Keynote paper: The contribution of livestock to food security and sustainable development[1]

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Introduction

Between 1960 and 1990 the world's human population increased by 75 per cent from 3.1 billion to 5.4 billion but developing country populations increased by 97 per cent from 2.097 billion to 4.138 billion (FAO, 1992). Food grain production per caput during the same period increased from 310 to 375 kg overall but from 190 to 260 kg in developing countries. In the late 1970s, 45 developing countries were unable to assure adequate food energy needs of 2200 calories per person per day for their populations and 25 of these countries were still in the same position in the late 1980s (Pinstrup-Andersen, 1994). There are now 800 million people suffering from malnutrition and hunger, not only due to insufficient production and inadequate distribution but also because the poor lack the income to acquire food of adequate quantity and quality to satisfy their needs (FAO, 1993a).

The world population is projected to increase from 5.4 billion in 1990 to about 7.2 billion in 2010. This increase will occur mainly in the developing countries and in urban areas and will have major effects on patterns of food production, marketing and consumption. Strategies are needed to ensure food security for the growing population, to increase income, to support economic development, and to protect the environment.

Livestock production is a major component of the agricultural economy of developing countries and goes well beyond direct food production. Sales of livestock and their products provide direct cash income to farmers. Livestock are the living bank for many farmers and have a critical role in the agricultural intensification process through provision of draught power and manure for fertilizer and fuel. They are also closely linked to the social and cultural lives of millions of resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability. Official statistics often underestimate the overall contribution of livestock and especially their multipurpose contributions to food and agricultural production in developing countries.

This paper considers both direct and indirect contributions of livestock to food security and sustainable development in the developing countries.

The meaning and scope of food security

The meaning of food security has evolved since the first World Food Conference of 1974. It is now accepted that it relates to access by all people at all times to enough food for an active healthy life (Reuntlinger, 1985; World Bank, 1986; FAO, 1989) but the concept is used differently at different levels.

At regional and national level it is equated with national or regional balances, i.e. between availability and need based on assumed per caput need. At household level, food security is equated with sufficiency of household entitlements - that bundle of food production resources, income available for purchases, and gift or assistance sufficient to meet the aggregate needs of all household members. Achieving food security in this case is largely determined by an assumption of minimum nutritional need. Security at the level of the individual is rarely, if ever, considered (Chen and Kates, 1994).

Irrespective of the reference level, food balance is now considered an inadequate criterion for food security because availability may not guarantee access due to poor distribution or lack of purchasing power. There are many examples of coexistence of aggregate food self-sufficiency and widespread malnutrition and hunger. Food security is therefore defined by a combination of criteria that are not mutually exclusive (Chen and Kates, 1994), as:

- balance between availability and need;
- absence of famine or temporary food insecurity;
- seasonal or chronic undernutrition;
- micronutrient deficiency, especially iron, iodine and Vitamin A; and
- nutrient-depleting illness such as malaria, diarrhoea and internal parasites.

In theoretical and empirical literature food security is defined with reference to food grains. This is especially misleading for societies where roots and tubers are major sources of food and income and for mainly pastoral or livestock-based societies where livestock products are important sources of food and income (Anon, 1989). For example, foods other than cereals supply 40 per cent of total food energy for half of the sub-Saharan African population with the highest risk of food insecurity (FAO, 1993b).

In this paper, the potential contribution of livestock to food security and economic development is assessed in relation to other functions. Exclusion of livestock is inappropriate because individual and household food security depends on access to assets, work and assured income. Livestock may contribute to food security through increased output of livestock and non-livestock products and by employment and income generation that may assure access to food.

Livestock and food supply

If food security is defined as "...access to enough food for an active healthy life" livestock can make a major contribution. An adequate quantity of balanced and nutritious food is a primary indicator of quality of life, human welfare and development. Animals are an important source of food, particularly of high quality protein, minerals, vitamins and micronutrients. The value of dietary animal protein is in excess of its proportion in diets because it contains essential amino acids that are deficient in cereals. Eating even a small amount of animal products corrects amino acid deficiencies in cereal-based human diets, permitting more of the total protein to be utilized because animal proteins are more digestible and metabolized more efficiently than plant proteins (Winrock, 1992, De Boer *et al,* 1994).

"Quality foods ... derived from animal sources have major importance for optimizing human performance in chronically mild to moderately malnourished populations" (Diaz-Briquets *et al,* 1992). This is especially important for young children.

In 1990, per caput consumption of meat, milk and fish in developing countries was 22, 18 and 33 per cent of that in developed countries (Table 1). Between 1962 and 1987, consumption of energy, protein and fats from livestock products increased 23 times faster in developing than developed countries (Table 2). Yet absolute levels of consumption of these nutrients in 1987 were nearly five times higher in developed than in developing countries.

Table 1 Per caput consumption of meat, milk and fish in 1990 (kg/year)

Region	Commodity		
	Meat	Milk	Fish
World	32.9	75.0	13.1
Developed	81.6	200.0	26.8
Developing	17.7	36.6	8.8
Africa	11.4	27.5	8.0
Latin	41.1	93.9	8.6
Near East	19.6	60.7	4.4
Far East	15.1	27.0	9.4

Source: FAO, 1992

Table 2 Per caput consumption of energy, protein and fat from livestock products in developed and developing countries, 1962 and 1987

Year	Developed countries			Developing countries		
	Calories cal/day	Protein g/day	Fat g/day	Calories cal/day	Protein g/day	Fat g/day
1962	859	44.9	66.1	138	8.4	9.9
1987	1034	59.4	79.0	226	13.2	16.8
% change	20.4	32.3	19.5	63.8	57.1	69.7

Source: FAO, 1992

Developed countries increased already high levels of consumption through slower population growth and rapid increases in livestock productivity by use of improved technology. Developing countries failed to bridge the gap in consumption in spite of a much more rapid increase in all categories of livestock (Table 3). In order to meet increased demand, developing countries imported increasing quantities of animal products, particularly dairy products (Figure 1a). There is a balance in aggregate imports and exports of meat (Figure 1b) but exports are primarily from a few developed countries while many developing countries are importers.

Table 3 Human and livestock populations (millions) in developed and developing countries, 1960 and 1990

Item	Developed countries			Developing countries		
	1960	1990	% change	1960	1990	% change
People	977	1251	28	2097	4138	97
Large ruminants	343	404	18	692	1029	49
Small ruminants	573	591	3	792	1217	54
Pigs	235	341	45	171	515	201

Poultry	2274	4465	96	1648	6305	283

Source: FAO, 1992.

Figure 1: Value of dairy and meat imports and exports in developing countries, 1961-1989

Figure 1a . Dairy

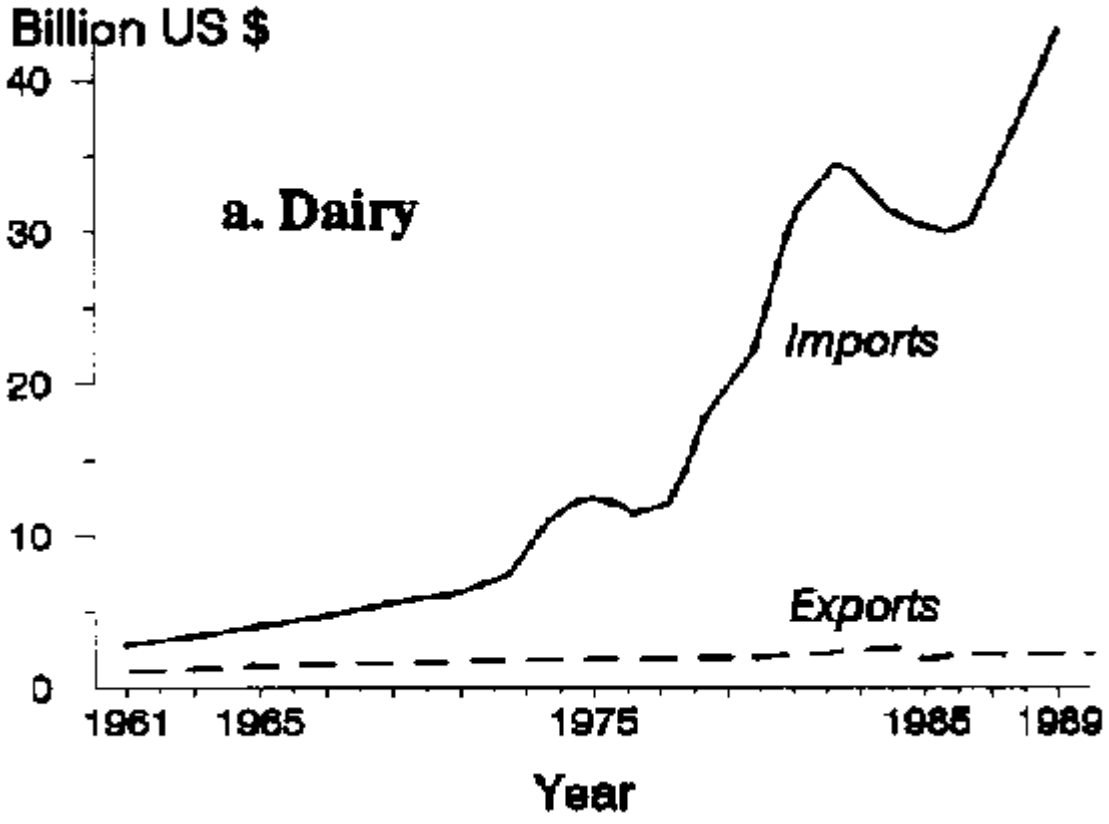
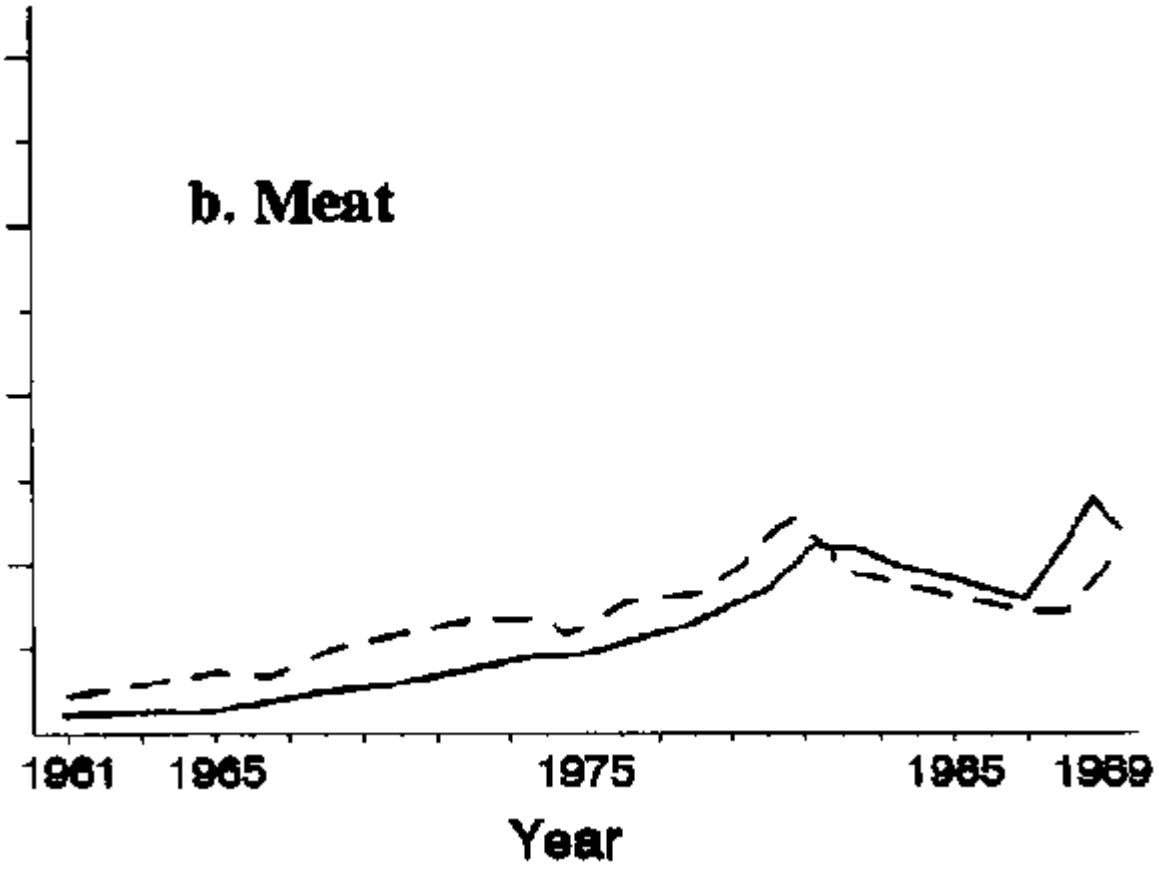


Figure 1b. Meat



Increased livestock production in developing countries may add to food security in several ways.

First, many poor small holders will have direct access to more food of livestock origin.

Second, increased production will keep livestock product prices down and allow low income groups access to such food. Producers should gain in the face of lower prices because livestock products are both price and income elastic, so lower prices should increase demand, total production and farm revenue. In many countries, low income people suffer more from energy than they do from protein deficiency. Increased production and low prices may allow consumers on low incomes to increase consumption of livestock products and help overcome the energy-protein deficiency simultaneously (Lipton, 1988).

Third, increased domestic production will reduce imports and save foreign exchange which can then be diverted to productive investment and indirectly contribute to food security. Some countries generate revenue by taxing imported goods including animal products. Taxing increased income from domestic production may serve the same purpose.

Livestock as a source of income

Animal products are a source of disposable income for many small farmers in developing countries. In fact, livestock are often the most important cash crop in many small holder mixed farming systems. Disposable income is important for purchase of agricultural inputs and other family needs.

The first five of 45 ranked agricultural commodities in developing regions are rice, milk, wheat, beef/buffalo meat and pig meat. Eggs, poultry meat and sheep/goat meat rank 9, 20 and 21 (FAO quoted in TAC/CGIAR, 1992). On a global basis meat, milk, eggs and fibre together contribute about 40 per cent of the total value of crop (excluding trees) and livestock (excluding fish) production. The proportion is about 50 per cent in developed areas and 25 per cent in developing

regions (USDA, 1990, quoted in Fitzhugh, 1993). If trees and fish are included in the definition livestock account for 19 per cent of all agricultural commodities in the developing regions as a whole but the share is up to 25 per cent in Latin America and the Caribbean and West Asia and North Africa (Table 4). These figures do not include the values of draught power and manure, and the contribution from equines, camels, yak and other minor livestock species. Adding these would further increase the proportional contribution of livestock in developing regions. In sub-Saharan Africa including non-food products and services would increase livestock's contribution by 50 per cent (Winrock, 1992).

Table 4 Relative importance of livestock products in developing regions, 1987/1989

Commodity group	Region				
	Asia	Sub-Saharan Africa	Latin America and Caribbean	West Asia and North Africa	Total
All commodities (US$ billion/year) per cent share of	379	66	145	48	638
Crops	59	53	51	69	57
Livestock	17	15	25	25	19
Trees	19	29	17	4	19
Fish	5	3	7	2	5

Source: FAO quoted in TAC/CGIAR (1992).

At farm level, the importance of livestock as an income source and the actual sources of income vary across ecological zones and production systems, which in turn determines the species raised and the products and services generated. Cash can be generated from sales of livestock products regularly (milk, eggs) or sporadically (live animals, wool, meat, hides) or from services (draught, transport). Dairy produce is the most regular income generator. Dairy development has been shown to increase income, consumption and repayment capacity in India (Kulkarni *et al,* 1989; Saini *et al,* 1989).

In densely populated Bangladesh, cattle fulfil multiple roles in generating income and ensuring food security. A survey in a periurban area and a remote village showed average land holdings in the former to be half of the latter but average cattle holdings were only marginally lower (Table 5). In the remote village 78 per cent of cows were dual purpose compared to 48 per cent in the periurban area. Average milk yield of draught cows was about 60 per cent of non-draught ones, yet farmers used cows as they did not have enough cash to buy bullocks nor enough feed to maintain both bullocks and cows.

Table 5 Land and cattle holdings and milk sales in a periurban and a remote village in Mynensingh district, Bangladesh

Item	Periurban village	Remote village
Sample households	100	100
Average land holding, ha/household	0.70	1.30
Number of cattle per household		
Bullocks	1.02	1.28
Cows	1.21	1.23
Young cattle	1.58	1.70
Total	3.81	4.21
% cows used for draught	48	78
Highest daily yield/cow (litre)		
Draught + milk cow	1.40	1.40

Milk cow	2.35	2.42
% households selling milk		
Entire output	51	36
Part of output	27	40
None	22	24

Source**:** Jabbar and Ali, 1988.

Crop production of such farmers would suffer without using cows for draught. About 77 per cent of households in both the villages sold part or all of the milk output to supplement income from crop and other sources. A higher proportion of households in the periurban village sold all their milk indicating that a high value nutritious food was given up to meet other family needs (Jabber and Ali, 1988).

The importance of livestock as a source of income for poor farmers in Bangladesh is illustrated by the fact that the Grameen Bank, which assists the "poorest of the poor", provides nearly 50 per cent of its loans for the purchase of livestock, mainly large ruminants for milk production and fattening for sale (Hossain, 1988).

In small holder crop-livestock systems in the Ethiopian highlands livestock accounted for 34-87 per cent of total cash income from crops and livestock. Crops are more often a subsistence enterprise. The livestock share in cash income was higher in those villages where total cash income was higher indicating that increased cash income came primarily from livestock (Gryseels, 1988; Asamenew, 1991; Omiti, 1995). In semiarid Mali, livestock contributed 78 per cent of cash income from crops and livestock on small holder mixed farms (Debrah and Sissoko, 1990). In both Ethiopia and Mali, a major part of livestock cash income was spent on food and medicines. In some crop-livestock systems, such as in semiarid areas of Botswana, self-sufficiency in food crop production may not be a major goal. Most food crops may be purchased by income generated by livestock. In a similar environment in a different place, as in northern Nigeria, farmers may place heavy emphasis on self-sufficiency in food crop production because food grain supplies cannot be reliably obtained through the market (Norman *et al,* 1988).

In many societies, women have specific family responsibilities and ownership of livestock and access to livestock products for sale helps them in these functions. In southern Nigeria 41 one per cent of 5460 sales of small ruminants in four village markets over a period of 14 months were by women. Although both male and female sellers sold primarily for cash needs (55 per cent of sales), cash needs for buying food and clothing were a more prominent reason for sale by women (Jabbar, 1995).

Livestock give increased economic stability to farm households, acting as a cash buffer (small stock), a capital reserve (large animals) and as a hedge against inflation. In mixed farming systems, livestock reduce the risk through diversification of production and income sources and there is therefore a much greater ability to deal with seasonal crop failures and other natural calamities. Livestock represent liquid assets which can be realized at any time, adding further stability to the production system.

Livestock as generators of employment

Increased production implies higher employment. Dairying is labour intensive at farm level and women are active in production and marketing. Labour typically amounts to over 40 per cent of total costs in small harder systems. It is estimated that each 610 kg per day of additional milk processed in India adds one man-day for feeding and care. In Kenya small holder systems, processing of 25 kg adds one man-day and similar levels were seen on parastatal dairy farms in Zimbabwe. Goats, sheep, poultry and rabbits, and especially from backyard production systems, are an important source of part-time work, particularly for landless women and children.

The processing sector has also been identified as a focus for generating employment and limiting rural depopulation. Small scale milk processing and marketing is labour intensive (50-100 kg per workday) and generates employment (and income) from local manufacture of at least part of the equipment used. The meat sector also provides employment for slaughter, marketing and processing (Table 6).

Table 6 Labour needs for processing and marketing for 30 head of stock

Animal species	Labour need (person/day)		
	Slaughter	Marketing	Further processing
Cattle	20	4	> 80
Pig	10	2	> 30
Small ruminants	3	1	n.a.

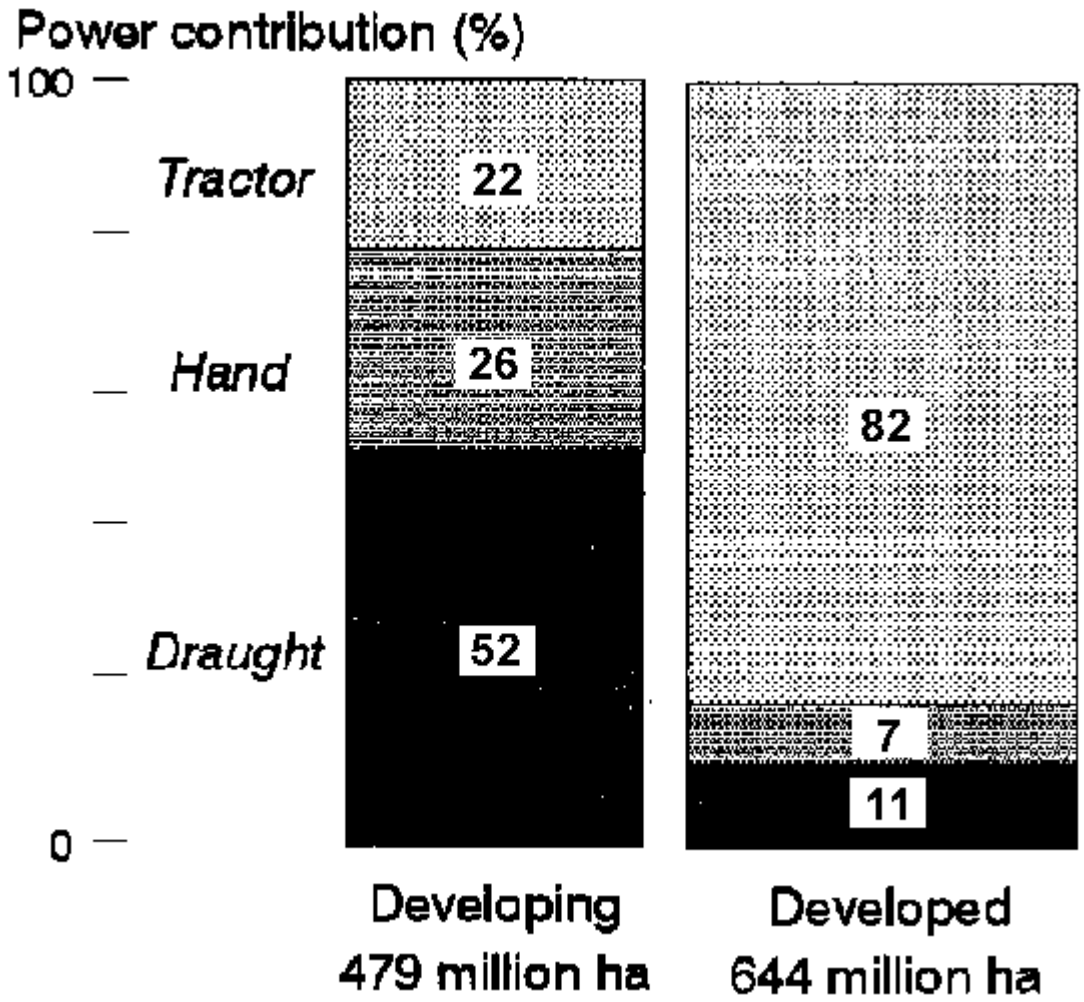
Source: FAO, unpublished data

Livestock as suppliers of inputs and services for crop production

Draught power

Bovines, equines, Camelidae and elephants are used in draught operations as diverse as pulling arable implements and carts, lifting water and skidding logs. The number of animals used for draught is estimated at 400 million. About 52 per cent of the cultivated area in developing countries (excluding China) is farmed using draught animals against 26 per cent with hand-tools (Figure 2). During the past ten years there has been a 23 per cent increase in the numbers of cattle and buffalo used for draught as well as meat and milk production. At the same time the number of equines used primarily for draught and transport has not significantly changed.

Figure 2 Livestock use in draught animal power, in developing and developed countries in 1992



It is expected that draught animal use will decline slightly by the year 2000 in all regions except Africa. In Latin America and the Near East, tractor use will increase slightly while use of human power will increase slightly in Asia (Alexandratos, 1988). In areas such as semiarid and subhumid West Africa, where crop-livestock mixed farming is evolving and expanding, increased use of animal traction will help intensification and contribute to higher output and income (McIntire *et al,* 1992) and therefore to greater food security. In the 1960s and 1970s, rapid urban and coastal economic growth encouraged migration from the Sahel and increased the opportunity cost of using cattle for traction. In recent years, however, this cost has been decreasing due to coastal economic stagnation and it is likely that the situation is now more conducive to development of mixed farming and increased use of traction in the inland countries (Delgado, 1989).

At farm level, draught animal ownership patterns have implications for food production and security. There are positive correlations between draught animals and cereal crop production (Gryseels, 1988; Omiti, 1995). In many developing countries ownership is skewed. Many small and marginal farmers own none or an inadequate number of traction animals (BBS, 1986; Gryseels, 1988; Asamenew, 1991). Crop production of these farmers suffers due to late planting, poor quality tillage, use of low value crops needing less tillage and an inability to cultivate all available land. These problems may be aggravated after natural calamities such as flood or drought due to death or poor health of animals and increased draught animal prices (Jabber, 1990).

Draught power economics are improved if one animal is used instead of two and if a cow is used instead of a male. This strategy reduces the cost of maintaining the larger herd necessary to satisfy

replacements and milk production. Draught cows need, however, to be given additional feed if milk production and reproduction are not to be affected.

Manure

Nutrient recycling is an essential part of any strategy for sustainable agriculture. Integration of livestock and crops allows for efficient recycling through use of crop residues and by-products as animal feeds and for animal manure as crop fertilizer. Cattle dung contains about 8 kg of nitrogen, 4 kg of phosphate and 16 kg of potash per tonne of dry matter (Ange, 1994). In addition, manure returns organic matter to the soil, helping to maintain its structure as well as its water retention and drainage capacities

Throughout the developing world, manure is the primary source of plant nutrients for traditional rainfed crops. Chemical fertilizers are expensive and applied mainly to high yielding varieties especially in irrigated conditions. A massive currency devaluation in the West and Central African Francophone countries in 1993 increased prices of fertilizers so much that farmers responded by applying more manure, by making compost in a systematic manner and by developing a market for manure (Sanders *et al*, 1995).

In areas where crop-livestock mixed farming is emerging manure is an important link. Manure is of paramount importance in these areas because most soils are fragile and of low inherent fertility. Only a small fraction of crop land receives adequate manure, however, and availability in a given year depends on the livestock population arid its species composition, location at manuring time, feed supply from range and crop land and efficiency of manure collection. Since crop and livestock production are not yet integrated on a wide scale, there is considerable loss of nutrients in the process of transfer from range-based livestock to crop fields. Nutrient flow may be further affected by drought-induced changes in livestock populations, species composition and animal mobility. For these reasons, it has been estimated that, in present production systems, animal manure is not adequate to sustain the current level of crop production in the semiarid areas because it requires a very high pasture area per unit of crop area (Fernandez-Rivera *et al,* 1994; McIntire and Powell, 1994: Williams *et al,* 1994).

This is probably an interim problem because population pressure and market conditions will drive intensification in the future and crops and livestock will be more integrated. Loss of manure will then be minimized as it becomes critical for sustaining soil productivity. It has also been suggested that efficiency of manure use can be increased by joint application of manure and fertilizer and manipulation of the relative amounts and times of application of manure (Brouwer and Powell, 1994; Murwira *et al,* 1994). Improved feeding, such as using urea-treated straw, improves manure quality which in turn gives higher crop yields. It is recognized, however, that achieving higher productivity in agriculture will require increased use of chemical fertilizers.

Dung for fuel and biogas

In many countries dung is valued as fuel for cooking and heating and for reducing expenditure for fuel wood or fossil fuels. It represents the major fuel for household use by millions of farmers in Asia and Africa and in parts of the Near East and Latin America. In India, 300 million tonnes of dung are used for fuel every year. The collection and drying of dung for cooking generates income for women. It is also used as plaster and as a building material.

In an historical context, use of dung as fuel is a recent phenomenon prompted mainly by scarcity of fuel wood and represents a loss to plant nutrition. An individual household in a given situation tries, however, to maximise its use by allocations between manure and fuel and by taking into account the trade-off between the two. Unless chemical fertilizer can adequately compensate the use of dung for other purposes, this competition may negatively affect food production and food security in some situations. Biogas production may be a viable alternative to reduce competition between fuel and manure use.

Biogas from manure is an excellent substitute for fossil fuel or fire wood. The best sources for these purposes are (in descending order) pigs, cattle, horse, camel, poultry (Kumar and Bisas, 1982). About 1 m^3 of gas is produced from 25 kg of fresh cattle dung. Simple low-cost plastic biodigesters have recently been developed by a number of FAO/TCP projects, for example in Cambodia, Tanzania and Vietnam. Biogas production on the farm reduces the workload of women by eliminating wood collection or the purchase of fuel. It is woman-friendly because of convenience, increased hygiene and the supply of services such as lighting, warm water and heating. Biogas can also be used to drive machinery such as water pumps.

Effluent from biodigesters can be recycled as fertilizer, with even better results than the original manure (Talukder *et al.* 1988), as a fish feed, or to grow azolla and duckweed. Biodigestion has positive public health aspects, particularly where toilets are coupled with the biodigester, and the anaerobic conditions kill pathogenic organisms as well as digesting toxins such as botulinum. Biogas from dung has also been used in China (Zhin and Pan, 1983) to control insects in stored grains, using the anaerobic reaction, without adverse effects on grain germination. Biogas technology is being successfully adopted by millions of farmers - about 25 million people use it in China alone - in developing countries (Marchaim, 1992).

Weed control

Livestock, particularly sheep, are efficient in controlling weeds and thus help to increase crop production. They are used in many countries in the Mediterranean basin to reduce forest undergrowth in order to reduce fire risk during summer. In Malaysia, it has been shown that, in rubber and oil palm plantations, the use of livestock on the ground cover under the tree canopy increases overall production and can save up to 40 per cent of the cost of weed control (Chen *et al,* 1988). Sheep have also been used to control weeds in sugar cane fields in Colombia (Carta Asolucerna, 1993), lowering the cost of herbicides, reducing by half the total cost of weed control and providing an additional income from meat production. Such systems also safeguard the environment and avoid chemical pollution while supplying additional organic material to the soil.

Recycling own secondary products and household and industrial wastes

Manure can be a valuable source of feed for other animal species and poultry manure is commonly used for ruminant feeding. Poultry and pig manure can also be used to generate algae as a feed for fish.

By-products such as slaughterhouse wastes, when adequately processed, are useful protein (offals and viscera) and mineral (bones) supplements in animal feeds. Household wastes are commonly fed to pigs and small animals in backyard systems in developing countries. In urban and periurban areas, restaurant and catering wastes can easily be processed for pigs.

Industrial fish waste creates pollution around canning plants. It is usual to dry it, at very high cost, for fish meal for export to developed countries. Preservation of fish waste in molasses for feeding has been shown to be technically and economically feasible for use by poor farmers.

Livestock production, resource management and environmental degradation

In recent years, the importance of animals as an efficient and economic means of food production has been challenged, as have their effects on the environment. These concerns are predicated on a number of issues, prominent among which are:

- competition with alternative land use, and between using cereals (and some roots and tubers) as animal feeds or directly for human consumption (Durning, 1991; Durning and Brough, 1991);
- resource degradation and environmental damage caused by deforestation, overgrazing and pollution (Durning, 1991; Rifkin, 1992; Earthwatch, 1993);

- failure or marginal success of many large investments in livestock development projects to increase productivity and create impact on agriculture (Blackburn and de Haan, 1993).

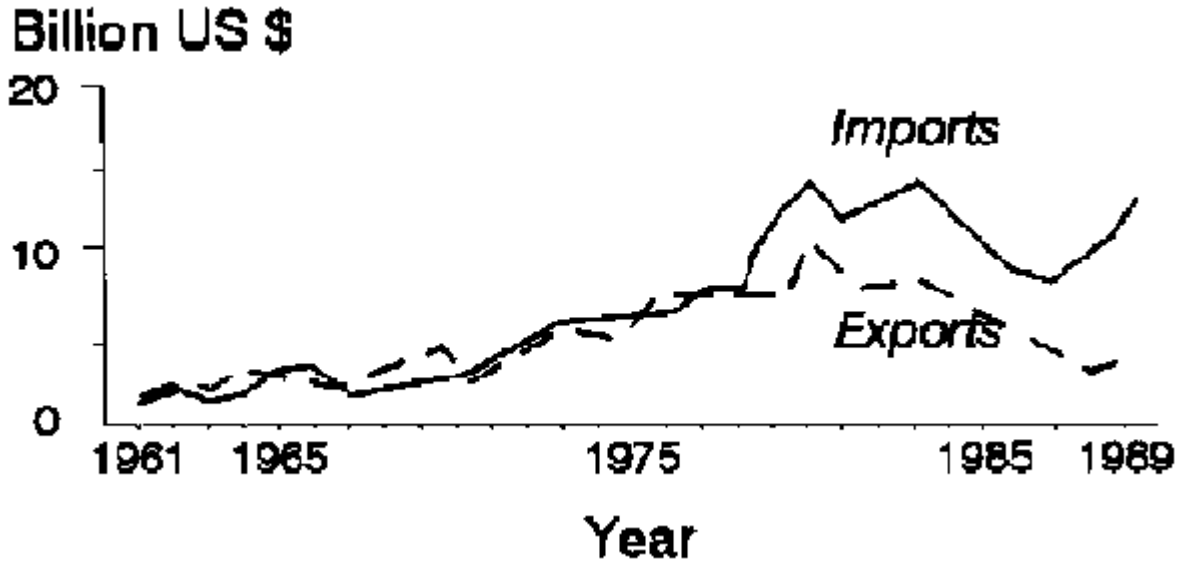
Grain as food or feed

Almost 50 per cent of world grain is fed to livestock yet 800 million people suffer from hunger and malnutrition (FAO, 1993a). This apparent paradox arises because 85 per cent of all fed grain is given to animals in developed countries whereas hungry people are mostly in developing countries because the poor cannot afford to buy cereals from the rich. Reduced use of grain as a feed in developed countries is sometimes suggested as a solution to the food security problem in developing countries. This approach can be used only to solve serious but temporary food insecurity such as a famine. Long term solutions lie in rationalizing production methods and appropriate costing and pricing.

Rapid expansion in poultry and pig output largely reflects worldwide changes in production practices from backyard, low input, scavenging systems to industrialized, high input intensive grain-based systems. Coarse grains and oil seeds have been regarded as the most convenient, if not the only, way to feed monogastrics and to fatten ruminants. Use of grain as feed has been assisted by production subsidies. Not including the costs of soil erosion, loss of soil fertility and environmental degradation have kept apparent production costs and prices low. If the ecological costs of grain production and intensive livestock management were fully charged to the livestock enterprise, costs of meat and milk would be so high that management practices would have to return to lower cost, lower intensity systems (Fitzhugh, 1993). Food security in the developing countries may be assured if production systems everywhere operate under a truly competitive environment.

Net grain imports into developing countries have steadily increased (Figure 3), however, particularly to feed animals that are eaten by the minority higher income sectors of society. Exports of animal feeds are not negligible, a large proportion of these being oilseed cakes which are important sources of by-pass protein and which could, in most cases, be better used locally to improve production from the national herd. This, in turn, would reduce imports of animal products. Grains are not indispensable for feeding stock and FAO has given high priority over the last 20 years to developing alternative feed systems, with little or no use of grains, for both monogastrics and ruminants. A Chinese project turned the cropping zones, over five years, in to the major producers of beef using untreated straw and cottonseed cake as supplements, with no use of grain (Mack, 1993). Sugar cane juice, palm oil, sugar palm juice and cassava roots have been successfully tested to replace grains in pig rations in about 15 countries in tropical America and Asia. Other local energy sources are being actively sought as alternatives to grain.

Figure 3 Value of feed grain imports and exports in developing countries, 1961-1989



Environmental degradation

In recent years, there has been a growing volume of criticism against livestock from environmentalists. Prominent among these criticisms are that livestock contribute to:

- increased desertification through long term over grazing particularly of semiarid rangelands;
- deforestation by lopping branches for use as fodder and felling trees to make way for pastures as in Latin America
- the greenhouse effect, since they produce methane as an end product of rumen digestion; and
- water and environmental pollution through animal wastes.

Some of these criticisms are unfortunately levelled without hard evidence but hard evidence is emerging to show that livestock are not the environmental villains they have been made out to be. An extensive literature review on the impact of livestock on rangelands (Dodd, 1991) concluded that the effects of grazing and drought have been confused and that there was no solid evidence of irreversible effects on vegetation from livestock other than around water points and permanent settlements. Long term research in the Sahel in Mali clearly shows the resilience of Sahel rangelands and that annual biomass yields closely track annual rainfall even after extended drought and heavy grazing pressure (ILCA, 1992; Fitzhugh, 1993).

Deforestation and expansion of ranching into Latin American forests is sometimes linked with supplying beef to the North American market and to profitability of production. In reality, neither the North American market nor profits as such are the main reason for expansion of ranching in Latin American forests (Belk *et al,* 1992). It is rather the policies of various governments to provide subsidized livestock credit, technical services, roads, favourable market prices and tenure policies that encouraged land speculation (Hecht, 1989; 1992; Durning and Brough, 1993; Kaimowitz, 1994; McCorkle, 1994). Expansion of shifting cultivation due to poverty and population growth is a principal cause of tropical deforestation in developing countries (Cleaver and Schreiber, 1992; Winrock, 1992).

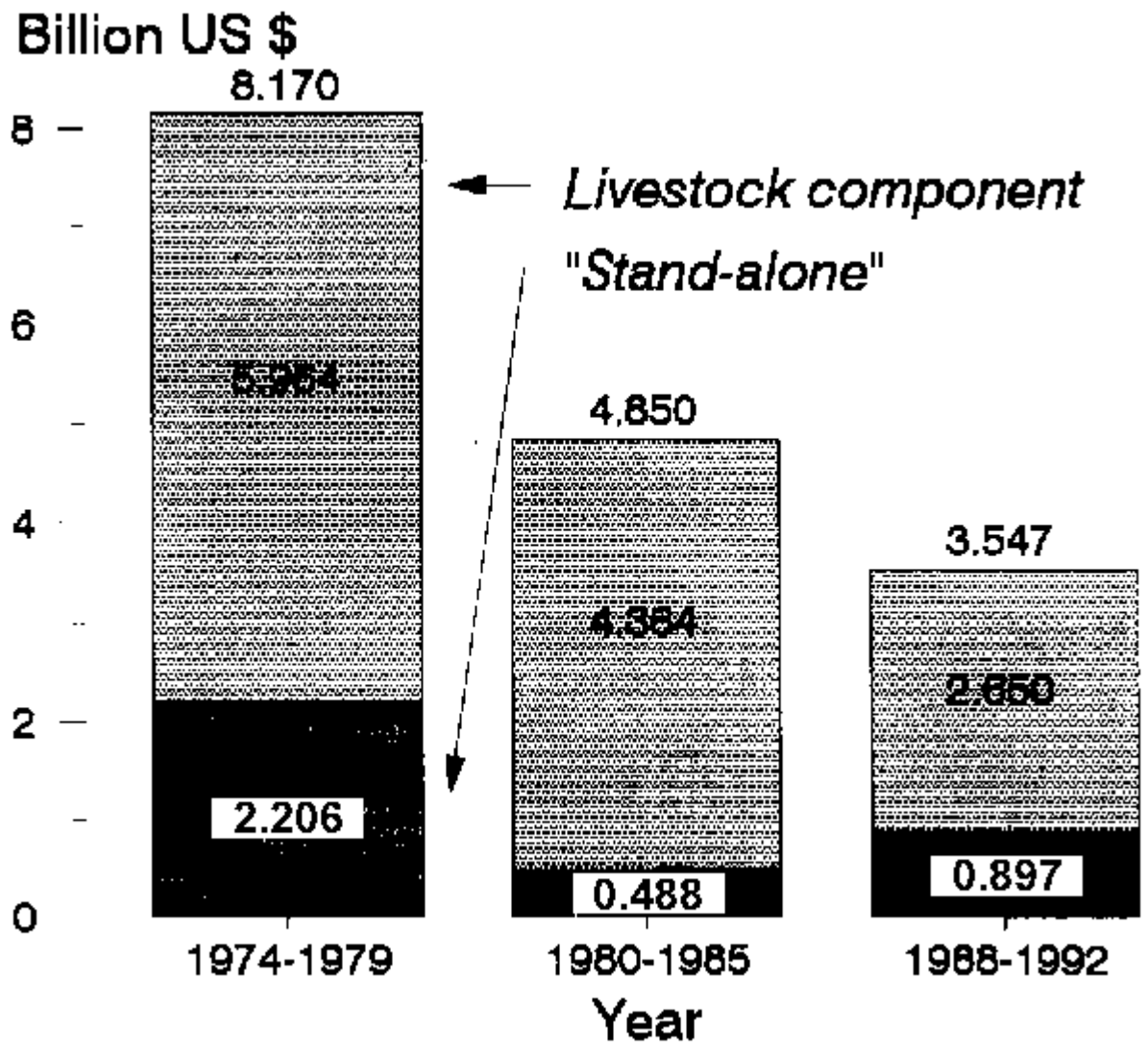
Livestock's contribution to the greenhouse effect has been overemphasized and ruminant livestock contribute only about 2.5 per cent of the total greenhouse gases. Gas emissions from cars and industries are far greater and have been increasing at a much higher rate. The problem of pollution created through waste disposal is specific to intensive production systems in developed countries.

In general, improved livestock productivity, economic development and sustainable natural resource management are not incompatible goals. Appropriate technologies, policies and institutions will, however, be required to achieve that goal.

Successes and failures of livestock projects

Relative to its importance as a direct and indirect source of food and as a major component of sustainable development, the livestock sector is under-funded and under-resourced throughout the developing world. As an example within FAO, livestock is represented by a Division within the Agriculture Department and receives about half the budget of the fisheries sector which merits a full Department. CGIAR core budget allocation to livestock research is not congruent with the value of livestock products when the values of non-food products and services are included. In the World Bank, only four per cent of the loans given to the agriculture and rural development sector were for livestock projects although livestock are components in some integrated agricultural projects (Figure 4).

Figure 4 World Bank loans to livestock projects in 1974-1992



Bank funding for livestock declined (in constant 1991 dollars) from 1974 to 1992, especially for standalone livestock projects. This happened in spite of the fact that the success rate for livestock projects increased from 43 per cent during 1974-1983 to 64 per cent in 1988 whereas that for agricultural projects decreased from 75 to 55 per cent in the same period (Blackburn and de Haun, 1993).

Many livestock development projects have failed to meet their initial objectives but there are many successful projects. Some examples are:

- Operation Flood in India which promoted dairy development among small or landless farmers and created a modern and efficient dairy industry;
- a similar dairy project in Uganda which, under difficult conditions, successfully developed milk production near Kampala;
- micro cheese making units in Niger that provided jobs and income to several hundred women;
- a beef fattening project in China which used local cereal straw treated with urea and supplemented with cottonseed cake turned the farmers of two provinces, in a span of a few years, into the most important beef producers in China;
- on-farm testing and field support activities for a successful beef fattening project in northern Tunisia in the 1970s;
- the New World Screwworm project in North Africa that, using environmentally safe biotechnology, eradicated this pest in less than four years and is an example of efficient organization and cooperation between donors and UN agencies.

Projects have failed most frequently in their initial objectives because inappropriate technologies or institutions were used or because they were implemented in an unfavourable policy environment. The Asian Development Bank noted that the principal cause of poor performance and even failure in publicly and donor-funded livestock programmes and projects was the use of inappropriate technology.

A particular mistake was the import of high producing breeds that were unable to adjust to local conditions, notably feeding and diseases (ADB, 1993).

In West Africa, modern dairy plants were set up in several countries with donor funding to process locally-produced milk for urban consumers. The policy of dumping dairy products by advanced countries combined with inappropriate domestic trade and monetary policies subsequently made import cheaper than local production and collection. The dairy processing plants remained severely under-used or totally so and the development of the domestic dairy sector remains an unfulfilled goal.

Trends and projections in food production

During the last 20 years, output of livestock products has increased at similar and, in a number of cases, at higher rates than major cereals (Table 7). Major increases have been in monogastric meat production. Egg production also increased from 4.6 million tonnes in 1969/1971 to 15.3 million tonnes in 1988/1990, or by 331 per cent. It is projected that during the next 20 years, rates of milk and meat production will surpass those of the major cereals and that the increases in production from monogastric animals will continue to be considerably higher than from ruminants, provided feed is economically available for production.

By 2010, animal products are expected to contribute proportionally more to food supply and food security in the developing countries than they do at present.

Table 7 Trends and projections in livestock products, wheat and rice (million metric tonnes) in developing countries

Item	Period			Growth rate (%)	
	1969/1971	1988/1990	2010	1970-1990	1990-2010
Milk	78.0	147.3	247.6	3.5	2.5
Meat	28.5	64.8	143.0	4.6	3.8
Large ruminants	12.1	18.6	32.3	2.2	2.7
Small ruminants	3.0	4.9	9.5	2.8	3.1
Pigs	9.7	28.3	64.0	6.1	4.1
Poultry	3.7	12.9	36.9	7.0	5.1
Wheat	67	132	205	3.8	2.1
Rice	177	303	459	3.0	2.0

Source: FAO, 1993b

Conclusions

The contribution of animals to both agricultural and overall economic development has not been adequately evaluated. Official statistics generally underestimate livestock contributions since many important non-food outputs which are difficult to quantify in monetary terms are excluded from calculations. The role of animals in development programmes is generally underrated, in spite of the increasing demand, especially in the developing countries, for animal products and services. Allegations about livestock's role in resource and environmental degradation are generally not fully documented.

Improved efficiency of animal agriculture with its various commodities and service products is critical to achieving sustainable agricultural development and food security, particularly in low income food deficit countries.

A prerequisite for sustainable development of animal agriculture is the development, testing under local conditions, and promotion of appropriate technologies that use local and affordable resources. Policies, infrastructure and support services must be established to enable such technologies to succeed and reach small scale farmers.

Integrating livestock and agriculture increases short term benefits to and long term sustainability of agriculture.

The multipurpose and flexible livestock sector is able to react to changes in national economies. Monogastric species and ruminants are adapted to varying local conditions and use local resources to produce products and services.

Increased ruminant productivity requires research to develop feeds and feeding systems, identify and use adapted genotypes, reduce mortality, improve production systems and inform appropriate policies.

Pigs and poultry are likely to remain the main source of meat where rapid urbanization is occurring. Use should be made of transferable technologies to expand small scale production. Emphasis should be given to feeds that do not compete with human food.

Facilities and credit for small scale producers should be emphasized, rather than major investments in institutions and facilities (such as big abattoirs, dairy plants and feedmills) which are usually oversized, overstaffed and overequipped.

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