-household nutrition security is a concern in the literature on food security. Attention is generally given to women and children, the more vulnerable members of poor households, because such households sometimes discriminate among its members in distributing food. Generally such discrimination may prevail under conditions of inadequate food supply and there may be specific reasons for discrimination. For example, household members performing energy-intensive tasks in certain seasons may require, and be given, a higher share of the limited food supply. Such discrimination usually declines and disappears when there is enough food. The problem of intra-household nutrition security is not specific to livestock production systems. However, the ownership of ruminant livestock may have an impact on the nutritional status of children in developing countries, because of the specific nutritional benefits of animal origin food on child growth (Sigman et al. 1991; Grosse 1998b). The effect of livestock on child nutrition is therefore given special attention in this review.

1.2 Objectives

The objectives of this review are to:

- examine who does what in smallholder ruminant production systems in developing countries
- identify who has access to resources (inputs) and benefits (outputs and income) in smallholder ruminant livestock production systems
- assess the effects of interventions, such as the introduction of new technologies and commercialisation of smallholder ruminant livestock production systems, on gender dimensions (division of labour and access to resources and benefits)
- indicate the constraints limiting women's participation in ruminant livestock production
- evaluate the effects of ruminant livestock production on the nutritional status of children.

In reviewing these aspects of ruminant livestock production systems, an attempt is made to bring out what is known and unknown about the gender dimension in livestock production. It is hoped that such information will guide research, development priorities and strategies to increase ruminant livestock productivity and enhance the well-being of all its keepers.

1.3 Hypotheses

The following hypotheses are examined with available literature:

- There are differences in gender division of labour and access to resources and benefits between smallholder ruminant livestock production systems and between regions.
- Women have more limited access to inputs necessary to boost productivity than men in ruminant farming.
- Gender roles and access to resources and benefits change with the introduction of new livestock technologies.

- Ruminant livestock production has a positive effect on children's nutritional status.

1.4 Approach

Gender analysis and case studies are among the approaches used for analysing intra-household dimensions within ruminant livestock production systems of developing countries. Application of gender analysis tools to agricultural research is changing the way production problems are identified, and the way division of labour and nature of farmer participation are understood (1991). Feldstein and Poats (1989) indicate that incorporating gender as an analytical variable in the agricultural development equation is necessary and can contribute to better science. Gender analysis can provide information needed for—and predict effects associated with—development of livestock production systems. The information needed includes: (a) knowledge of current practices, nutrition, healthcare, management etc.; (b) timing and intensity of labour for different activities; and (c) resources, benefits and constraints. Gender analysis provides this information by asking the following questions:

1. Who is responsible for which activity as indicated by sex and age? This identifies sex-specific knowledge.

2. Who does what? This is useful for identifying whose labour might be affected by proposed changes and the potential for competing uses of labour.

3. Who has access to and decides about the use of resources and benefits? This question identifies resource constraints. Adoption of new livestock technologies normally demands additional resources—land, labour, supplementary feed, capital etc.—in comparison to traditional practices. The degree of access to resources by different household members can be important in understanding different management practices. Associated with this is the issue of incentives—who derives benefits from the production activities? Do the investments match with likely benefits? If they do not, this may have implications for the availability of additional resources, particularly labour and consequently for the adoption of new/improved livestock technologies.

4. What are the preferences of men and women in livestock production systems? These preferences may also affect adoption of new livestock technologies. Such information is critical in developing successful ruminant livestock research and development activities.

The review begins with a discussion of the important roles of ruminant livestock in smallholder livelihood systems in developing countries. This is followed by a brief overview of the ruminant livestock productions systems of developing countries. The subsequent sections present gender dimensions in different ruminant livestock production systems, constraints to the effective contribution of women in ruminant livestock production systems and the effects of ruminant farming on the nutritional status of children. There are two case studies showing how gender concerns are included in research to improve smallholder ruminant livestock systems and finally a note on a possible framework for gender analysis in livestock technology and research.

2 Gender roles in smallholder ruminant livestock production systems

2.1 The importance of livestock in smallholder systems

Livestock are important in maintaining the livelihood of their keepers. The functions of livestock include:

1. Food supply: Ruminant animals provide food products such as milk, butter, cheese, meat and, in some societies, blood. These foods are high in protein and are important sources of energy, minerals and vitamins.
2. Source of traction power: Ruminant animals provide power for ploughing, threshing and sometimes for weeding and hauling. They are also used to operate irrigation equipment.
3. Manure production: Manure from ruminant animals is an important source of nutrients and organic matter needed to maintain soil fertility.
4. Medium of exchange: Livestock and their products are exchanged or sold to obtain grains and other non-livestock products and services.
5. Source of raw materials: Ruminant livestock provide raw material such as wool, hides and skins, bones and dried dung. These materials are used to make clothes, furnishings and implements. They are also used as fuel and building materials etc., for home consumption as well as for sale. Processing of these materials can be an important source of additional employment and income for rural communities.
6. Means of investment: Raising of ruminant livestock can be viewed as a form of investment, with offspring as interest in situations where there is limited access to financial institutions. In most rural areas in developing countries, this form of investment is often more profitable than putting money in a bank.
7. Source of cash: Sales of animals, particularly small ruminants, provide emergency sources of cash for unexpected or unusually high expenses, such as payments for medical treatment, marriages, funerals and school fees. Daily milk from lactating animals provides a regular flow of cash income. This is often used to pay for small regular purchases of food and household items. Manure is another source of income, particularly where cropping is intensive and supply of chemical fertiliser is unreliable. Another means of income is from hiring out animals for ploughing.
8. Source of security: Live animals act as food stores, particularly when risk of cropping is high. When crop

yields are not enough to meet family needs, animals—particularly small ruminants—can be sold to buy additional food or slaughtered for consumption.

9. Source of social and cultural identity: Social relations are affirmed among traditional livestock keepers by exchange and transfer of animals, co-operation in herding and sharing of meat from slaughtered animals. Gifts in the form of animals are common and for some people, are important sources of capital.

2.2 Smallholder ruminant livestock production systems

Men and women raise ruminant livestock in a wide range of ecological and socio-economic contexts. In this section, we look at three main ruminant livestock production systems in which smallholders in developing countries are involved: nomadic pastoral systems, agropastoral systems and mixed crop–livestock farming. The livestock production systems are characterised by climate, the predominance of various livestock and crop species and the relative importance of livestock and crops to the farming system (De Boer et al. 1994). The main features of these basic systems are presented in Table 1 and explained below.

Table 1. *The main ruminant livestock production and management systems of smallholders in developing countries.*

System	Contribution of livestock	Influence of		Resources		Level of technology	Linkages	
		Climate	Culture	On farm	Ex-farm		Public sector	Private sector
Pastoral	High: provides proteins, clothing, carpets, fuel, draft and fertiliser for rangelands	Large	Strong: generally travel as family and tribal units; tribal regulations important	Ruminant stocks; Land: none Labour: family Capital: some	Rangelands, crop residues of sedentary farmers	Practice only traditional grazing methods; no improvements in feed and water resources	Generally only with veterinary extension and tribal agents	Between and within tribes, villages and traders
Agropastoral	High: provides proteins, clothing, carpets, fuel, draft and fertiliser for rangelands	Large	Strong: community living as related family and tribe	Land: own or rented Labour: family and joint family Capital: some livestock	Rangelands, crop residues of sedentary farmers; some purchased feed and forage	Traditional, but contact with sedentary farmers has transferred some advances in technology	Strong because of sedentary nature; depend on public sector institutions for various support services	Strong mainly for obtaining credit, marketing and purchase of essential inputs
Mixed crop–livestock	High: provides proteins, clothing, carpets, fuel, draft, manure, capital accumulation and savings	Large	Weak	Land: own or rented Labour: family or hired Capital: some Stocks: mainly ruminant and others	Purchased inputs such as seeds, stock and fertiliser; hired draft animals, tractors	Advanced and readily adaptable if demonstrated successfully	Agricultural extension and research agencies, educational institutions, credit and co-operatives	Markets, credit agents, transportation and communications

Table 1. Cont.....

System	Output		Disposal of products		Interactions	Constraints	Strengths	Adoption of new technology	Intervention strategy
	Crops	Livestock	Private sector	Public sector					
Pastoral	None	Livestock products from sheep, goat, cattle and camel	Home consumed, bartered between tribes and with villagers and sold to traders at fairs	Practically none	With other tribal groups and settlements that they frequent on their migrations	Overstocking; uncontrolled animal health; little flexibility to account for risks (weather, raiding, prices etc.)	Use marginal lands that have little alternative use; low dependence on public support	Their wandering nature hinders the adoption of new technologies	Expanding pastures and ranges; providing more water points; extension to limit stock numbers to prevent overgrazing all of which have largely failed
Agropastoral	Cereals, cash crops, fodder and fruits	Livestock products from sheep, goat and cattle	Partially home consumed, largely traded for cash; virtually no barter	Practically none except where government agencies procure products such as wool	With nomadic tribes, settlements, and established systems such as cereal mills and processing industries	Careful planning necessary for allocation of scarce resources between crops and livestock production activities	Diversify into crop production hedges against risks during fluctuations in weather, pasture etc.	Readily adopted if available at affordable cost and seem profitable	Introduction of irrigation for higher yields and consistency, better varieties, development of infrastructure and access to markets and processing

									industries and provision of inputs to increase yields
Mixed crop–livestock	Cereals, vegetables, cash crops, oil seeds and fodder	Milk and products from sheep, goat and cattle	Partially home consumed; most sold to private traders	Sales to co-operatives, processing industries, marketing organisations and government procurement agencies	Strong with private sector for supply of inputs and disposal of outputs; moderate with public sector for advisory services, community and local governments	Weather dependent with unpredictable and fluctuating output; fragmentation due to division of inheritance; capital and labour-intensive	Growing subsidiary crops and livestock averts risks; nearness of farms makes transfer of technology easier; by-products for animals are available	Readily adopted because of ease of contact with relevant agencies and perceived gains	Improvement of animal quality, reduction of overstocking, promotion of more efficient use of by-products and straws and by-products preservation

Source: Adapted from Camoens (1985).

2.2.1 Nomadic pastoral systems

Nomadic pastoralism, also known as range livestock systems, are more widespread and better documented in Africa than elsewhere. They are also common in harsh and diverse environments like the desert of West Asia and the High Andes of South America (Wilson 1995). Arid and semi-arid environments are subject to unpredictable seasonal and annual fluctuations in rainfall, and are unsuitable for crop production. Matching the highly limited seasonal pasture supply with the constant feed requirement of live stock is quite a challenge in these environments. Management of the animals therefore entails nomadism and transhumance, as well as the use of multiple species of animal with different feeding habits and production cycles, in a system without crops (Wilson 1995). Nomadic pastoralists move as a team (generally, they move at the household level or maybe two or three households, but not usually more than that) with varying degrees of co-operation and hostility amongst them. Productivity of the livestock depends on feed availability and herd sizes are increased and decreased according to pasture avail ability. Movement of animals from place to place prevents spread of diseases (Camoens 1985), but may also be a source of disease for sedentary herds, which come in contact with nomadic herds.

The livelihoods of nomadic pastoralists depend on raising livestock. The pastoralists obtain their main daily requirements—food, shelter, fuel and clothes—from livestock. Surplus stocks and animal products are traded for cash or exchanged (barter) for grain and services from non-pastoral systems. Livestock and their products provide more than 50% of total household revenue; this includes value of consumed products and cash (Wilson 1995). In Africa, milk provides more than 80% of the energy in human diets, with meat being of less importance (Jahnke 1982). Blood is consumed in some countries of East Africa, e.g. in Kenya. Although the pastoral system is unimportant in sub-Saharan Africa (SSA) in terms of the proportion of agricultural population engaged in it (12%), it is important with respect to the percentage of grazing land devoted to it (35%) and the percentage of total ruminant animals associated with it (35%) (De Boer et al. 1994). The main source of feed is rangeland supplemented by grasses in the forest and by-products of sedentary farming systems. Nomadic pastoralism is a labour- and land-based system with little dependence on privately owned land, capital and technology.

The system has several constraints apart from water and feed that are occasionally in short supply. Communal land tenure inhibits control of stocking rates, since reduction in livestock holding by some members of the group will benefit others. Ingrained cultural attitudes prevent the adoption of new or improved technologies. Markets are generally very far from the production areas, served by poor infrastructure (Wilson 1995). Support services such as veterinary clinics and facilitation of inter-regional trade are almost non-existent.

2.2.2 Agropastoral systems

The system develops from nomadic systems when livestock keepers settle around permanent sources of water and grow crops to supplement livestock production (Camoens 1985). This is induced by feed shortages due to reduction of grassland and difficulties in moving with large herds with expansion of crop production. Settlement forces animal keepers to reduce their herd sizes because it is difficult to manage large herds without shifting them around in search of food and water. An agropastoral system is defined as one in which between 10% and 50% of household revenue is obtained from livestock and its products (Wilson 1995). This system is found in the arid and semi-arid areas north and south of the equator, on the mainland of Africa, western Asia, India, Central and South America and also on some islands like Madagascar (Wilson 1995).

Agro pastoralists raise animals and grow crops, with livestock as their main source of livelihood and subsistence, with strong market orientation for livestock products. Agropastoralists have a fixed or semi-fixed abode. Management of ruminant livestock is by herding on rangelands closer to settlements and migration with animals

during certain times of the year is common. Hardy and adaptable crops like millet and sorghum, vegetables, fruits and some cash crops are cultivated. Agropastoral farming systems are labour-intensive with some dependence on privately owned land, capital and technology (Camoens 1985).

There is a moderate to strong link between crop and animal production in agropastoral systems. Cattle are sometimes used for draft power and are important suppliers of milk. Goats and sheep are mainly kept for meat production, but their milk and fibre (wool and hair) also contribute significantly to household subsistence and cash income. Animal droppings are used as fertiliser, and hides and skins are used to make household items. The main sources of animal feed after harvest are crop by-products and stubble. Links with formal institutions are weak. The inflows of extension and animal health care services for example, are minimal. Links with informal institutions are, however, moderately strong as these institutions provide food, and sometimes credit, feed and farm inputs and are the main outlets for crops and livestock sales. The family provides the main labour for livestock rearing; labour input from outside is occasionally used during peak periods such as herding during the cropping season when greater control on animals may be required.

2.2.3 Mixed crop–livestock farming systems

Mixed crop–livestock farming refers to livestock production that takes place in arable areas or areas with arable potential (Jahnke 1982). It is practised in semi-arid, subhumid and humid ecological zones. These zones have moderate to high rainfall. Crop production both for subsistence and cash generation is the major activity of this system, with livestock playing a supportive role.

There is a strong linkage within the system between crop and livestock production. Crops provide by-products and unmarketable surpluses which livestock convert into high value products. Livestock help clear stubble, trample wet fields, and provide manure and draft power for cultivation. In these systems livestock serve as living banks for capital accumulation and provide milk and proteins. The system is labour-intensive, with some dependence on capital and land (rented, share-cropped or owned), and is receptive to new technology (Camoens 1985). Partial or total confinement is the common livestock management technique. Sources of animal feed are farm-grown pastures, crop by-products and residues, grasses around settlements, communal grazing lands, cut-and-carry feed from forest and irrigated canals and concentrates. Livestock productivity varies from region to region depending on the importance of crops to the system and the availability of labour and capital for livestock-related activities.

The sedentary nature of farmers in mixed systems and the relatively well-developed infrastructure in most locations give room for strong links with formal institutions and easy access to markets. Research and extension agencies provide services and advice to the farmers and have led to the adoption of new technologies (Camoens 1985).

Mixed crop–livestock farming in the highlands, favoured by good and suitable climate, has higher agricultural productivity and also supports higher population density. The ecological conditions are suitable for the introduction of high yielding plant and animal breeds, such that in the highlands modern improved techniques, semi-improved farms and traditional systems co-exist. The largest population of exotic breeds of cattle, sheep and goats is found in the highlands of Africa and the semi-arid areas of South Asia compared to other agro-ecozones. In the improved mixed farming systems livestock, rather than crops, account for a higher proportion of farm income. Mixed farming systems are common in the highlands of eastern (Ethiopia, Kenya, parts of Uganda and Tanzania) and central (Rwanda, Burundi and parts of Zaire) Africa, in a large part of Asia and in the Andean region of Latin America (Jahnke 1982; Sere et al. 1996). A significant proportion of highlands are also found in southern Africa including Madagascar, but are relatively unimportant in western Africa because the higher arid highlands have closer land use characteristics to the arid lowlands, than to the remaining African highlands (Jahnke 1982).

The highlands have the highest ruminant livestock densities of all ecological zones; all ruminant livestock species are represented here. Meat and milk production have acquired a significant level of commercialisation via the introduction of new technology. The highlands show special trends with regards to feeding regime, land tenure system and herding arrangement used in characterising livestock management (Jahnke 1982). Smallholder feeding regimes range from extensive grazing to stall-feeding. High human population pressure and environmental limits on the growth in livestock population have given rise to individualised forms of land tenure and intensification of mixed farming. The specific mixed crop–livestock system prevailing in a given region/location depends on the level of development.

The distinctions made among the different ruminant production systems are aimed at making the discussion more focused. The role of women in ruminant livestock production is better documented in sub-Saharan Africa than in any other region of the developing world, probably because women constitute a greater proportion of the population economically involved in agriculture. However, the information is not always analysed and is rarely used for planning. Furthermore the statistics on employment of women in agriculture are inadequate (Martins 1990).

2.3 Gender roles and issues in nomadic pastoral systems

2.3.1 Gender division of labour

Gender division of labour in nomadic pastoral societies varies across regions. Grandin et al. (1991) describe gender division of tasks and responsibilities in the nomadic pastoral livestock production system practised by the Maasai of Kenya in East Africa. Their findings indicate distinct age and sex division of work. Men are largely the decision makers for livestock production, and are in charge of general herd management. Their management responsibilities require constant attendance at markets and other gathering places to obtain information on range conditions, water availability and incidence of diseases. Men make initial decisions on when to move, where to move to, and who to herd the stocks. They accompany the herders (young men and hired labour) to ensure that the right paths are taken. This trains the young men as future herders. Men also oversee watering to make sure that animals, particularly the young ones, get sufficient water. They organise other men to maintain and repair water points and pay hired labour when necessary. Men also take care of the dips, carry out most of the dipping and supervise spraying of animals. In the evening they inspect animals returning home to ensure that none are missing or sick, that they have been well-grazed and if any is about to give birth. They search for any missing animals. Men perform minor veterinary procedures and castration and buy and administer veterinary drugs. They decide, after consulting other family members, which animals to slaughter or sell and when.

The Maasai women retain primary responsibilities for dairy-related activities. They are responsible for milking, processing of milk and marketing of surplus milk and dairy products. In areas where they are restricted in mobility by pregnancy and raising children, religion etc., women take care of stock kept near the camp, requiring particular attention such as pregnant cows, newly born calves, injured and sick animals. Women ensure that calves have ample suckling time and supply fodder to them. They also provide sick animals with water. Maasai pastoral women also play a significant role in animal disease control. Their close contact with the cows via milking enables diseases to be spotted early. The actual treatment of the animals is done by men and herd boys; women take part only when need arises. Women inspect animals in their subhousehold to ensure that all have returned from grazing and are healthy. Any problems are reported to the household head. Women also sell and purchase small ruminants. Owning small ruminants gives prestige and offers security.

Children in the society carry out most of the routine animal husbandry work; they do all the herding and much of the work around the homestead. Children aged 6–7 years herd small stock. This is a demanding job, as the animals move a lot and are easily lost or attacked by predators. Older children (8–9 years) herd calves which is less arduous than herding small stock. Boys (aged 11 years and older) herd cattle, which is mainly a supervisory activity as animals know their way around and set the pace. Herders merely keep the animals from straying and protect them from predators. Girls herd mostly small stock and calves. Cattle herding is seen to be too strenuous for girls, especially if they have to walk long distances. Herding small stock and calves permits girls to return to the homestead in time to help prepare food and carry out other domestic chores. The girls also assist in milking and watering of animals. It is also common in Maasai pastoral societies for girls to join boys and young men in the cattle camps for long periods. Children who attend school herd during the weekend.

Herding and watering of animals dominate overall labour requirements in nomadic pastoral systems. In Maasai society, children do 92% of the herding, spending an average of 4.5 hours a day on this activity. Men supervise 74% of the watering, dipping and spraying and spend an average of 2.3 hours a day doing so. Women do most of the milking (81%) with some help from older girls, who carry out 18% of this activity. Women and children spend an average of 1.2 and 0.4 hours a day, respectively, milking cows. In all, boys, girls, men and women spend on average 5.8, 6.8, 5.5 and 2.6 hours a day, respectively, on livestock-related work. The average number of hours devoted to livestock management and milking per day by each age/sex group indicates that girls spend the most time on livestock-related work and women the least.

In addition to animal husbandry tasks, Maasai pastoral women are responsible for the daily and time consuming tasks of childcare, food preparation, and water and fuel collection. They spend an average of 6 hours a day on these domestic chores. Women also build and maintain homes which involves dismantling the houses, loading them on donkeys for transportation and rebuilding them at the next camp.

The division of labour described above (Grandin et al. 1991) is observed in most nomadic pastoral societies in semi-arid Africa. Examples include the Borana of Ethiopia (Coppock 1994), the Fulani nomads of Niger (FAO 1979) and the Baggara and Fulani nomads of South Dafur in Sudan (Kerven 1987).

Similarly in North Africa and the Middle East, women in nomadic systems take care of the animals, milk, process milk into butter and cheese and weave tents, in addition to other household chores (Kandiyoti 1990). Among the Ahaggar Tuareg group of people who keep camels and small ruminants in the southern Algerian desert, women take an active part in livestock production. They are responsible for supervision, hygiene, choice of grazing land, herding and milking of sheep and goats while men look after the camels (Bourgeot 1987). Nomadic women in Somalia graze cattle, sheep and goats, whilst men are responsible for the camels (Martins 1990).

Gender division of labour in nomadic pastoral society is not very rigid; when necessary, women assist in herding and watering, and men in milking. For example, the keeping of animals is a man's job among the Fulani in Atakora, Benin. Men and boys milk, graze and look after the animals. Apart from the elderly, all men in the family milk their animals, with the assistance of girls and women who keep the calves away from the cows. Women use a small proportion of the milk for making cheese; butter is rarely made. Besides cattle, sheep and goats are kept and are regarded as savings accounts for medium financial needs (Bierschenk and Forster 1987, cited in Martins 1990). The varying degrees of milking between men and women in the Fulani societies have been explained as being influenced by the distance that the cattle have to cover in the respective societies. The lesser the nomadic life, the more milking women undertake (Dupire 1963). There may also be some differences due to religion, for example, the Fulani pastoralists in West Africa being mostly Muslims, may have differences with the Maasai.

2.3.2 Gender and access to resources and benefits

Livestock are the central means of survival for pastoral nomads. Access to livestock and their products is therefore indispensable for the economic, social and cultural survival of these households. Access to livestock by different household members in nomadic pastoral systems is a complex issue. This point is confirmed by the fact that different household members often have varying degrees of claims to the same animals (Joekes and Pointing 1991). The dual role of livestock as a source of subsistence and basis of wealth and prestige reflects entitlements of different household members to livestock and its products, based on their responsibilities and acquisition through several means.

Men are generally associated with animals as herd managers and are generally considered owners of cattle, with women and children having usufruct privileges. Women, however, do own livestock. Small ruminants kept by nomadic households are more the property of women than men (Waters-Bayer 1988). They are acquired via gifts from their fathers and husbands at marriage, through dowries and bride prices, and via purchase with proceeds from brewing, sale of milk and dairy products and wage labour. Generally, women do not inherit cattle from their husbands or fathers. Inheritance laws in most pastoral societies differ based on local culture and religious traditions, and are in most cases discriminatory to women. Girls, like boys, obtain animals from their parents during special occasions and through inheritance. Based on gender division of responsibilities, women keep small stock as a source of cash for general family expenses (such as buying food), for paying of school fees, for health care and for investment (Martin 1990). Although men own most of the cattle, they do not make major decisions, such as sale of cattle, in isolation; other household members, particularly women are consulted.

Women are generally associated with animals as milk managers. In most pastoral societies, they milk the cows and know how much milk to extract for household use and how much to leave for the calves for their survival and growth. Women allocate the milk and its products to different uses: for home consumption, exchange and marketing. The amount of milk and dairy products marketed depends on the number of milking cows, the number of people in the household, marketing possibilities, prices of milk and dairy products, and the need to buy cereals and other non-dairy food products.

The Borana women of southern Ethiopia (Coppock 1994), for example, are responsible for milking of animals, selling of milk and buying of provisions for the family. Revenue from women's sales of dairy products contributes 20% of the annual household income of the Borana in southern Ethiopia (Holden and Coppock 1992). The Borana men in northern Kenya own the cattle and are responsible for them. Women are in charge of the calves and small ruminants, milk the cows, process the milk and use the proceeds as they deem necessary (FAO 1979).

The nomadic women in South Dafur in Sudan own some cows but milk all the cows belonging to the family and decide how much milk is used for making buttermilk and ghee for home consumption and for sale, how much milk is given to children, and how much is left for men and guests. The decision is based on the quantity of milk available, the number of children in the family and the possibility of processing surplus milk for sale. Men make decisions on the sale and slaughter of cattle (Kervin 1987). In contrast to the Fulani women in Benin and the Borana women in northern Kenya and southern Ethiopia, the Maasai women in Kenya give money from milk sales to their husbands (FAO 1979).

Among the Ferwan Tuareg in Air, Niger, social status (servant, master) is more important than gender; the wife of the head of the family owns more animals than the man of lower status. In better-off families, men of lower status milk animals under the supervision of senior women. Women distribute the milk from all the cows in the herd among family members. When a man dies, his animals are passed to his son(s), while women who usually own fewer animals pass them on to their sons and daughters in equal numbers. Men sell their animals to buy cereals (mostly millet) for the family. Only when women own more animals than men, are their animals sold to purchase millet (Oxby 1987). Animals from the bridegroom's family are given to the bride's family as dowry among the Tuareg. The animals belong to the father or the eldest brother, but the offspring are passed to the bride for whom dowry was paid and her children, but remain with her father's herd. The bride also receives animals from her family and husband which are kept in her husband's herd for family use (Spiro 1984).

Fulani households in Atakora, Benin, have different budgets. Income from different sources, men from sales of

cattle and women from sales of milk and dairy products, are used to meet different family needs—men for larger expenses and women for continuous expenses. Women own a few cattle, acquired at their birth or during the first year of their lives. When the girl gets married, these animals remain with her father or brothers to safeguard family linkage and solidarity. The animals are inherited by the woman's sons, in the event of death (Bierschenk and Foster 1987, cited in Martins 1990).

Men and women have varying degrees of ownership, access, rights of disposal (e.g. sale, transfer) and use of incomes from sales of livestock and their products. However, this is more to do with shared responsibilities towards meeting family welfare given household resource endowments and needs, rather than control *per se.*

Summary: Gender roles in pastoral societies

Gender division of labour in pastoral societies (nomadic and sedentary) is distinct but not very rigid. Men are decision makers for livestock production and herd management. Women are responsible for vulnerable animals, milking and dairy-related activities, while children herd. When necessary, women assist in herding and watering, and men in milking.

2.4 Gender roles and issues in agropastoral systems

2.4.1 Gender division of labour

Gender division of labour and participation in decision-making processes are influenced by the value and uses of animals and their products. If the animals serve purposes that are within the domain of women's responsibilities, such as feeding the family, women will have greater influence on decisions regarding the animals. Women participate less in decision making regarding animals such as draft oxen that are mostly used by men for ploughing (Martins 1990). Men are responsible for the general welfare of livestock, such as animal care, breeding and herd movements. They organise access to grazing fields and water points. Men accompany younger herders when the risk of crop damage by cattle is high and carry out irregular tasks like building fences for cattle enclosures. Men also buy and sell livestock and assist in milking.

In most societies, milking, processing of milk, allocation of milk to different uses and care of pregnant cows, newborn calves and animals suffering from diseases or injury are the duties of women. They contribute to animal disease control by detecting sickness early because of their close contact with cows and calves during milking. An abrupt drop in the milk yield is an indication of ill health (Bruggeman 1994). Young men herd, water, protect and milk animals. Girls assist in milking, milk processing, watering the animals and food preparation. Children of both sexes do herding, tying, milking and watering of small ruminants kept around the house.

According to Kandiyoti (1990), in the agropastoral systems in North Africa and the Middle East, gender division of labour is based on the main crop grown, the number and type of livestock kept, the development and market orientation of the region, the availability and demand for hired labour and the economic situation at home.

Vabi (1991) examined the division of tasks and responsibilities among the Fulani agropastoralists in south-western Nigeria and north-western Cameroon. Male children are responsible for 68% and 46% of intra-seasonal movements of animals in south-western Nigeria and north-western Cameroon, respectively. Male household heads herd in only 21% and 31% of the observed cases in south-western Nigeria and north-western Cameroon, respectively. In south-western Nigeria 37% of male household heads milk cows compared with 24% in north-western Cameroon. Compared to the 56% of the Fulani respondents in south-western Nigeria who indicated that boys milk cows, only 19% of the respondents in north-western Cameroon indicated that boys do this task. Of the Fulani grazers in southern Nigeria and north-western Cameroon, 76% and 74%, respectively, confirmed that their wives were responsible for processing milk. Furthermore, 54% of the grazers in south-western Nigeria and 32% in north-western Cameroon indicated that their wives sell dairy products.

Although there are similarities in gender division of labour in agropastoral societies, some differences exist. There are few cases among pastoralists, in which milking is not primarily the task of women. Women belonging to the upper caste of the Ankole in Uganda are barred from milking. Milking of cows among the camel-owning nomads is a man's job and the milking of small ruminants is seen as a woman's task (Dahl 1987). Among the agropastoralists in central Nigeria (Waters-Bayer 1988) and the Beja of Sudan (Morton 1990), it is mostly the men and the boys who milk the cows and allocate the milk to different uses. In agropastoral societies with insecurity problems, such as in Dodoth County, northern Uganda, animals are kept far away from the homestead and are herded by male warriors. Under these circumstances, milking and distribution of milk is the responsibility of men.

In the agropastoral systems of southern Africa men look after the cattle, clear the land and plough, while women take on other work in the field; both men and women look after ruminant animals. Women are also involved in cattle rearing and their knowledge of cattle is at par with that of their husbands or sons. Men and women are interdependent in agriculture (Peters 1985).

In addition to animal husbandry, agropastoralists do some cropping to reduce the necessity of selling cattle to buy cereals. In the agropastoral system in central Nigeria, men, who in addition to hired labour and older sons undertake crop cultivation activities, manage the plots. Women help in planting, applying fertiliser and weeding. All family members harvest grain, but women and girls carry most of the harvest home. Women do post-harvest work, though the men construct granaries and help in crop storage. Women also keep small kitchen gardens where they grow various vegetables, condiments, shrubs and trees bearing edible leaves and fruits. They work on their gardens with the help of their children and hired farm boys.

Besides crop and livestock production, men and women are involved in different income generating activities. Men generally make ropes for sale, keep small roadside shops, practice as specialists in traditional medicine and work as wage labourers. Women undertake minor income generating activities such as petty trade in commodities (salt and kerosene), and make handicrafts. They also generate income from food processing. Women's other tasks include childcare, food preparation (the most time-consuming household activity) and other domestic chores such as fetching water and firewood. Children, mostly girls, assist women with domestic chores.

2.4.2 Gender and access to resources and benefits

Agropastoral systems generally evolve out of pastoral systems and thus they have certain features in common. These involve a wide range of customary accesses to livestock and their products as well as to land and labour; and are dependent on individual responsibilities. Contrary to the popular belief that men are the sole livestock owners, women also own livestock and are active in acquiring them.

Among the agropastoral Fulani in central Nigeria, animals belong to men, women and their sons. Women own 27% of all cattle (Waters-Bayer 1988). Women acquire 41% of the cattle from their fathers and 3% from mothers as gifts, they purchase 8% and obtain 48% from offspring. Ownership of livestock is regarded as a source of security and independence, enabling individual household members to meet their obligations, determined by culture. Household members, particularly men and women, jointly make decisions regarding disposal of livestock. Animals cannot be sold, slaughtered or transferred to another herd without seeking women's opinions in the agropastoral system of central Nigeria.

The settled Fulani women in Nigeria are responsible for all milk processing and marketing and decide on the quantity of the milk to be kept for consumption and for sale. They market milk only in the form of cheese and butter and collect income in the form of cash; very little exchange of milk for grain takes place. Marketing is seen as an economic and social activity. Only a handful of wealthy Fulani women and strictly Muslim women sell their milk using female intermediaries. The money they earn is used for everyday necessities and sometimes to buy small ruminants (Waters-Bayer 1986). Revenue from dairy products contributes substantially to household income. In central Nigeria this revenue accounts for 33.3% of total cash income from cattle herds (Waters-Bayer 1985). The majority of the household earnings come from animal sales by men and a small amount comes from sale of manure. Women use most of the proceeds from sales of dairy products to purchase vegetables, fruits and seasonings, and to supplement home grown cereals. Similar findings on women's use of milk, its products and milk revenues are reported in the system in central Chad, where women use revenues from milk and dairy products to purchase additional food items. These women use the remainder of the milk, butter and cheese revenue to buy goods for themselves and their children and to invest in small stock (Bruggeman 1994).

Women in the agropastoral systems in northern Africa and the Middle East are free to move in the countryside, but are restricted to their neighbourhoods in towns and can only go to the market if accompanied by a man. Women come in contact with monetary matters through men and have limited access to resources (Kandiyoti 1990).

The fact that women from the agropastoral systems in Central Nigeria and Chad allocate milk, dairy products, and their incomes to different uses, does not necessarily imply control, as would be implied by the collective household model, but rather fulfilment of agreed responsibilities towards making provisions for their households.

Summary: Gender roles in agropastoral systems

Men and women have varying degrees of ownership, access, rights of disposal and use of incomes from sale of livestock and their products. Women generally sell milk and dairy products and use the proceeds to pay for small regular purchases of food and household items. Men sell live animals and livestock products and use the proceeds to meet unexpected and large family expenses, e.g. medical treatment, school fees and purchase of grains. The varying degrees of access to resources and benefits by different household members is more to do with shared responsibilities towards meeting family welfare, given households resource endowments, needs and gender division of labour, rather than control per se.

2.5 Gender roles and issues in mixed crop–livestock production systems

2.5.1 Gender division of labour in traditional systems

Gender is an important dimension in labour allocation in mixed crop–livestock production systems. Both men and women do a large number of tasks related to animal production, with some degree of variation in involvement from region to region. These tasks include harvesting and transportation of feed (green grasses/weeds, fodder, forages etc.), chaffing of fodder, feeding and milking of animals, cleaning of cattle sheds and sale of milk products through formal and informal channels. Milk processing is primarily the work of women. Children of both sexes graze animals while men make decisions about breeding of animals and marketing. A few examples will be given below to illustrate these points.

There are regional and tribal differences in Togo and in Ghana in the division of labour in traditional livestock farming, particularly in the herding of cattle and small ruminants. The satisfaction of social and economic needs is viewed as the aim of traditional livestock production in Togo (Cheaka et al. 1989, cited in Martins 1990). Abu (1990) looked into the socio-economic conditions of people keeping livestock in northern Ghana. He noted variations in division of labour in livestock production between tribes.

Women in Burundi carry out a more significant part of agricultural work than their husbands though men, as owners of the farm business, regard women's work as assistance (Schorry-Klinger 1990, cited in Martins 1990). Men make decisions on goat keeping, after consultation with their wives. Gender division of labour regarding goat keeping is not strict, but it is usually the men and the boys who herd and women clean the sheds. Men are more involved in tasks regarding keeping of crossbred goats.

In the Ethiopian highlands, women are more involved in cattle production than in arable farming. They clean cow sheds, milk the cows, look after calves and sick animals, cut the grass and supervise feeding and grazing of cows, make dung cakes, butter and cheese and sell these products once or twice a week. Women distribute the milk to different uses. Men feed the oxen and take the animals for veterinary treatment when need arises. Joint decisions by husband and wife are made on the purchase and sale of livestock. Boys, and sometimes girls, generally graze ruminant livestock. During the rainy season, women assist in keeping the animals away from growing crops (Whalen 1984). In Debre Birhan, the average daily amount of time women spend on livestock-related activities are: 23 minutes in milking, 1.25 hours in cleaning the barn, 1.5 hours in collecting dung, 1 hour making dung cakes and 1.75 hours every other day in processing milk (Giglietti and Steven 1986). The same study noted children spending an average of 9 hours a day herding and watering animals and collecting dung.

In Kafr al Bal in the Nile Delta, women are responsible for rearing small ruminants, as well as milking cows and small ruminants, milk processing and sale of dairy products (Zimmermann 1982). These women water cows and buffaloes, cut clover or tether the animals in shady places and prepare dung cakes for fuel. The wife of the head of the household and her daughters-in-law form part of the household. The wife of the head of the household does simpler tasks such as separation of milk, processing and sale of butter and cheese. The daughters-in-law undertake the harder and more difficult jobs such as caring for small ruminants, milking, watering stock, feeding and tethering of animals. Sale of milk within the farming community is seen as the inability to feed children, but the disposal of milk in the form of gifts is acceptable. The family consumes most of the butter and women sell cheese and surpluses of butter to female shopkeepers. Both men and women clean the sheds. Men decide on the purchase and sale of cattle and maintain contacts with co-operatives and the veterinary department. Gender division of labour in cattle farming is different in other parts of the Nile. Here, men take care of the cows, milk and sell most of the milk to the dairy, while women process cheese.

In the Aswan region in Egypt, Khafagy and Sholkami (1987) report that women are hardly involved in agricultural tasks; their ruminant livestock production activities include cleaning of sheds, milking, preparing manure and butter. In wealthy villages, where most of the men work outside the villages, fresh milk is sold and butter and cheese are purchased. In poorer villages, women prepare cheese and butter. Women only engage in income generating activities that can be done at home, mostly poultry keeping. Men raise, sell and purchase small ruminants while boys and girls herd and collect fodder; women traditionally do not engage in fodder collection.

Division of labour in Turkey is based on honour: men who carry out women's tasks are made fun of. Women undertake household chores, stable work, and work in the fields while men assist in driving tractors and ox carts. In Turkey, women manage milk cows. Men help out in the cow shed if there is an expensive high-yielding cow involved or if the shed is equipped with modern technology (Kromka and Kruel 1990, cited in Martins 1990). Azmaz's (1990, cited in Martins 1990) investigation in the same region indicates that women are almost exclusively responsible for milking and selling of surplus milk as well as attending to cows.

In their study of gender differences in livestock production management in the Chitwan District of Nepal, Tulachan and Batsa (1994) estimated the daily labour contribution of men and women to livestock production activities. Women's labour makes up more than 80% of the total labour spent in different livestock raising activities. The average daily hours spent by women farmers in the collection of green grasses/weeds and tree fodder is 3.9 hours, while men spend less than an average of 3 hours daily on the same activities. The time women spend in collecting feed fluctuates by season depending on the intensity of crop production activities. Feeding is done

mainly by women, who spend approximately 2 hours daily on this activity. Men sometimes help, but do not contribute more than 40 minutes daily on feeding. Grazing and cleaning of animal sheds are predominantly women's tasks, with occasional assistance from men. Women prepare concentrates and feed them to lactating animals. Women exclusively do milking during the lean season. Men assist in milking during the crop production season, when women's labour is in high demand. Purchase of manufactured feed (during the dry months) and marketing of raw milk is the responsibility of men.

The findings of Paris (1992) in Nepal reveal the important roles played by women in dairy and how they vary across regions. In the mid-hills of Nepal, the proportion of livestock activities carried out by women are feeding concentrate to large animals (66%), grazing animals (55%), collecting fodder from grassland or forest (53%), cleaning animal sheds (52%) and feeding fodder to large animals (34%). Feeding concentrates to animals recorded the highest share of women's labour in the lowlands of Nepal (54%), followed by cleaning of animal sheds (50%), feeding fodder to large animals (42%), milking of large animals (38%) and grazing of animals (25%). The percentages refer to share of men's and women's total labour for each operation.

In the Ahmedabad and Udaipur districts of India, rich families hire labour to carry out most of the animal husbandry operations. Women of middle income high caste families undertake indoor jobs like milking and feeding, while out-door jobs such as sale of milk, taking animals for artificial insemination or treatment are done by men or hired labour. In the tribal families, women carry out all the management operations (cleaning, feeding, watering, milking, grazing and management of bullocks), except in a few tribes such as those found in Udaipur District where men undertake operations like milking, collection of fodder, feeding, watering, calving and administration of medicine (Rangnekar et al. 1992, cited in Dhaka et al. 1993).

Women account for 33% of the total labour input in the various operations of dairy enterprises in the Karnal District of Haryana State and 32% in Nadia District of West Bengal. Female participation is high in butter and cheese production, collection and chaffing of fodder/grasses, cleaning of cattle sheds and feeding of animals. The preparation of milk products recorded the highest share (100%) of women's labour input in dairying as a percentage of total labour, followed by cleaning of cattle-sheds (80%), collecting and cutting of grass fodder/grasses (32%) and feeding of animals (25%) in Karnal District. Similar results were recorded in Nadia District, with the labour contribution of women being highest in preparation of milk products (86%), followed by feeding of animals (60%), chaffing of fodder/grasses (57%) and cleaning of cattle-sheds and animals (44%) (Dhaka et al. 1993).

In the Punjab Province of Pakistan, the important factors that influence the gender division of labour in livestock production are the place where the animals are kept, the size of the area being farmed and the caste of the family. The material value of the animals and their use impinge on the decision-making powers in cattle farming. Women are involved in all cattle-farming tasks if the animals are kept in the farmyard; larger farms do not involve women in these tasks. The more valuable the animals, the smaller the possibility that women will make decisions on their purchases and sales. If the animals serve a purpose which is in the women's realm of responsibilities, e.g. feeding the family, her influence on decision making is greater than with animals that fulfil purely farming purposes, such as draft oxen (Adelt 1984, cited in Martins 1990).

A study of the participation of men and women in feeding and milking livestock in male and female headed households in Bangladesh show that women participate more in all activities in both households types (Paris 1992). Women and children are closely associated with the management of small ruminants—goats and sheep—in Bangladesh farming families. Rearing of goats is an effective means for poverty alleviation in Bangladesh. It has been observed that with 7–8 goats given to a poor farm family using grazing and cut-and-carry feeding systems, poverty could easily be alleviated (Saadullah et al. 1998). Keeping of goats in Sri Lanka is traditionally a task for women. Adults (both men and women) and children undertake herding. Men and boys cut and carry fodder in the evening when girls and women are cooking (Schmitt 1990, cited in Martins 1990).

Gender division of labour in livestock farming in South-East Asia is similar to that described in other regions. Men are principally responsible for large animals and women for small ruminants. According to Petheram and Basuno (1986), the involvement of family members in small ruminant production varies across villages and households. Women, however, generally take care of feeding, herding and cleaning of small ruminants. Women do not have much say when decisions are to be made regarding sale or purchase of animals, but they are responsible for making day-to-day decisions on livestock production. In Santa Barbara in the Philippines, men are responsible for buffaloes and cattle, but women also contribute towards their care (Paris 1987). In Indonesia, women's contribution to animal husbandry varies by farm area, with their participation growing with increasing farm size (Paris 1992).

In Peru, women are responsible for grazing of animals with the help of children; they gather fodder, look after animals, select and sow seeds and weed. The men are responsible for ploughing, branding of livestock, purchase of agricultural products and harvest of crops. Gender division of tasks and responsibilities is not strict. Though women take care of animals and men take care of crops, decisions on crop and livestock production overlap and influence each other. When men are absent women carry out their tasks. Women are described as 'shepherds' in Latin America; they spend about 38 hours a week looking after cows (McCorkle et al. 1987;

Fernandez 1988). Women in both Peru and Indonesia play significant roles in treating veterinary problems and in marketing animals (McCorkle et al. 1987).

Summary: Gender division of labour in mixed farming systems

Gender division of labour varies across regions. Both men and women take part in livestock management. However, women generally contribute more labour inputs in areas of feeding, cleaning of barns, milking, butter and cheese making and sale of milk and its products than men and children. Children herd animals.

2.5.2 Gender division of labour in intensified mixed farming systems

In intensified mixed farming, different household members are responsible for different tasks in livestock production. Their traditional animal husbandry responsibilities and access to resources and livestock products are subject to negotiation and change over time with intensification (introduction of new technologies). Technological change and market orientation of smallholder dairying, for example, affect the basis of gender division of labour and access to resources and benefits. This section focuses on the extent to which gender roles have changed under intensification of smallholder mixed crop–livestock production systems.

Livestock innovation in mixed systems involves the introduction of high-yielding cows, complementary feed production and feeding strategies, and management technologies for the production of dairy products, mainly fresh milk for sale. Intensified dairying has been shown to potentially raise milk production and household incomes (Walshe et al. 1991; Thomas-Slayter and Bhatt 1994; Pankhurst 1996; Baltenweck et al. 1998; Shapiro et al. 1998). This is an improvement welcomed by everyone in the household, but the welfare consequences of technological change to different household members are not the same in the short term. The Green Revolution in Asia increased labour demand (employment) for both men and women (Conway 1997). There have also been structural changes where the labour burden and income opportunities of women have been reduced in the short run, but alternative opportunities arise over time. The labour contributions of individual family members to intensified dairying are a function of the gender division of labour defined partly by culture and tradition, and the specific nature of the dairy technology adopted. It has been reported that where intensified dairying is associated with hand feeding (stall feeding), the extra labour burden falls disproportionately on women (Chavangi 1983; Whalen 1984; Mullins et al. 1996).

Thomas-Slayter and Bhatt (1994) examined the effect of intensification of dairying in Ghusel, a village in Nepal, and noted some benefits to the households involved and gender-based inequalities. The introduction of the Small Farmers' Development Program (SFDP) and integration of livestock producers into the cash economy through dairy initiatives and milk sales increased dairy activities and altered the roles and responsibilities of rural men and women. SFDP and the National Dairy Corporation facilitated dairying by providing credit and an assured milk market, respectively. These provisions resulted in an intensification of the traditional system requiring additional inputs of capital and labour. Thomas-Slayter and Bhatt (1994) report that, buffalo keeping and milk sales increased the well-being of many households in Ghusel village through improved access to cash and increased food security; these activities also increased inequalities in gender roles and responsibilities. Under the new initiative, buffaloes are stall-fed and women, with the help of girls, undertake all activities relating to their care. This involves a variety of time-consuming and laborious tasks such as collecting feed, cleaning stalls, milking, collecting fodder and feeding the animals. Scarcity of fodder and fuel wood in the village resulted in women and girls travelling longer distances and spending much time collecting forage for animals and household needs. In addition to livestock tasks, women with the assistance of girls, undertake daily chores—cooking, washing, cleaning, child rearing, agricultural work, tending kitchen gardens etc. According to Thomas-Slayter and Bhatt (1994), the new initiative increased women's workload, lessened their mobility and leisure and even resulted in girls dropping out of school. Women acknowledged the economic benefits accruing to the members of the household as a whole, but cited little personal gains from these activities.

The involvement of men in traditional livestock production is largely marginal in village. With the new initiative, young men and boys have more responsibilities for buffalo care. Male involvement was traditionally centred on monetary transactions and crisis situations demanding external assistance, such as calling for veterinary assistance or transporting of livestock. Faced with high financial stakes in terms of initial investment and potential income, men are taking a more active role in buffalo production. Since milk quantity is affected by fodder type and availability, men are slowly becoming involved in some aspects of buffalo management (Thomas-Slayter and Bhatt 1994).

The workload of women in India increased with the introduction of crossbred cows (Muylwijk 1995), which require more feeding and care than local cows. The livestock activities women perform include milking of animals, harvesting and bringing fodder, feeding and watering of animals, cleaning of sheds, preparation of dung cakes, processing of milk, marketing of dairy products and animal health care (Dhaka et al. 1995; Muylwijk 1995).

Seventy-five per cent of the daily harvesting and transportation of fodder is done by women with the help of children. Women, by virtue of being responsible for feed mixing, know how to influence the quality of cow's milk in relation to the products. The work of women, though not usually calculated in monetary terms, is economically important because of scarcity of feed. Rural women in India are known to be working 14–15 hours a day (Muylwijk 1995). Men's livestock-related activities include purchasing of concentrate and fodder and taking animals for treatment and artificial insemination.

In the mixed farming system in Kenya, intensified dairying usually takes the form of zero grazing where water and fodder are stall-fed to cattle, a labour-intensive operation. Maarse (1995) in her study of gender differentiated impacts of intensified dairy farming on socio-economic position of smallholders in five districts (Kiambu, Meru, Migori, Nandi and Vihiga) of Kenya found that women provide 32% of all labour related to dairy farming. Women contribute more labour than men in areas like grass cutting, manure application, feeding animals, general cleaning, milking, fetching water, heat detection and follow-up, and sale of milk. Men contribute about 23% of the total dairying labour, and participate more than women in planting Napier and fodder trees, buying dairy inputs and spraying animals. Hired workers handle 33.3% of the overall dairy farming activities, contributing most in the following areas: grass cutting, Napier weeding, manure application, feeding animals and buying dairy inputs, thus complementing women's labour activities. Children contribute 5% of the total dairy labour, assisting in water collection, sale of milk and application of manure. Mullins et al. (1996) reported similar findings from the Coast Province of Kenya, where women supplied 48% of the total labour input in dairy farms. An earlier study reported women as contributing 85% of the total labour to zero-grazing units of smallholder farms in western Kenya (Chavangi 1983). Women's high labour contribution corresponds both to their traditional roles as agriculturalists and milkers in Kenya. Their crop responsibilities also increased because of shifts in the cropping pattern to accommodate fodder cultivation.

Unlike in Kenya, the role of women in intensified mixed farming in Holetta, Ethiopia, is relatively small with average weekly labour contribution of 2.7 hours, compared with 10.7 hours from men and 24.7 hours from children (Shapiro et al. 1998). Men and children provide much of the additional labour required for intensified dairying.

Studies reviewed in this section point to the same general conclusion: women's labour contribution to intensified dairying is substantially higher than that of other individuals, the exception being in Ethiopia, where children's labour supply is the highest (Shapiro et al. 1998). Where women may be contributing more labour to intensified dairying, men's labour may be higher in other activities. Unless total labour allocation and relative burden are examined, the implication of higher women's labour in dairying cannot be fully understood. Differences in the labour contribution of family members to intensified dairying can be explained by the traditional roles of women in crop and livestock production and the nature of the technology adopted, for example open grazing or stall feeding. Women's labour demand is more likely to increase where the technology is labour-intensive and where gender division of labour entails women performing much of the livestock-related activities. It is generally observed that women invariably do milking, feeding, watering and cleaning of animals. This has significant short-run implications for introduction of new ruminant livestock technologies.

2.5.3 Gender and access to resources and benefits

A concern of many researchers and policy makers involved in ruminant livestock production in mixed systems and the introduction of new technologies is the issue of access to benefits and its impact at the household level. In most traditional dairy production practices, women are responsible for milk allocation and use part or all of the incomes from sale of dairy products to purchase goods for the family. The important concern is whether introduction of new dairy technologies brings intra-household changes in resource and outcome allocation, and how the household as a whole is affected.

In northern Ghana, ethnic traditions prevent women from owning cattle, e.g. in one tribe women can only keep animals after the birth of two children. Division of labour in livestock production also varies between individual tribes (Abu 1990, cited in Martins 1990).

Women own very few animals in the Southwest Province of Cameroon: 0.1% of the goats, 0.15% of all sheep and no cattle (Kerenge 1984). One possible cause of the low proportion of female livestock owners is the restriction of livestock ownership due to sociocultural and economic factors—women have other numerous diverse tasks, and may not have time for keeping livestock.

In Kenya, Luo women have no possibility of taking charge of cattle owned by the family (Chavangi 1983). A woman may buy cows but if she separates from her husband, the cattle remain with him.

In Kafr al Bal in the Nile Delta, sales of dairy products by women contribute to one-third of the family income. This money is spent on every day needs, while proceeds from harvests are spent on larger purchases (Zimmermann 1982).

In 50% of the zero-grazing dairy units in the five districts of Kenya studied by Maarse (1995), husbands are the

main decision makers in relation to land use for cash crop and fodder production. Decisions concerning dairy management such as watering, feeding, milking, cleaning animal sheds, spraying/dipping, hiring employees, selling milk and using dairy incomes are made by women. Men make more decisions in the buying and selling of cows and land. Women in 66% of the households studied made decisions regarding use and appropriation of milk. Husbands and wives receive 33% and 45%, respectively, of the incomes from milk sales. Eighty-five per cent of the respondents (both men and women) indicated that their financial status and family welfare improved after the adoption of zero grazing. An earlier study of small farms in Kenya (Chavangi 1983) showed women contributing 85% of work input required in intensified cattle production. In Bahati Division of Nakuru District in Kenya, the roles of women in livestock production are reported to have increased with intensified dairying (Waiganjo and Maina 1998).

In the traditional crop–livestock systems in the Ethiopian highlands, women milk, process and sell milk and dairy products. Revenue from the sale of butter and cheese is the main source of income for women (Whalen 1984). With the introduction of crossbred cows, men take the milk to the collection points and receive money from it. Though women contribute the least labour to intensified dairy activities, the milk and dairy incomes they collect are higher with intensive dairy than with traditional cattle farming, although the milk incomes collected by men are significantly higher than those of women. Incomes collected by men are largely spent on food and other items for the family (Shapiro et al. 1998). This implies that there are different responsibilities and shared tasks and a lot of flow or exchange of resources and outcomes among family members in the Ethiopian highlands. In this region, selling products and collecting incomes does not mean control of income, and changes in roles played by different family members do not necessarily imply loss of control.

Commercialisation does not lead to women losing access to dairy income in eastern Africa (Maarse 1995; Shapiro et al. 1998). In Ghusel village in Nepal, intensified dairying brought mixed blessings. It led to greater economic security for families through increased milk and livestock sales and employment at dairies, but at the same time circumscribed the lives of women in ways previously unexpected. While acknowledging the economic benefits accruing to the family as a whole, women in Ghusel village complained about the increased workload from the new livestock initiative. According to Kandiyoti (1990), women in South Asia—Pakistan, India, Nepal, Bhutan, Bangladesh and Sri Lanka—have no or limited rights to inherit land and other assets like animals and their access to production resources is minimal.

The traditional right of disposal of the proceeds from milk was taken over from Turkish women when project activities were introduced—the setting up of milk collection places which were under male management (Azmaz 1990, cited in Martins 1990). In north-west Jordan the course of commercialisation has reduced the importance of women in preparing and marketing dairy products (Martins 1990).

Gender division of labour and issues of access to resources and benefits in smallholder livestock production systems in developing countries can be understood better if studies are done using appropriate analytical frameworks or household models consistent with the socio-economic context in which the producers operate. Furthermore, information on gender and ruminant livestock production is more meaningful if gender division of labour, responsibilities and access to resources and benefits in the whole farming system are fully understood.

Summary: Effects of intensification of livestock production in mixed farming on gender roles and access to resources

Technological change and market orientation of smallholder dairying affect the basis of gender division of labour and access to resources and benefits. It generally increases the workloads of men, women and children, particularly that of women. Food purchases are reported to have increased and the economic security of the household improved as consequences of intensification, though men, in most regions, collect most of the milk income from the formal marketing institutions.

2.6 Factors constraining the effective contribution of women in ruminant livestock production systems

As indicated earlier, ruminant animals are an important source of livelihood for millions of smallholder farmers in developing countries, but their productivity remains low (Akhter et al. 1995). For example, Asia has 96% of the world's buffalo and 30% of its cattle, but supplies only 17% of the world's milk (FAO 1990, cited in Paris 1992). The low productivity is explained by both biological and socio-economic constraints. Constraints such as unavailability and high cost of exotic breeds and commercial feed, lack of market access and unstable livestock and livestock product prices, and access to veterinary services and drugs are gender neutral. Studies and experiences in the field indicate that there are some obstacles like lack of capital and access to institutional credit, workload and lack of technical skills and access to extension services that may affect women more than men. Factors such as low literacy level, sex stereotyping of roles and socio-cultural factors, e.g. early marriages, seclusion, childcare and other reproductive chores obstruct women from getting access to productive resources

(Tarfa and Ogunwale 1998). Constrained access to productive resources further limits participation of women and their efficiency in ruminant livestock production.

2.6.1 Lack of capital and access to institutional credit

A critical reason for the slow growth in livestock production in developing countries is the low rate of adoption of available improved livestock technologies (Jabbar and Ehui 1998). This is due mainly to limited capital and access to institutional credit. Credit has been shown to play a major role in the rapid expansion of improved crop technology in developing countries (Malik et al. 1991, cited in Freeman et al. 1998). Many farmers know about livestock technologies and the potential higher benefits they offer compared to current practices. But the intensity of adoption remains low, because improved technologies require initial investments and recurring expenditure which are significantly higher than those required for traditional ownership and management.

In developing countries, access to formal credit for animal production is limited compared to that for crop production (Devendra et al. 1997; Freeman et al. 1998). Livestock credit for example, accounts for under 10% of total agricultural credit in Ethiopia, Uganda and Kenya and few smallholder livestock farmers have access to this credit because of the method and criteria used by the credit institutions to screen applicants. The loans available are limited, thus requiring rationing, and are short term. Short-term loans are not suitable for livestock enterprises, which require longer periods than crops to generate income and capacity for repayment (Freeman et al. 1998).

Women farmers are particularly constrained in raising animals due to lack of capital and access to institutional credit. Potential borrowers in Ethiopia, Uganda and Kenya are required to show existing infrastructure for livestock operations before loans can be approved. Creditworthiness of potential borrowers determined by observable characteristics such as wealth or social standing, is also used in place of collateral security (Freeman et al. 1998). Both of these conditions are unfavourable to smallholders, particularly women who cannot meet the requirements. They often resort to informal loans, borrowing at interest rates higher than those prevailing in conventional financial settings. This makes it impossible for women who cannot afford the high interest rate to be engaged in improved livestock activities.

Women in the Philippines borrowed 77% of the loans from informal sources and used part of the money for purchasing animals (Paris 1992). Farmers' (household heads') co-operatives get credit for agricultural inputs at interest rates lower than those of private banks. Women farmers do not have access to such credit since they are not formally organised into co-operatives and do not have collateral such as land titles to qualify for credit from banks.

One of the formal institutions providing credit to the rural poor, particularly to women, for self-employment is the Grameen Bank in Bangladesh. It exemplifies one micro-lending strategy to overcome social customs restricting women from seeking wage employment and assist very poor women to earn an income and participate in the local economy (Jansen and Pippard 1998; Khandker 1998). It issues loans without collateral, and thus reaches women, one of the most disadvantaged groups in the rural society. In 1986, women made up 74% of the members and accounted for 69% of outstanding loans of Grameen Bank (Hossain 1988). Major activities financed by the Grameen Bank are non-crop agricultural activities, such as raising milk cows, cattle fattening, cattle and goat trading etc. In 1986, 46% of the loans were taken for livestock and poultry raising (Hossain 1988). A loan utilisation index was computed to determine extent of loan utilisation, using data collected from the Dinajpur District in Bangladesh, in 1995. The results showed 79.8% of borrowers with high loan utilisation scores. Younger women and those with small families had the highest loan utilisation (Chowdhury et al. 1998). Results indicate that involvement in credit has improved the relative well-being of women (Osmani and Sinha 1998).

In regions where women are the main dairy operators, such as in the intensified dairying enterprises in Kenya, their inability to obtain necessary credit due to lack of collateral can be a serious drawback to raising the productivity of dairy production.

2.6.2 Workload

Culture and tradition define most of women's roles in the agricultural sector. In most societies, their role as primary caregivers may limit the time women have to spend on non-reproductive activities including livestock production. Women in the agricultural sector are heavily involved in home production activities, which involve childcare, food preparation and hauling of water and fuel. Women in Africa have been observed (Quisumbing 1994) to spend up to 2 hours a day on childcare, 3 hours on food preparation and 2 hours fetching water. In rural Asia, food-processing activities take 2–3 hours a day (Quisumbing 1994). In Bangladesh, women may spend about 6 hours fetching water (McGuire and Popkin 1990, cited in Quisumbing 1994). Pregnancy and cultural seclusion may also limit the participation of women in livestock and other activities outside the home.

Traditional responsibilities and new development initiatives sometimes add to women's workload. Vishwanathan (1989, cited in Rangnekar 1992) indicated that in some areas of India, women work 14–16 hours daily. Women were also noted to be handling labour-intensive and low-output jobs. Although livestock development increases

milk yields and cash flows, it also requires better attention and additional labour in carrying out new tasks such as stall feeding, barn cleaning and fodder collection—jobs in which women contribute significant amounts of labour. This leaves women with little time to participate in extension and training to improve their knowledge and skills. Migration of men from rural areas in search of supplementary income is common in many livestock production systems. Women and children are left behind to share the agricultural tasks of the departed male member. Women are a stable work force in agriculture, lacking only opportunities to improve their operational skills. The *de facto* female-headed farm is a typical situation where women are overworked, both in on- and off-farm wage activities to increase household income (Xuto and Bell 1992).

2.6.3 Lack of technical skills and access to extension services

An important factor that enhances agricultural productivity is the extent to which farmers and farm workers have access to training and extension services (Overholt et al. 1985). Studies (e.g. Cloud 1985) show positive effects of training on technology adoption and agricultural productivity. Women are rarely targeted for livestock-related training and extension services. Information and training programmes are generally directed to men. Why women are not targeted can be explained by the following assumptions: (i) information given to men is automatically passed to their wives; (ii) women are less literate than men and will not understand the proposed technology; and (iii) women are very occupied with housework (Paris 1992). Training given to women is often on activities related to home economics rather than on improving agricultural production.

In the study done by Maarse (1995) among Kenyan dairy farmers, 69% of those first exposed to information regarding the zero-grazing technology were men, while only 19% were women, yet women undertake most of the dairy operations. Similarly, though women are involved in the management of crossbred cows in some areas of the Ethiopian highlands, only one-third of the surveyed women acknowledged receipt of extension advice. The remaining two-thirds of the women had never attended a demonstration or field day programme. Women felt the information they had about improved dairying was inadequate; the main source was from their husbands. The surveyed women expressed a desire for more advice, especially on disease control and feeding (Whalen 1984).

A study carried out in Kano State, Nigeria, showed that women respond promptly and positively to any opportunity that enables them to participate in development. Integration of women into development of processing technologies in Kano facilitated their access to agricultural inputs, supervised credit and training, and improved their social and economic domains (Tarfa and Ogunwale 1998).

These constraints (lack of capital and access to institutional credit, competing use of time, poor technical skills and lack of access to extension services) further limit women's participation and efficiency in ruminant livestock production and in their contribution to food production. Gladwin and McMillan (1989) make the point that without helping women to farm, there can be no realistic turnaround in Africa's food production. To alleviate the food crisis currently facing developing countries, particularly Africa (Winrock International 1992), animal husbandry needs to be more productive to contribute its potential. This requires training men as well as women in ruminant livestock husbandry.

Summary: Constraints to women's participation in livestock production

Constraints to livestock production such as lack of capital and access to institutional credit, competing use of time, poor technical skills and lack of access to extension services affect women more than men, and may further limit the participation of women and their efficiency in ruminant livestock production.

3 Impact of livestock ownership and livestock technology use on child nutrition

3.1 Introduction

Security of intra-household nutrition is a concern raised in the literature on food security. Attention is generally given to women and children, the more vulnerable members of the poor households, because such households sometimes discriminate among its members in distributing food. Generally such discrimination may prevail under conditions of inadequate food supply and there may be specific reasons for discrimination. For example, household members performing energy-intensive tasks in certain seasons may require and be given a higher share of the limited food supply. Such discrimination usually declines and disappears when there is enough food. The problem of intra-household nutrition security is not specific to livestock production systems. However, this section reviews literature on the effects of animal products (especially milk) and the ownership of ruminant livestock on the nutritional status of children in developing countries, because of the specific nutritional benefits of food of animal origin on child growth.

Of the number of children aged 6–24 months that die each year in developing countries, 2.3 million (41%) deaths are attributed to malnutrition (Schroeder and Brown 1994). Malnutrition is a growth condition depicting some degree of functional disadvantage (Neumann and Harrison 1994). Growth retardation in children is a warning signal of increased risk of morbidity and mortality, and delay in physical and mental development (Seireg et al. 1992). Short structure in children is often attributed to genetics. It has, however, been shown that variations in preadolescence child growth are due more to differences in diet and morbidity patterns, a reflection of poverty, than to genetics. These results imply that children should be expected to grow in height in accordance with the National Center for Health Statistics (NCHS) standards (Smith et al. 1993).

3.1.1 Causes of malnutrition

The growth rates of most children in developing countries are below but parallel to the National Center for Health Statistics (NCHS) reference values. Factors that affect child growth include: parental education, household income, types of agricultural production activities, economic and agricultural policies, family size, childcare, taboo and feeding practices, diet quantity and quality, processing and storage of food, water supply, hygiene and sanitation,

health services utilisation, epidemics and political upheaval (Vella et al. 1995; Grosse 1998b). An integrated intervention is therefore necessary to produce the highest impact on children's nutritional status. Nutritional status of children is affected more by the socio-economic factors than by other factors such as health services. If the socio-economic structure does not change, as Vella et al. (1995) argue, the inequality of resource distribution will persist with the continuation of poverty that forms the basis of the nutritional problem. This section examines the impact of dairy product consumption and livestock ownership on children's nutritional status.

3.1.2 Measurements and forms of malnutrition

Nutritional anthropometrics (body measures) parameters such as weight-for-age (W/A), height-for-age (H/A), weight-for-height (W/H), head circumference and upper mid-arm circumference for age are commonly used as bases for assessing malnutrition and evaluating the effects of dietary treatment on children. Weight, height, head circumference and upper mid-arm circumference for age are the percentages of adequacy of each of these measurements based on the respective standards for the child's chronological age (De Gwynn and Sanjur 1974). Malnutrition is depicted in chronic and acute forms. Anthropometrics indicators for acute and chronic malnutrition are W/H and H/A standardised z-scores 2 or more deviations below reference. Weight for age (W/A) (underweight) is an intermediate measure of malnutrition that combines wasting and stunting (Grosse 1998b). Acute malnutrition or wasting denotes short-term factors such as diseases or severe food shortages. It is most frequent among children below 2 years of age (Grosse 1998b). Chronic malnutrition or stunting is more common than acute malnutrition and reflects past shortage of food intake and recurring bouts of diseases. It is common among children older than 1 year of age (Grosse 1998b).

3.2 Livestock ownership, livestock technology use and child nutrition in developing countries

3.2.1 Direct effects of animal origin foods on child nutrition

Foods from animal origin have high energy densities and provide low bulk diets, compared to foods from non-animal origin. This makes it possible for children to obtain more calories in tolerable quantities (Sigman et al. 1991; Grosse 1998b). These foods also provide high quality protein, micronutrients and better nutrition for pregnant and breastfeeding women (Grosse 1998b).

The importance of milk consumption for child growth has been demonstrated numerous times. Several studies have shown significant positive effects of the consumption of food from animal origin on children's nutritional status in developing countries. Seireg et al. (1992) found in urban Nicaragua that non-breastfeeding children between the ages of 2.5 and 5 years who drank cow's milk are less than half as likely to be stunted as non-breastfeeding children of the same age who did not drink milk.

In rural Dominican Republic, milk and sausage consumption have been shown to have a significant positive association with children's nutritional status as measured by W/A, W/H and H/A growth anthropometrics parameters (Smith et al. 1993). Similar evidence from rural Embu District in the Eastern Province of Kenya points to milk, fat and potatoes as key dietary elements in influencing the linear growth in toddlers (children aged between 18 and 30 months) (Neumann and Harrison 1994). The dietary intake of stunted and non-stunted children in Kingston, Jamaica, indicates less dairy product consumption in stunted children (Walker et al. 1990). A similar pattern has been reported in Seoul, South Korea. After adjusting for energy intake of children, animal protein intake correlated most significantly with

height-for-age (Paik et al. 1992).

Findings from studies undertaken by De Gwynn and Sanjur (1974) showed animal protein intake by children from Colombia to be positive and significantly associated with height-for-age and weight-for-age. This finding is supported by research conducted among Kenyan children (Sigman et al. 1991). A similar pattern has been reported in Mexico. Controlling for morbidity, maternal education and nutritional knowledge, and socio-economic status, higher consumption of animal-origin foods (as per cent of energy or protein intakes) was associated with Mexican children being heavier and taller at 30 months (Allen et al. 1992). In Indonesia, children consuming animal-origin foods were found to be less likely to suffer from malnutrition than children on vegetarian diets (Thaha and Pudjiadi 1990).

The addition of cow's milk to the diet of children after weaning can increase linear growth and reduce stunting in populations with low milk intake. In the Khartoum Province of Sudan, 300 children aged 6–26 months were given fortnightly take home supplement of dry skimmed milk or of local beans. Each group of children was followed for 3 to 6 months. The group receiving skimmed milk showed a significant increase in length, compared to the group receiving beans (Vaughan et al. 1991). The introduction of a school milk-feeding programme reduced the prevalence of protein-energy malnutrition—underweight, stunting and wasting of children aged 6–9 years—by half in 2 years, in Ulu Selangor, Malaysia (Chen 1989). It also increased the attendance rate of children during the study period (1985–86). Since there was no major development change in Ulu Selangor, Chen concluded that reduction in the prevalence of protein-energy malnutrition and the improvement in school attendance rate among children were due to the impact of the school milk-feeding programme. The heights of village children in rural Papua New Guinea were found to be strongly correlated with animal protein from meat and fish consumption (Smith et al. 1993).

An examination of the impact of dairy technology adoption on the nutritional status of pre-school (0–59 months) children in coastal Kenya shows consumption of dairy products to have a negative effect on stunting, i.e. children from households with improved cattle breeds were found to be taller than those from households without improved breeds (Nicholson et al. 1998). Dairy technologies reduced chronic malnutrition in Kenyan pre-school children. The same study, however, indicated that dairy technology did not have a significant impact on wasting (acute malnutrition), suggesting that solutions to reduce acute malnutrition in the coast of Kenya may not be obtained only through dairy development intervention, as children do not consume milk in quantities large enough to derive the needed calories to reduce wasting (Nicholson et al. 1998).

3.2.2 Indirect effects of animal ownership and technology use on child nutrition

Ownership of livestock and livestock technologies can give households more opportunities to improve the nutritional status of their children. For example, introducing ruminant livestock technologies—such as intensified dairying using crossbred cows—increases household incomes via the sale of surplus milk and dairy products. This allows households to respond in ways that favour nutritional improvements of children other than direct consumption of milk and dairy products. Higher incomes from sales of milk and dairy products may enable households to:

- purchase high quality non-dairy foods
- hire labour, which may substitute women's dairy labour input, and thus reduce their workload and give them more time for food preparation and childcare
- spend money on improving their sanitation and environment, thereby reducing exposure to infectious diseases

- improve the household's access to better quality and increased quantities of water (von Braun 1995).

All these changes can strengthen the effective demand for health inputs and services and thus contribute towards improving children's growth. In addition, when a household's resources are increased (made possible with introduction of livestock technologies), its ability to respond to existing or new knowledge on nutritional improvements may be increased.

In a study conducted in rural coastal Ecuador, access to market foods, as measured by per capita food expenditures and ownership of livestock, mostly cows, showed the strongest correlation with children's nutritional status (H/A, W/A and mid-arm circumference measures). Children from farm households owning livestock were less likely to be growth retarded than children of farmers without livestock (Leonard et al. 1994). One of the findings from a rural study in Nepal was that households with a milk-producing buffalo had less chance of having a severely stunted child than households without lactating buffalo (Nabarro et al. 1988, cited in Grosse 1998b).

Analysis of data from Zona Da Mata, Minas Gerais, Brazil, showed that only farm households deriving above average percentage of total income from livestock tended to have healthier children according to all three nutrition anthropometrics measures (W/A, H/A and W/H) (Vosti and Witcover 1991). The same study indicated that families who depended more heavily on off-farm employment as a source of income tended to fare worse, both in terms of caloric intake and nutritional status. The authors, however, did not observe a direct correlation between higher incomes and better nutritional status of children. Though dairy and coffee farmers registered the highest and second highest income per capita, only on dairy farms did high incomes accompany healthier children, according to W/A, W/H and H/A anthropometrics measures of nutritional status. The presence of well-nourished children in households with ruminant livestock is probably due to the availability and consumption of high quality protein and calories from dairy products.

Controlling for several indicators of economic status (e.g. occupation, land owned, years of education), Vella et al. (1995) found ownership of a cow to be the significant predictor of H/A (long-term) nutritional status in children in south-western Uganda.

Studies in rural Rwanda indicated that children between the ages of 2 and 5 years old from households with dairy animals (cattle and goats—the only form of dairy livestock in the country) were significantly taller than children from households without (Grosse 1998a). The difference in child growth was explained more by ownership of dairy animals than by household wealth, mother's education and access to land. Controlling for other influences, Grosse (1998a) did not find ownership of non-dairy farm animals to be positively associated with child height in rural Rwanda. Since the economic value of livestock did not account for the positive association of dairy animals with child growth in rural Rwanda, Grosse (1998a) wondered whether consumption of dairy products could be the main contributing factor to child growth.

3.3 Nutritional risks from livestock production and consumption

Consumption of animal products provides both nutritional benefits and dangers. Substitution of milk from ruminant animals for mother's milk, for example, increases the risk of severe disease and death in children below the age of 6 months (Grosse 1998b). Exclusive human milk provides sufficient nutrients to children below the age of 6 months and protects them from persistent or severe diarrhoea (De Zoysa et al. 1991). Animal products are a source of bacterial food contamination and animal parasites (zoonotic infection) (Grosse 1998b). Children living in compounds where animals are kept in the absence of proper veterinary care

and careful hygiene are at higher risk of animal-borne diarrhoeal diseases than other children (Pickering et al. 1986; Grosse 1998a). Studies by Pickering et al. (1986) in Bakua, a peri-urban area in The Gambia, suggest that households keeping chicken and goats are more likely to experience child death than other households. Furthermore, analysis of data from rural Kenya adds comparable information on the association of a greater risk of child mortality to the presence of ruminant animals in living areas (Gemert et al. 1984).

Summary: Livestock and child nutrition

Ownership of ruminant livestock directly and indirectly improves the nutritional status of children in developing countries. Consumption of milk from ruminant animals by children after weaning increases linear growth and reduces stunting. Incomes from sales of milk, dairy products and animals enable households to purchase high quality non-dairy foods; improve their sanitation, environment, quality and quantities of water, thereby reducing exposure to infectious diseases; hire labour, which substitutes women's labour input, and thus reduces their workload and gives them more time for food preparation and childcare. However, substitution of ruminant livestock milk for human milk before the age of 6 months, and the presence of ruminant animals in the living areas without proper veterinary care and good health poses serious risk of poor growth and disease to children.

4 Gender in livestock technology research: Case studies

Gender analysis is required to understand the various roles of men, women and children in farming systems and the way these roles are affected by new interventions. Particular attention is normally given to the roles of women because in many cases they undertake major responsibilities in agricultural production, processing and marketing in addition to performing household chores, and reproductive and child rearing activities. Research for technology generation, testing and adaptation often requires long periods and passes through several stages. When and how gender analysis is considered in the research process may depend a great deal on the nature of the technology being studied and the overall research approach used. Two case studies are presented below that critically examine how gender concerns were included in the two livestock research projects.

4.1 Case study 1: Alley farming for improving small ruminant productivity in West Africa[1]

1. This case study is based on a study by Jabbar et al. (1996).

4.1.1 The setting and the problem

Small ruminants are the main types of livestock kept in the humid zone of West and central Africa. They form a minor part of the crop dominated farming systems in the zone, and are a frequent source of cash for special needs of poor families. Women own a significant proportion of these animals, obtained through inheritance, gifts or purchases. Small ruminants owned by different family members are jointly managed. Management ranges from free ranging where population density is low to year-round confinement and cut-and-carry feeding in densely populated areas. The rearing of small ruminants is mainly the responsibility of women and children, as this activity can generally be under-taken in the vicinity of the household. Men contribute to feed collection where cut-and-carry feeding is required, particularly if it involves travelling long distances. In addition to rearing small ruminants, women in most West African countries contribute a high percentage of total labour input in food production, processing and trade, as well as in domestic tasks.

Observations over time of village herds in southern Nigeria noted that disease and undernutrition were the main constraints to small ruminant production, especially with confined

animals. This indicated the importance of better quality feed, as interaction between diseases and undernutrition was also noticed. With population growth and more intensive crop production, small ruminant management under confinement will increase requiring better quality cut-and-carry feed.

4.1.2 Potential solution and the research approach

In 1978, the Humid Zone Programme (HZP) of the International Livestock Centre for Africa (ILCA, now the International Livestock Research Institute, ILRI), was established in Ibadan, Nigeria, to undertake research for developing low-cost interventions to improve animal nutrition and health as ways of increasing small ruminant productivity. Given that crops dominate the farming systems in the zone, it was envisaged that for better nutrition, a technology beneficial to both crop and livestock would have better prospects for adoption.

Before the establishment of the , the International Institute of Tropical Agriculture (IITA) in Ibadan had developed the alley cropping technology to improve soil fertility, control soil erosion, reduce fallow periods and increase crop yields. Alley cropping is an agroforestry system in which crops are grown in alleys formed by leguminous trees and shrubs. The hedgerows are pruned periodically and the pruning is used as mulch during the crop season. ILRI introduced the alley farming technology, which involved using the non-crop dry season and part of the crop season pruning as protein-rich feed supplements to traditional village diets to increase small ruminant productivity. ILRI undertook agronomic, on-station and on-farm studies to modify alley cropping, to use tree foliage as mulch and fodder. On-station and on-farm studies were also conducted to determine animal response to herbage supplementation and to develop appropriate feeding strategies for utilising limited feed supply. Socio-economic studies were conducted to assess the benefits of supplementation of small ruminants traditional village diet with tree foliage and identify factors related to the potential for adoption of alley farming. Alley farming necessitated the integration of crops and livestock based on household objectives, resources and production practices. A systems approach was therefore pursued in the research programme.

Between 1981 and 1983, some aspects of the technology (viability and performance of alley trees) were tested under real farm conditions with five volunteer farmers. Only male farmers were contacted. Though farmers used tree herbage from the feed gardens to feed animals, they expressed more interest in the mulching function of the trees. No extension services were provided with the on-farm trials, so involvement of the national extension service was deemed necessary, to assist in refining the technology on station and further test on farm for wider diffusion.

The second phase of the project started in 1984 in two villages (Owen-Ile and Iwo-Ate) in Oyo and Imo states. A baseline survey in the two villages showed that women made up 31% of the farming population. Twenty-nine per cent of the adult women indicated farming as their major occupation. Women owned over 50% of the small ruminants (Okali and Sumberg 1985, cited in Jabbar et al. 1996). The research team therefore expected a significant number of independent alley farms to be established by women. Both male and female members of the households were invited to the several village discussion meetings held, but attendance of women was fairly small. Benefits and operational procedures of alley farming were explained in these meetings. Volunteers were sought to participate in the on-farm testing programme. The ILRI team members were assisted at each site by extension staff from the Ministry of Agriculture and Natural Resources.

Women planted only 14% of the 86 alley plots established in the two villages in 1984. Most of these women were heads of their families. The research team postulated a number of hypotheses to explain the apparent low participation of women in alley farming:

1. Village extension workers were all male, so it was felt that either the invitations to meetings were not reaching women or they were not certain about the appropriateness of the technology to their needs and resources.
2. The primary contacts in the villages were men who might have passed information to other men, ignoring women.
3. Meetings were held at times not suitable for women given their other responsibilities, so they could not attend.
4. Although women owned a lot of livestock, they owned little or no land and thus had little incentive to plant trees on family land.

To further understand why few women established alley farms and to further promote their participation, a female research-cum-extension worker was employed in 1985. Although she worked with the main on-farm research team, she contacted, organised and communicated with women members of the households separately. Women were reached through visits to their homes, via churches and co-operatives, and even through local school children who were taught and persuaded to take messages about alley farming to their mothers. The Humid Zone encouraged men to give women land to establish independent alley farms, since women owned a significant proportion of the small ruminant stocks. By the end of 1985, 27 women planted small alley plots on land given to them by their husbands.

Before the trees reached maturity and were ready for use, the female research-cum-extension worker finished her contract and left the team. The special status, facilities and advice given to women were replaced by a general advisory approach by the core ILRI on-farm research team. Women gradually lost interest and most gave up managing alley trees. In 1990, only 3 out of the 27 alley plots established by women with the assistance of the female research-cum-extension worker were functional. While all 15 alley plots belonging to women established under the general community approach during the first 2 years of the on-farm trial were still operational, their level of performance varied widely.

4.1.3 Conclusion

Several lessons were learnt about the involvement of women in alley farming.

- Except for widows, women in West Africa do not normally own or inherit land, nor do they make the ultimate decisions on land use. Women are, however, given separate land by their husbands for farming to meet their specific responsibilities. Such land can be taken from women at any time, if the need for alternative use arises. Though cultivation of separate plots by women is common, the temporary nature of access to such land makes it unsuitable for establishment of independent alley farms, which require long-term access for growth, maturity and use.
- The small ruminants owned by women are managed together with the other animals owned by the family. These are mainly free roaming animals, given household wastes and crop residues as supplements. Women feed the animals most of the time. Cutting herbage to feed animals is a new practice, growing in importance with an increasing number of small ruminants being managed under confinement. Both men and women participate in herbage cutting, irrespective of who planted the trees and on which plot. A family alley farm is therefore likely to benefit both men and women and it was not necessary to encourage establishment of separate alley farms by women. This is confirmed by the female research-cum-extension worker's recommendation at the end of her contract that a common alley farm be built up for the nuclear and extended families.
- All women farmers and women participating in farming activities with their husbands and

other members of the households need to be exposed to new technology so that they understand the implications of adoption and take an active role in decisions about adoption. Participation of women should be sought within the framework of the team, rather than by using special approaches that may be difficult to replicate.

4.2 Case study 2: Dual purpose cows for smallholder farming systems in the highlands of Ethiopia

4.2.1 The setting and the problem

Ethiopia accounts for 50% of the highland area of tropical Africa and has the highest livestock population in the region. The highlands with areas 1500 m or more above sea level, are favoured by good soils and climatic conditions allowing higher productivity of crops and livestock and higher population densities than elsewhere on the continent. Cattle, sheep and goats are the dominant types of livestock in the mixed smallholder farms. Here, livestock are very important as they provide subsistence, security and assets for households, and draft and manure for crop production; livestock also perform other social and cultural functions. Men, women and children participate in animal husbandry to varying degrees. Both men and women take part in harvesting, transportation and chaffing of fodder, feeding of animals, milking, cleaning of sheds and sale of milk. Processing of milk is solely the responsibility of women. Children of both sexes tether and graze animals.

Ethiopian agriculture has been using indigenous ox traction for centuries. An average household has a pair of oxen plus a follower herd of several head to replace older oxen and for other functions. With population pressure, cropping intensity has increased and marginal lands, including grazing areas, are being cultivated. These have created feed shortage in terms of quality and quantity, and contributed to low animal productivity and land degradation.

4.2.2 Potential solution and the research approach

Given that the consequences of population pressure on cropland are irreversible in the near future, a possible avenue to solve the feed problem is to reduce the number of low productivity indigenous zebu cattle and replace them with better quality animals. Another possibility is to use the local cows for both draft and milk, as practised in some South and South-East Asian countries. But the effects of using local cows for dual purpose while feed is scarce will be to reduce their milk production and reproductive performance. A third possibility is to use crossbred cows for dual purpose—to produce milk and traction power. Crossbred cows are already adapted and used for dairy in the highlands of East Africa, including Ethiopia. Because of their larger size and strength and higher milk yielding potential, it may be possible to use them for dual purpose on smallholdings whose power requirement is modest. Any negative effect of draft on milk output and reproduction may be compensated for by the better feed to which they are already exposed as dairy animals. The use of crossbred dairy cows for traction, rather than oxen, would reduce the stocking rate and alleviate overgrazing, entailing better management of natural resources. Furthermore, a smaller, more productive herd will release capital and feed resources to achieve more sustainable production systems, higher incomes and better nutrition.

The Ethiopian Agricultural Research Organization (EARO) and ILRI started a research programme on crossbred cows for both milk production and draft in 1989. The project envisaged on-station and on-farm stages. Between 1989 and 1993 on-station studies were conducted to determine if there was a trade-off between traction and milk production. The aim was to develop strategies for feeding crossbred cows for both milk production and traction, to increase their efficiency in both areas. The results showed that with appropriate feeding

regimes dairy cows could be used for draft purposes without any detrimental effects on lactation and reproduction, but the calving interval will be extended. High productivity indices for well-fed working crossbred cows indicated that the technology has the potential to reduce stocking rates, increase efficient use of on-farm resources and raise farm productivity (Zerbini et al. 1998).

The scope of the on-farm research was not detailed in the beginning, rather it evolved with experience. In 1993, and ILRI initiated on-farm testing of the technology in villages around EARO's Holetta research station in a joint effort with 14 farmers, half using crossbred cows for milk production only and the other half using crossbred cows for both traction and milk production. The purpose was to establish whether and how crossbred cows requiring new feed production and feeding strategies could be managed for dual purpose in real farm conditions. Another objective was to evaluate the economic performances (investment returns) of crossbred dairy cows on smallholder farms and their impacts on total household resource use, including labour. Thus, biological and socio-economic data including labour by gender were collected. Whole farm analysis, based on the concept of the farm as a system, indicated that it was feasible and profitable to use crossbred cows for both milk production and traction (Mengistu Buta 1997). The analysis showed gender division of labour for various farming activities as currently practised and also revealed that total household labour input for farms with crossbred cows would increase, compared to local livestock rearing, but did not show what changes would occur by gender.

Before cow traction was introduced, only oxen were used for traction in the study area. and ILRI felt the need to find out whether farmers would be willing to use cows for traction, this not being a traditional practice. Thus in 1993 a consultant carried out an anthropological study at the on-farm testing site among 52 farmers without prior experience with crossbred cows. The aim of the study was to understand the farmer's attitude toward the use of crossbred cows for both milk production and traction. The study was conducted in the period just before and after most of the 14 selected farmers received their crossbred cows. Nineteen per cent of the farmers surveyed thought it was feasible to use cows for ploughing (Pankhurst 1993). For a complex new capital-intensive technology about which farmers did not have previous experience, a 19% approval rate was encouraging. However, this survey did not solicit household members' attitudes and perceptions about the technology on their welfare though the technology would have implications for their workload, income, and food and nutrition security. Whether discussions with all members of a household about their perceptions of the potential benefits and costs would have changed the household's decisions about dual use of cows was not known.

In 1995, the on-farm research programme was expanded to another 60 households with crossbred cows and 60 with indigenous cattle. To select farmers to participate, volunteers were sought from a number of villages; people showed a willingness to participate. The project then selected 60 farmers based on the following criteria:

- willingness to use crossbred cows for traction and milk production
- planting and use of improved fodder and forages
- use of artificial insemination and veterinary services
- improved management of cows, calves and milk
- willingness to share information with the project.

Observation of the initial 14 farmers indicated that gender (age and sex) was an important variable in the adoption, use and performance of crossbred cows, according to the gender division of labour. Men contribute 90% of the time for hand feeding animals, and women and

children 10%. Herding is mostly done by children between ages 10 and 16 years and requires 10 hours each day. Women contribute 50% of the labour for barn cleaning, children 33% and men 17%. Women account for 81% of the milking labour per day, men 16% and children 3% (Mengistu Buta 1997). So at this stage, along with biological data, on-farm monitoring also included data on intra-household resource allocation, task sharing, income generation and expenditure patterns.

While preparing for the expanded on-farm testing another anthropological survey was conducted in 1995, to assess the acceptability and potential diffusion of the new technology. The survey sought to understand the attitudes of the farmers selected by the project in 1993 and 1995, those who were rejected or withdrew from the project and neighbouring farmers who were not considered by the project. The study also intended to verify whether there had been any change in farmers' attitude towards the use of crossbred cows for traction and milk production, since the previous survey of 1993. The survey also aimed at establishing the profile of likely innovators of the new technology and to predict which of the selected farmers were likely to be the most successful adopters. The results showed that 51% of the farmers believed that crossbred cows could plough and give milk simultaneously. Forty per cent of the farmers believed that using cows for ploughing would result in a decrease in milk yield. A few farmers even suggested that milk yields would increase after traction because the bodies of the cows would be relaxed. Some claimed that ploughing and milk production were complementary, since cows that plough eat more and hence give more milk. It was the younger, more educated and smaller landholders who believed crossbred cows could plough and produce milk (Pankhurst 1996).

During this phase of field work, the research team realised that the impact of the technology should be measured not only in terms of intra-household labour, income and expenditure allocation, but also in terms of human nutrition, particularly of women and children. Dairy with crossbred cows could have an impact on human nutrition both directly via consumption of increased milk and dairy products and indirectly via sale of increased output and purchase of more and better quality food. In traditional cattle production systems, local cows produce 2–3 litres of milk per day, part of which is consumed and part of which may be sold fresh or more commonly after processing into butter or cheese by women. Crossbred cows, however, produce 4–5 times as much milk per day (8–15 litres per day) as local cows. A higher proportion of this milk is sold fresh to the Dairy Development Enterprise (DDE), a government dairy marketing and processing parastatal that has collection centres for fresh milk. A smaller proportion of the milk, but higher in volume than with local cows, is used for home consumption, especially by children, and for processing into cheese and butter for sale by women. Since alleviating poverty and improving food security are ultimate goals of technology generation and diffusion, in 1996 and 1997 additional questions on food consumption, nutrition and health were added to the on-going survey. The objective was to assess the impact of dairy–draft technology on the welfare of household members, particularly women and children, and to identify policy options that could help ensure that the benefits are equitably shared by all. The 1997 survey is being repeated in 1999. Analysis of all the data is also in progress.

4.2.3 Conclusion

A few lessons can be learnt about gender issues from the dual-purpose cow project.

- The project envisaged on-station and on-farm stages in the research process. The focus of the on-station stage was to establish the biological feasibility of using crossbred cows for traction and milk production. The activities and scope of on-farm research, which involve gender, were not detailed at the beginning of the project, they evolved with experience.

During the initial design and at the early stage of implementation of the on-farm tests, the primary interest and focus of the project was on biological performance of the cows when used for dual purposes under farm conditions. Some attention was also given to profitability and labour implications, including gender, but the gender aspect was not analysed with sufficient detail.

- Though anthropological surveys were carried out before and during the early stage of the on-farm tests they only focused on whether or not crossbred cows would be used for traction and by which farmers—young or old, rich or poor, educated or illiterate. The gender implications of crossbred cows, whether used for dairy only or for dairy and traction, were not addressed because of the focus on the cows rather than on the families whose benefits were the ultimate objective.

- Though anthropological surveys were carried out before and during the early stage of the on-farm tests they only focused on whether or not crossbred cows would be used for traction and by which farmers—young or old, rich or poor, educated or illiterate. The gender implications of crossbred cows, whether used for dairy only or for dairy and traction, were not addressed because of the focus on the cows rather than on the families whose benefits were the ultimate objective.

- During the second phase of the on-farm testing, socio-economic issues were given more detailed attention along with biological interests. The socio-economic aspects monitored included intra-household resource allocation, gender division of labour and responsibilities for sales and purchases of farm products. During this phase, the team realised that the impact of the dairy–draft technology should also be measured in terms of direct and indirect effects on household nutrition, particularly of women and children. A year after the second phase was started, additional questions on nutrition and health were therefore added to the ongoing survey.

Experience with the project suggests that the involvement of men, women and children at the beginning of the project would have indicated the likely effects of the new technology on the farming and livelihood systems, identified expectations of the farmers about the project, and pointed out potential problems and remedies. This could have helped any modifications in the design of the technology or its testing process and eventual adoption.

5 Summary and conclusion

5.1 Gender roles in smallholder ruminant livestock production systems

Work on gender and ruminant livestock production is limited, especially gender disaggregated data on work sharing and access to resources and benefits. Most of the studies did not use any conceptual or theoretical constructs for analysing gender roles, though one can relate narratives and descriptions to either resemble the tenets of unitary or collective household model. Some of these studies are more rhetorical than empirical.

Available information on gender roles in the smallholder ruminant livestock production systems of developing countries indicates that all household members play significant roles in animal husbandry. The review shows variation in the extent and nature of involvement of women, men and children in ruminant livestock production according to culture, religion, stage of economic development, species of predominant animals, farming systems and population pressure. In spite of the variation noted, some tentative, general conclusions can be reached. Aspects of animal husbandry such as care of the young, pregnant and sick animals, processing of milk, sale of dairy products and milk in pastoral systems are mainly undertaken by women. The gender responsible for milking, cleaning cattle sheds, collecting and transporting feed; feeding animals and selling milk varies between regions. Men are generally involved in herd management, sale of animals, purchase of feed and sale of milk in intensified systems. Children, principally boys, herd animals. Girls assist in herding, especially of small ruminants.

Men and women, both have varying access to resources and products from animal husbandry. Obstacles such as the lack of capital and access to institutional credit, competing use of time, and lack of technical skills and access to extension services may affect women more than men and further limit women’s participation and efficiency in ruminant livestock production. The issues surrounding ownership of livestock, access to resources and benefits, allocation of livestock, its products and incomes and their implications for gender roles, equity and household welfare are not well understood and require further research using appropriate conceptual and theoretical frameworks.

5.2 Impact of ruminant livestock and ruminant livestock technologies on child nutrition

From the literature reviewed, a few implications can be drawn about the relationship between livestock and the nutritional status of children. Livestock ownership directly and indirectly

affects the nutritional status of children in developing countries. The significant correlation of the quantity of milk consumed by children and the nutritional anthropometrics variables corroborates the importance of protein food sources from animal origin to child growth. Child growth depends on the quality of their diet; a better quality diet is important in fostering growth in toddlers. Nutritional status of children with low consumption of dairy products can be improved with ruminant animal product intake. However, consumption of non-human milk before the age of 6 months, and the presence of ruminant animals in the living area without proper veterinary care and good hygiene pose serious risks of disease to children.

Nutritional status of children may be easily improved from dairy animals if all the milk produced is not sold. Even families with limited land resources can raise dairy animals such as goats that require fewer resources than cattle. As Grosse (1998b) suggests, promotion of dairy animals can be an effective tool in preventing stunting in developing countries.

There is a common misconception that dietary treatments of growth-retarded children are a waste, since the damage has already been done and cannot be improved upon (Seireg et al. 1992). Although height is not as responsive as weight to nutritional interventions, Waterlow and Golden (cited in Seireg et al. 1992) provide evidence of rapid responsiveness of linear growth during a relatively short period of treatment of malnourished children. Restoration of normal height is possible, up to the age of about 10, in the absence of continuing deprivation (Garrow and Pyke 1967). In his review of the growth effects of supplementary feeding programmes, Golden (1988) notes that the majority of the cases that have reported gains in height have been based on the use of milk or soya-based supplements. Malcolm (1970, cited in Seireg et al. 1992) documented growth responses of children in boarding schools in Papua New Guinea to be proportional to the amount of milk in the supplement. The use of milk to improve growth is a realistic approach for low-income preschoolers.

The fact that individual indicators (such as milk consumption, ownership of cows) are associated negatively with malnutrition when the influence of the other factors is accounted for in some of the reviewed studies, suggests that specific focused interventions would be of value. The majority of children from the rural areas of developing countries with ruminant livestock in the farming system would be less malnourished if their mothers (parents) are given nutrition education that would encourage them to make optimum use of available food, particularly those of animal origin and other resources.

Gender division of labour and issues of access to resources and benefits in smallholder livestock production systems in developing countries can be better understood if studies are done using an appropriate analytical framework or household models that are consistent with the goals and the socio-economic context in which the producers operate. A note on a possible framework for gender analysis in livestock technology research is given below.

5.3 Gender analysis in livestock technology research: A possible framework

The literature on gender indicates that in analysing gender roles most researchers used two broad household models, though others did not explicitly use any model. The characteristics of the two household models are briefly described below. The theoretical underpinnings of the household models are based on the new household economics pioneered by Becker (1965) and synthesised by Singh et al. (1986) and Haddad et al. (1997). The essential feature of Becker's (1965) approach is that, with a set of preferences, the household combines its resources (principally labour/time) and marketable goods to generate household utility. The household models—unitary and collective—both treat the farm household as a unit of production and consumption.

5.3.1 The unitary model

This model takes Becker's (1965) view, treating the household as a single entity with one set of preferences, represented by a household utility function. Given a set of prices, the household pools its resources and allocates them among its members according to their competence in converting the resources into goods from which the household derives utility.

An attractive feature of the unitary approach is that the arguments in the utility function can extend to cover the demand for any type of good and its distribution among household members (Pitt 1997). Although the unitary approach allows for intra-household analysis, i.e. analysis of differential outcomes across household members as the product of a single decision maker, it does not attribute diverse outcomes to variations in preferences of household members. This implies that preferences of household members are aggregated, whether or not they vary. The conclusions resulting from the application of the unitary model have been questioned on this basis. Samuelson (1956), Sen (1966) and Becker (1974, 1981) outlined possible solutions to the problem, though some of these have been questioned in the development context.

Folbre (1986), Bruce (1989) and Alderman et al. (1995) suggest that the identity of the family member controlling income affects how it is used. It is particularly maintained that incremental income effects on household food expenditure and nutritional status are larger from income controlled by women rather than by men (Katz 1995; Quisumbing et al. 1995; Thomas 1997). This suggests that the unitary view of the household can have serious limitations for design of food security policy, implementation and evaluation, if household members do not have a common goal but rather act as individuals.

5.3.2 The collective models

Alternative models, 'collective household models', that allow heterogeneity in preferences among household decision makers have been developed recently (Ulph 1988; McElroy 1990; Kanbur 1991; Carter and Katz 1992; Chiappori 1992; Lundberg and Pollak 1993). These models explicitly consider the household as a collective entity, but with more than one decision-making unit. They allow the household welfare index to be dependent on prices and income, as well as tastes, thereby not requiring any unique index to be interpreted as a utility function (Chiappori 1992; Haddad 1994; Haddad et al. 1997). Collective models are categorised as co-operative and non-co-operative depending on the allocation mechanism.

The co-operative models are grouped into two classes. The first one assumes that household decisions are always efficient in the Pareto sense (Chiappori 1992; Browning et al. 1994). The rules of distribution regulating intra-household allocation are estimated from the data. The second model, in addition to assuming Pareto optimality, applies more structure on the household, by depicting household decisions as resulting from some bargaining process and applying the tools of co-operative game theory (Manser and Brown 1980; McElroy 1990). The division of gains from household formation is modelled as a function of each member's threat position.

The non-co-operative approach (Ulph 1988; Kanbur 1991; Lundberg and Pollak 1993) does not assume that members necessarily enter binding and enforceable contracts with each other. It assumes that household members have different preferences, do not pool resources and act as autonomous subeconomies. The only link between individuals is the net transfer of income between them (Haddad et al. 1997). The tenets of collective models may not be applicable in many developing countries, where men and women may not always own different resources. Division of responsibilities and tasks, and ownership of livestock and collection of revenues from sale of different farm products by different family members

(husbands, wives and children) do not, in most cases reflect control of resources, income or other outcomes. Also there may be flows of resources and incomes between members of different sexes in the household, but such flows do not generally denote control and exchange (e.g. intra-household labour market) relationships, but rather sharing of responsibilities and incomes to assist individuals meet their socially assigned responsibilities, which contribute towards the attainment of family goals and welfare.

The norm in most developing countries is that couples marry with common objectives—to share their lives together happily to the extent possible, have children and raise them together. Other reasons to form families include religion, culture and the history of human societal evolution. This necessitates division of responsibilities and tasks by gender, a phenomenon that has existed culturally since the beginning of humankind. Gender division of responsibilities and tasks was defined for different household members, given the resource base, population pressure and economic conditions. Though the economic, demographic and resource endowments have been changing, gender division of labour—a cultural norm—has changed more slowly. It is a structural problem that cannot be always changed by law or regulation. However, technological change, based on research and market opportunities, can alter division of labour by gender. The unitary model may thus be a more appropriate framework in the context of most developing countries. Within this framework, there may still exist gender inequities in terms of work burden and benefits, which need to be understood and addressed to make development more equitable. Questions arise when there is a major imbalance or when a new intervention creates imbalances in the volume of work between men, women and children. Examples of these questions are why there is an imbalance and whether it is ‘fair’ (according to what criteria) and permanent, whether it is subject to change over time, and how imbalances in workload influence current and future welfare of the households.

Changes resulting from the introduction of new agricultural technologies may create temporary imbalances in roles and in access to resources and benefits. These impacts of change have to be measured in terms of net benefits to the family rather than to specific individuals; these impacts should also be evaluated in terms of temporary or permanent imbalances in the family. Some technological changes, such as the green revolution, initially seemed to increase the labour burden of women and reduce their access to traditional cash generating activities as in rice processing, for example. However, adjustments in labour allocation by gender have taken place both at the household and higher social/economic organisational levels through the extension of markets and other institutional changes. Structural change in employment is an essential feature in the process of development, and may negatively affect some family members in the short run, but not necessarily in the long run.

Summary: Conceptual models for gender analysis

Research on gender and agricultural production needs to be undertaken using appropriate conceptual and theoretical constructs that fit the varying socio-cultural situations in the developing world. The theoretical underpinnings of such a framework can be based on the new household economics. The tenets of the collective models may not be applicable in many developing countries, where men and women do not always own different resources, thus the simpler unitary model may be appropriate.

References

Abu K. 1990. *Socio-economic study of livestock in the northern region*. Draft Report for ZOPP Project Planning Workshop, GTZ.

Akhter S.K., Banu S., Sarker N.J., Joarder R.I and Saha R.R. 1995. Women in farming and income earning: Study of a Gazipur village. *Journal of Rural Development Bangladesh* 25(2):79–98.

Alderman H.P., Chiappori L.H., Hoddinott J. and Kanbur R. 1995. Unitary versus collective models of the household: Is it time to shift the burden of proof? *The World Bank Observer* 10(1):1–16.

Allen L.H., Backstrand J.R., Stanek E.J., Pelto G.H., Chavez A., Molina E., Castilo J.B. and Mata A. 1992. The interactive effects of dietary quality on the growth and attained size of young Mexican children. *American Journal of Clinical Nutrition* 56:353–364.

Ashby J. 1999. *Poverty and gender: A proposal for action research.* Paper Prepared for the CGIAR Conference on Poverty, San Jose, Costa Rica, 14–16 September 1999. 14 pp.

Baltenweck I., Staal S.J., Owango M., Muriuki H., Lukuyu B., Gichungu G., Kenyanjui M., Njubi D., Tanner J. and Thorpe W. 1998. *Intensification of dairying in the Greater Nairobi Milk-Shed: Spatial and household analysis*. KARI/ILRI Collaborative Research Report, Nairobi, Kenya.

Becker G. 1965. A theory of the allocation of time. *Economic Journal* 75:493–517.

Becker G. 1974. A theory of marriage. Part II. *Journal of Political Economy* 82(2):S11–S26.

Becker G. 1981. *A treatise on the family*. Cambridge, Mass., USA: Harvard University Press. 288 pp.

De Boer J., Yazman J.A. and Raun N.S. 1994. *Animal agriculture in developing countries: Technological dimensions.* Development Studies Paper Series. Winrock International Institute for Agricultural Development, Morilton, Arkansas, USA. 43 pp.

Boserup E. 1970. *Women's role in economic development*. St. Martin's Press, New York, USA. 283 pp.

Bourgeot A. 1987. The Twarek women of Ahaggar and the creation of value. *Ethnos* 52(1–2):103–118.

von Braun J. 1995. Agricultural commercialization: Impacts on income and nutrition and implication for policy. *Food Policy* 20(3):187–202.

Browning M., Bourguignon F., Chiappori P.A. and Lechene V. 1994. Income and outcomes: A structural model of intrahousehold allocation. *Journal of Political Economy* 102(6):1067–1096.

Bruce J. 1989. Homes divided. *World Development* 17:979–992.

Bruggeman H. 1994. *Pastoral women and livestock management: Examples from northern Uganda and central Chad*. Dryland Networks Programme Issue Paper 50. IIED (International Institute for Environment and Development), London, UK. 28 pp.

Camoens J.K. 1985. Asian livestock production and management systems. In: Camoens J.K., McDowell R.E., de Boer A.J., Wimaladharma K.P., Bawden R.J. and Moog F.A. (eds), *egional workshop on livestock production management. The proceedings*. Asian Development Bank, Manila, The Philippines. pp. 3–35.

Carter M. and Katz E. 1992. *Household resource allocation when income is not pooled: A reciprocal claim model of the household economy*. Paper presented at the IFPRI/World Bank Conference on Intrahousehold Resource Allocation: Policy Issues and Research Methods. IFPRI (International Food Policy Research Institute), Washington, DC, USA. pp. 95–111. (Mimeo).

Chavangi N.A. 1983. *Women's role in the livestock sector with special reference to Kenya*. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy.

Chavangi N.A. and Hansen A. 1985. *Women in livestock production with particular reference to dairying*. Expert Consultation on Women in Food Production, FAO, Rome, Italy, 7–14 December 1983. 12 pp.

Chen S.T. 1989. Impacts of a school milk programme on the nutritional status of school children. *Asia-Pacific Journal of Public Health* 3:19–25.

Chiappori P. 1992. Collective labor supply and welfare. *Journal of Political Economy* 100(3):437–467.

Chowdhury S.H., Kashem M.A. and Miah A.M. 1998. Loan utilization behaviour of the women beneficiaries of Grameen Bank: An empirical study in Bangladesh. *Economic Affairs, Calcutta* 43(3):160–167.

Cloud K. 1985. Women's productivity in agricultural systems: Considerations for project design. In: Overholt C., Anderson M.B., Cloud K. and Austin J.E. (eds), *Gender roles in development projects. A case book*. Kumerian Press, West Hartford, Connecticut, USA. pp. 17–56.

Conway G. 1997. *The doubly green revolution: Food for all in the twenty-first century*. Penguin Books, London, UK. 335 pp.

Coppock L. 1994. *The Borana plateau of southern Ethiopia: Synthesis of pastoral research, development and change,* 1980–91. ILCA System Study 5. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 20 pp.

Dahl G. 1987. Women in pastoral production. In: Dahl G. (ed), The realm of pastoral women. *Ethnos* 52(1–2):246–280.

Devendra C., Thomas D., Jabbar M.A. and Kudo H. 1997. *Improvement of livestock production in crop–animal system in rainfed agro-ecological zones of South-East Asia.* ILRI (International Livestock Research Institute), Nairobi, Kenya. 107 pp.

Dhaka J.P., Singh C.B., Patel R.K. and Sigh L. 1993. Role of farm women in dairy farming sub-systems in rural India. In: Singh K. and Schiere J.B. (eds), *Feeding of ruminants on fibrous crop residues. Aspects of treatment, feeding, nutrient evaluation, research and extension. Proceedings of an international workshop held at the National Dairy Research Institute, Karnal, Haryana, India, 4–8 February, 1991*. ICAR (Indian Council of Agricultural Research), Delhi, India. pp. 67–76.

Dhaka J.P., Singh C.B., Muylwijk J. and Chakravarty R. 1995. Gender analysis of dairy and crop farming systems in Karnal District. In: Singh C.B., Rao S.V.N. and Jain D.K. (eds),

Farming systems research for improving livestock production and crop residue utilisation. Proceedings of a national seminar held at the National Dairy Research Institute, Karnal, Haryana, India, November 24–26 1994. Indo-Dutch Project on Bioconversion of Crop Residues, Wageningen, The Netherlands. pp. 129–139.

Dupire M. 1963. The position of women in a pastoral society (The Fulani WoDaaBe, nomads of the Niger). In: Paulime D. (ed), *Women of tropical Africa*. University of California Press, Los Angeles, California, USA. pp. 47–92.

FAO (Food and Agriculture Organization of the United Nations). 1979. *Women in food production, food handling and nutrition with special emphasis on Africa*. Food and Nutrition Paper 8. FAO, Rome, Italy. 223 pp.

Feldstein H.S. and Poats S.V. 1989. *Working together: Gender analysis in agriculture.* 2 Volumes. Kumarian Press, West Hartford, Connecticut, USA.

Fernandez M. 1988. Technological domains of women in mixed farming systems of Andean peasant communities. In: Poats S., Schmink M. and Spring A. (eds), *Gender issues in farming systems research and extension*. Westview Press, Boulder, Colorado, USA. pp. 271–280.

Folbre N. 1986. Hearts and spades: Paradigms of household economics. *World Development* 14:245–467.

Freeman H.A., Jabbar M.A. and Ehui S.K. 1998. Role of credit in the uptake and productivity of improved dairy technologies in Ethiopia. In: Freeman H.A., Jabbar M.A. and Ehui S.K. (eds), *Role of credit in the uptake and productivity of improved dairy technologies in sub-Saharan Africa*. Socio-economic and Policy Research Working Paper 22. ILRI (International Livestock Research Institute), Addis Ababa, Ethiopia. pp. 16–35.

Garraw J.S. and Pyke M.C. 1967. The longterm prognosis of severe infantile malnutrition. *Lancet* 1:1–4.

Gemert W., Sloof R., Ginneken J.K. and Leeuwenburg J. 1984. Household status differentials and childhood mortality. In: van Ginneken J.K. and Muller A.S. (eds), *Maternal and child health in rural Kenya*. Croom Helm, London, UK, and Sydney, Australia. pp. 271–280.

Giglietti R. and Steven R. 1986. *Labour requirements in livestock enterprises among ILCA sample farmers in Debre Berhan area*. Highlands Program, Addis Ababa, Ethiopia. 44 pp.

Gladwin C. and McMillan D. 1989. Is a turnaround possible without helping African women to farm? *Economic Development and Cultural Change* 37(2):345–369.

Golden M.N.H. 1988. The role of individual nutrient deficiencies in growth retardation of children as exemplified by zinc and protein. In: Waterlow J.C. (ed), *Linear growth retardation in less developed countries*. Nestle Nutrition Workshop Series 7. Raven Press, New York, USA. pp. 143–163.

Grandin B.E., de Leeuw P.N. and de Souza M. 1991. Labour and livestock management. In: Solomon Bekure, de Leeuw P. N., Grandin B.E. and Neate P.J.H. (eds), *Maasai herding: An analysis of the livestock production system of Maasai pastoralists in eastern Kajiado District, Kenya*. ILCA System Study 4. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 71–82.

Grosse S.D. 1998a. *Farm animals and children's nutritional status in rural Rwanda*. Paper Presented at the Symposium on Human Nutrition and Livestock, October 14, 1998. Heifer Project International, Little Rock, Arkansas, USA. 16 pp.

Grosse S.D. 1998b. *Farm animals, consumption of animal products, and children's nutritional status in developing countries*. Paper Presented at the Symposium on Human Nutrition and Livestock. October 14, 1998. Heifer Project International, Little Rock, Arkansas, USA. 16 pp.

De Gwynn E.R. and Sanjur D. 1974. Nutritional anthropometry, diet and health-related correlates among pre-school children in Bogota, Colombia. *Ecology of Food and Nutrition* 3:273–282.

Haddad L. 1994. Strengthening food policy through intrahousehold analysis. *Food Policy* 19(4):347–356.

Haddad L., Haddinott J. and Alderman H. (eds). 1997. *Intrahousehold resource allocation in developing countries: Models, methodology and policy*. The Johns Hopkins University Press, Baltimore, USA. 341 pp.

Holden S.J. and Coppock D.L. 1992. Effects of distance to market, season and family wealth on dairy sales and their contribution to pastoral cash income in semi-arid Ethiopia. *Journal of Arid Environments (UK)* 23(3):321–334.

Hossain M. 1988. *Credit for alleviation of rural poverty: The Grameen Bank in Bangladesh.* IFPRI Research Report 65. IFPRI (International Food Policy Research Institute), Washington, DC, USA. 88 pp.

Jabbar M.A. and Ehui S.K. 1998. Background, objectives and organization of the study. In: Freeman H.A., Jabbar M.A. and Ehui S.K. (eds), *Role of credit in the uptake and productivity of improved dairy technologies in sub-Saharan Africa*. Socio-economic and Policy Research Working Paper 22. ILRI (International Livestock Research Institute), Addis Ababa, Ethiopia. pp. 4–5.

Jabbar M.A., Larbi A. and Reynolds L. 1996. *Alley farming improving small ruminant productivity in West Africa: ILRI's experiences.* ILRI Socio-economic and Policy Research Working paper 20. ILRI (International Livestock Research Institute), Addis Ababa, Ethiopia. 96 pp.

Jahnke H.E. 1982. *Livestock production systems and livestock development in tropical Africa*. Kieler Wissenschaftsverlag Vauk, Kiel, Germany. 273 pp.

Jansen G.G. and Pippard J.L. 1998. The Grameen Bank in Bangladesh: Helping poor women with credit for self-employment. *Journal of Community Practice* 5(1–2):103–123.

Joekes S. and Pointing J. 1991. *Women in pastoral societies in East and West Africa*. Drylands Network Programme Issue Paper 28. IIED (International Institute for Environment and Development), London, UK. 30 pp.

Kanbur R. 1991. *Linear expenditure systems, children as public goods, and intrahousehold inequality*. Discussion Paper 104. Development Economics Research Centre, University of Warwick, Coventry, UK.

Kandiyoti D. 1990. Women and rural development polices: The changing agenda. *Development and Change* 21(1):5–22.

Katz E.G. 1995. Gender and trade within the household: Observations from rural Guatemala. *World Development* 23(2):327–342.

Kerenge A. 1984. Women and small ruminant production: *Potential for development*. Paper prepared for IITA/ILCA/Ford Foundation workshop on Women in Agriculture in West Africa, Ibadan, Nigeria, 7–9 May 1984. 9 pp.

Kerven C.K. 1987. The role of milk in a pastoral diet and economy: The case of the South Darfur, Sudan. *ILCA Bulletin 27*:18–27. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

Khafagy F. and Sholkami H. 1987. *Daily activities of women of El Manshiya and Qalabsha villages in Aswan government*. UNICEF Egypt, Document ID WP/1987/3.

Khandker S.R. 1998. *Fighting poverty with microcredit: Experience in Bangladesh*. Oxford University Press, Oxford, UK.

Lele U. 1986. Women and structural transformation. *Economic Development and Cultural Change* 34:195–221.

Leonard W.M., DeWalt K.M., Uquillas J.E. and DeWalt B.R. 1994. Diet and nutritional status among cassava producing agriculturalists of Coastal Ecuador. *Ecology of Food and Nutrition* 32:113–127.

Lundberg S. and Pollak R. 1993. Separate spheres bargaining and the marriage market. *Journal of Political Economy* 93(5):901–918.

Maarse L.M. 1995. *A gender differentiated study on impacts of intensive dairy farming on socio-economic position of smallholder households in Kiambu, Meru, Migori, Nandi and Vihiga Districts, Kenya*. National Dairy Development Project, Ministry of Agriculture, Livestock Development and Marketing, Nairobi, Kenya. (REF: NDDP/GEN/006). 77 pp.

Manser M. and Brown M. 1980. Marriage and the household decision making: A bargaining analysis. *International Economic Review* 21(1):31–44.

Martins C. 1990. *The role of women in the production of livestock in third world countries. A review of literature*. Working paper. (GTZ Project 90.9127.3–91.100). Berlin, Germany. 29 pp.

McCorkle C.M., Nolan M.F., Jamtgaard K. and Gilles J.L. 1987. *Highlights from sociological (CRSP) research on small ruminants*. ODI Pastoral Development Network Paper 24d. ODI (Overseas Development Institute), London, UK. 21 pp.

McElroy M. 1990. The empirical content of nash-bargaining household behavior. *Journal of Human Resources* 25:559–583.

Mengistu Buta. 1997. *Use of crossbred cows for milk and traction in the highlands ecoregion: A whole-farm evaluation*. MSc thesis, Alemaya University of Agriculture, Alemaya, Harar, Ethiopia. 87 pp.

Morton J. 1990. *Aspects of labour in an agro-pastoral economy: The northern Beja of Sudan.* ODI Pastoral Development Network Paper 30b. ODI (Overseas Development Institute), London, UK. 14 pp.

Mullins G., Wahome L., Tsangari P. and Maarse L. 1996. Impacts of intensive dairy production on smallholder farm women in Coastal Kenya. *Human Ecology* 24(2):231–253.

Muylwijk J. 1995. The impact of new technologies in livestock keeping and crop residues on women farmers: Experience with BIOCON on-farm trials in India. In: Singh C.B., Rao S.V.N. and Jain D.K. (eds), *Farming systems research for improving livestock production and crop residue utilisation. Proceedings of a national seminar held at the National Dairy Research Institute, Karnal, Haryana, India,* 24–26 November 1994. Indo-Dutch Project on Bioconversion of Crop Residues, Wageningen, The Netherlands. pp. 140–151.

Neumann C.G. and Harrison G.G. 1994. Onset and evolution of stunting in infants and children. Examples from the Human Nutrition Collaborative Support Program. Kenya and Egypt Studies. *European Journal of Clinical Nutrition 48* (Supplementary 1):S90–S102.

Nicholson C.F., Thornton P.K., Mohammed L., Muinga R.W., Mwamachi D.M., Staal S.J. and Thorpe W. 1998. *The impact of dairy technology adoption on the nutritional status of pre-school children in Coastal Kenya.* A collaborative study by KARI (Kenya Agricultural Research Institute), MoA (Ministry of Agriculture), and ILRI (International Livestock Research Institute), Nairobi, Kenya. 14 pp.

Osmani L.N.K. and Sinha S. 1998. Impact of credit on the relative well-being of women: Evidence from the Grameen Bank. In: Micro-credit: Impact, Targeting and sustainability. *IDS Bulletin* 29(4):31–38.

Overholt C., Anderson M.B., Cloud K. and Austin J.E. 1985. Women in development: A framework for project analysis. In: Overholt C., Anderson M.B., Cloud K. and Austin J.E. (eds), *Gender roles in development projects. A case book*. Kumarian Press, West Hartford, Connecticut, USA. pp. 3–15.

Oxby C. 1987. Women unveiled: Class and gender among Kel Ferwan Twarek. In: Dahl G. (ed), The realms of pastoral women. *Ethnos* 52(1–2):119–136.

Pail H.Y., Hwang S.H. and Lee S.P. 1992. Comparative analysis of growth, diet, and urinary N excretion in elementary school children from urban and rural areas of Korea. *International Journal for Vitamin and Nutrition Research* 62:83–90.

Pankhurst A. 1993. Anthropological survey: *Crossbred cows for dairy production and draught work*. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 162 pp.

Pankhurst A. 1996. *Cross-bred cows for dairy production and traction*. A report based on case studies of 131 farmers and their attitude to the Holetta Project. ILRI (International Livestock Research Institute), Addis Ababa, Ethiopia. 95 pp.

Paris T.R. 1987. *Integrating women's concerns in a crop–livestock farming systems projects in Sta. Barbara, Pangasinan, Philippines*. ASPAC, Food and Fertilizer Technology Center Extension Bulletin 264. FFTC/ASPAC (Food and Fertilizer Technology Centre for the Asian and Pacific Region) Taipei, The People's Republic of China.

Paris T.R. 1992. Socio-economic issues concerning women in animal production. In: Bunyavejchewin P., Sangdid S. and Hangsanet K. (eds), *Animal production and rural development. Proceedings of the sixth AAAP animal science congress held at Sukhothai Thammathirat Open University, Nonthaburi, Thailand, 23–28 November 1992*. Volume 1. AHAT (Animal Husbandry Association of Thailand), Bangkok, Thailand. pp. 247–270.

Peters P.E. 1986. Household management in Botswana: Cattle, crops, and wage labor. In: Moock J.L. (ed), *Understanding Africa's rural households and farming systems*. Westview Press, Boulder, Colorado, USA. pp. 133–154.

Petheram R.J. and Basuno E. 1986. Livestock component farming systems research in Java —the case for work with women. *Agricultural Administration* 21:119–127.

Pickering H., Hayes R.J., Ng'andu N. and Smith P.G. 1986. Social and environmental factors associated with the risk of child mortality in a peri-urban community in The Gambia. *Transaction of the Royal Society of Tropical Medicine and Hygiene* 80:311–316.

Pitt M. 1997. Specification and estimation of the demand for goods within the household. In: Haddad L., Haddinott J. and Alderman H. (eds), *Intrahousehold resource allocation in*

developing countries: Models, methodology and policy. The Johns Hopkins University Press, Baltimore, USA. pp.19–38.

Poats S.V. 1991. *The role of gender in agricultural development*. Issues in Agriculture 3. CGIAR (Consultative Group on International Agricultural Research), Washington, DC, USA. 63 pp.

Quisumbing A. 1994. *Improving women's agricultural productivity as farmers and workers.* Education and Social Policy (ESP) Discussion paper Series 37. The World Bank, Washington DC, USA.

Quisumbing A. 1998. *Women, livestock, and family food security*. Luncheon Address, Symposium on Human Nutrition and Livestock in the Developing World. Heifer Project International, Little Rock, Arkansas. IFPRI (International Food Policy Research Institute), Washington, DC, USA. 25 pp.

Quisumbing A., Brown L.R., Feldstein H.S., Haddad L. and Pena C. 1995. *Women: The key to food security*. Food Policy Report. IFPRI (International Food Policy Research Institute), Washington, DC, USA. 21 pp.

Rangnekar S. 1992. Women in livestock production in rural India. In: Bunyavejchewin P., Sangdid S. and Hangsanet K. (eds), *Animal production and rural development. Proceedings of the sixth AAAP animal science congress held at Sukhothai Thammathirat Open University, Nonthaburi, Thailand, 23–28 November 1992*. Volume 1. AHAT (Animal Husbandry Association of Thailand), Bangkok, Thailand. pp. 271–285.

Saadullah M., Hossain M.M. and Akhter S. 1998. Goat raising by women as an income generating source in Bangladesh: Case studies. In: Ranaweera N.F.C, Gunasena H.P.M., Senanayake Y.D.A. (eds), *Changing agricultural opportunities: The role of farming systems approaches. Proceedings of the 14th International Symposium on Sustainable Farming Systems. Colombo, Sri Lanka, 11–16 November, 1996*. AFSA (Asian Farming Systems Association), Pradeniya, Sri Lanka. pp. 269–278.

Samuelson P. 1956. Social indifference curves. *Quarterly Journal of Economics* 70:1–21.

Schroeder D.G. and Brown K.H. 1994. Nutritional status as a predictor of child survival: Summarizing the association and quantifying its global impacts. *Bulletin of World Health Organization* 72:569–579.

Seireg M., Zeitlin M.F., LaMontagne J. and Morales C.M. 1992. Field validation of the tallstick in marginal communities in Nicaragua. *Journal of Tropical Pediatrics* 38:214–223.

Sen A. 1966. Labor allocation in cooperative enterprise. *Review of Economic Studies* 33:361–371.

Sere C., Steinfeld H. and Groenewold J. 1996. *World livestock production systems: Current status, issues and trends*. FAO Animal Production and Health Paper 127. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy. 82 pp.

Shapiro B.I., Haider J., Alemu Gebre Wold and Abebe Misgina. 1998. *Crossbred cows and human nutrition and health in the highlands ecoregion: Evidence from Ethiopia*. ILRI (International Livestock Research Institute), Addis Ababa, Ethiopia. 22 pp. (Mimeo).

Sigman M., McDonald M.A., Neumann C.G. and Bwibo N. 1991. Prediction of cognitive competence in Kenyan children from toddler nutrition, family characteristics and abilities. *Journal of Child Psychology and Psychiatry* 32:307–320.

Singh I., Squire L. and Strauss J. (eds). 1986. *Agricultural household models: Extensions, applications, and policy*. Johns Hopkins University Press for the World Bank, Baltimore, Maryland, USA. 323 pp.

Smith T., Earland J., Bhatia K., Heywood P. and Singleton N. 1993. Linear growth of children in Papua New Guinea in relation to dietary, environmental and genetic factors. *Ecology of Food and Nutrition* 31:1–25.

Spiro H.M. 1984. *Women in agricultural production in West Africa—the research gaps*. Paper prepared for IITA/ILCA/Ford Foundation workshop on Women in Agriculture in West Africa, Ibadan, Nigeria, 7–9 May 1984. 55 pp.

Tarfa S.B. and Ogunwale S.A. 1998. Women's integration into decision-making on the utilization of agricultural processing technologies in Nigeria. In: Ranaweera N.F.C, Gunasena H.P.M., Senanayake Y.D.A. (eds), *Changing agricultural opportunities: The role of farming systems approaches. Proceedings of the 14th International Symposium on Sustainable Farming Systems, Colombo, Sri Lanka, 11–16 November, 1996*. AFSA (Asian Farming Systems Association), Peradeniya, Sri Lanka. pp. 279–285.

Thaha A.R. and Pudjiadi S. 1990. Zinc deficiency and alkaline phosphates in protein-energy malnutrition children under five years of age. In: Pongpaew P., Sastroamidjojo S., Prayurahong B. and Migasena P. (eds), *Human nutrition: Better nutrition in nation building. SEAMEO-TROPMED, Bangkok, Thailand*. pp. 344–358.

Thomas D. 1997. Income, expenditures, and health outcomes: Evidence on intrahousehold resource allocation. In: Haddad L., Haddinott J. and Alderman H. (eds), *Intrahousehold resource allocation in developing countries: Models, methodology and policy*. The Johns Hopkins University Press, Baltimore, Maryland, USA. pp. 142–164.

Thomas-Slayter B. and Bhatt N. 1994. Land, livestock, and livelihoods: Changing dynamics of gender, caste, and ethnicity in a Nepalese village. *Human Ecology* 22(4):467–494.

Tulachan P. and Batsa A. 1994. Gender differences in livestock production management in the Chitwan district of Nepal. *Journal of Farming Systems Research-Extension* 4(3):121–135.

Ulph D. 1988. *A general non-cooperative Nash model of household consumption behavior*. Bristol University, Bristol UK. (Mimeo).

Vabi B. 1991. *Social relationships between indigenous cultivators and Fulani grazers in the derived savannah of southern Nigeria and the northwestern province of Cameroon*. MSc thesis, University of Ibadan, Ibadan, Nigeria.

Vaughan J.P., Zumrawi F., Waterlow J.C. and Kirkwood B.R. 1991. An evaluation of dried skimmed milk on children's growth in Khartoum province, Sudan. *Nutrition Research* 1:243–252.

Vella V., Tomkins A., Nviku J. and Marshall T. 1995. Determinants of nutritional status in southwest Uganda. *Journal of Tropical Pediatrics* 41:89–98.

Vosti S.A. and Witcover J. 1991. Income sources of the rural poor: The case of the zone de Matt, Mines Gears, and Brazil. In: Von Braun J., Pandya-Lorch R. (eds), *Income information and policy implications*. IFPRI (International Food Policy Research Institute), Washington, DC, USA. pp. 47–68.

Waiganjo M. and Maina P.M. 1998. Changing roles in livestock (dairy) management in Nakuru District, Kenya: A gendered perspective. In: Ranaweera N.F.C, Gunasena H.P.M. and Senanayake Y.D.A. (eds), *Changing agricultural opportunities: The role of farming systems*

approaches. Proceedings of the 14th International Symposium on Sustainable Farming Systems, Colombo, Sri Lanka, 11–16 November, 1996. AFSA (Asian Farming Systems Association), Peradeniya, Sri Lanka. pp. 286–291.

Walker S.P., Powell C.A. and Grantham-McGregor S.M. 1990. Dietary intake and activity levels of stunted and non-stunted children in Kingston, Jamaica. Part 1. Dietary intakes. *European Journal of Clinical Nutrition* 44:527–534.

Walshe M. J., Grindle J., Nell A. and Bachmann M. 1991. *Dairy development in sub-Saharan Africa: A study of issues and options*. World Bank Technical Paper 135. The World Bank, Washington, DC, USA. 94 pp.

Waters-Bayer A. 1985. *Dairying by settled Fulani women in central Nigeria and some implications for dairy development*. Pastoral Development Network Paper 20C. ODI (Overseas Development Institute), London, UK. 24 pp.

Waters-Bayer A. 1986. Modernizing milk production in Nigeria: Who benefits? *Ceres* 113(19):34–39.

Waters-Bayer A. 1988. *Dairying by settled Fulani in central Nigeria: The role of women and implications for dairy development*. Farming Systems and Resource Economics in the Tropics 4. Wissenschaftsverlag Vauk, Kiel, Germany. 328 pp.

Whalen I.T. 1984. *ILCA's Ethiopian highlands programme: Problems and perspectives in expanding the participation of women*. Paper prepared for IITA/ILCA/Ford Foundation workshop on Women in Agriculture in West Africa, Ibadan, Nigeria, 7–9 May 1984. 24 pp.

Wilson R.T. 1995. *Livestock production systems*. The Tropical Agriculturalist. Macmillan, Basingstoke, UK. 141 pp.

Winrock International. 1992. *Assessment of animal agriculture in sub-Saharan Africa*. Winrock International Institute for Agricultural Development, Morrilton, Arkansas, USA. 125 pp.

Xuto N. and Bell S.F. 1992. Gender issues in livestock production in Thailand. In: Bunyavejchewin P., Sangdid S. and Hangsanet K. (eds), *Animal production and rural development. Proceedings of the sixth AAAP animal science congress, Sukhothai Thammathirat Open University, Nonthaburi, 23–28 November 1992*. Volume 1. AHAT (Animal Husbandry Association of Thailand), Bangkok, Thailand. pp. 287–299.

Zerbini E., Alemu Gebre Wold and Shapiro B.I. 1998. Development of cow traction technologies and implications for adoption in the east African highlands. In: Zerbini E., Shapiro B.I and Chirgwin J.C. (eds), *Technology transfer: Multi-purpose cows for milk, meat and traction in smallholder farming systems. Proceedings of an Expert Consultation held at ILRI, Addis Ababa, Ethiopia, 11–14 September 1995*. ILRI (International Livestock Research Institute), Nairobi, Kenya. pp. 21–32.

Zimmermann S.D. 1982. *The cheese makers of al Bahr—the role of Egyptian women in animal production*. Women and Development Series. Leiden, Cairo, Egypt.

De Zoysa I., Rea M. and Martines J. 1991. Why promote breastfeeding in diarrhoeal disease control programs? *Health Policy and Planning* 6:371–379.