Pro-Poor
Livestock
Policy
Initiative

The Role of Livestock in Economic Development and Poverty Reduction

Martin Upton

A Living from Livestock

PPLPI Working Paper No. 10

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PREFACE

This is the tenth of a series of Working Papers prepared for the Pro-Poor Livestock Policy Initiative (PPLPI). The purpose of these papers is to explore issues related to livestock development in the context of poverty alleviation.

Livestock is vital to the economies of many developing countries. Animals are a source of food, more specifically protein for human diets, income, employment and possibly foreign exchange. For low income producers, livestock can serve as a store of wealth, provide draught power and organic fertiliser for crop production and a means of transport. Consumption of livestock and livestock products in developing countries, though starting from a low base, is growing rapidly.

The development of world trade in livestock and livestock products is analysed. Despite expanding markets for livestock products the developing countries as a group have recently switched from being net exporters and become net importers of livestock products. Although patterns of trade depend on differences in comparative advantage between countries they are also influenced by trade regulations. Domestic producer protection by the European Union, the USA and Japan in particular is identified as destabilising world prices and imposing cheap priced competition on developing country producers. Nevertheless, the overall gains from trade liberalisation for developing countries are expected to be small.

We hope this paper will provide useful information to its readers and any feedback is welcome by the author, PPLPI and the Livestock Information, Sector Analysis and Policy Branch (AGAL) of the Food and Agriculture Organization (FAO).

Disclaimer

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Keywords

Pro-poor livestock policy, livelihoods, economic development, poverty alleviation.

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EXECUTIVE SUMMARY

Introduction

Globally, agriculture provides a livelihood for more people than any other industry. Growth in agricultural production and productivity is needed to raise rural incomes, to support the increasing numbers dependent on the industry and to meet the food and raw material needs of the faster growing urban populations. Enhancing agricultural productivity contributes to industrial growth by providing cheap labour, capital investment, foreign exchange and markets for manufactured consumer goods.

Agriculture has a key role in reducing poverty since most of the world's poor live in rural areas and are largely dependent on agriculture, while food prices determine the cost-of-living for the urban poor. About half of the total poor live in South Asia, and half the remainder in Sub-Saharan Africa, with smaller numbers in the rest of the developing world. The global objective, of halving poverty levels by 2015, is unlikely to be reached at current levels of assistance to agriculture.

Livestock provide over half of the value of global agricultural output and one third in developing countries. Rapid growth in demand for livestock products (LPs), in the developing countries, is viewed as a 'food revolution'. LPs are costly in relation to staple foods, so developing country consumption levels are still low, but increase with rising incomes. Pig and particularly poultry meat consumption are growing fastest. Growth in consumption is at the expense of increasing net imports of all LPs. Increased production, and higher self-sufficiency would save foreign exchange. Livestock also contribute to rural livelihoods, employment and poverty relief. They integrate with and complement crop-production, embody savings and provide a reserve against risks. Some livestock have special roles in traditional culture.

Diverse and changing roles of livestock

Livestock are capital assets, produced in the past and contributing to future product output. Investment in, or the acquisition of, livestock involves saving or borrowing, justified by the expected future return on capital. Apart from durable capital embodied in the animals, circulating capital is needed to meet current costs of production.

Investment in livestock raises farm production through (a) extension of the area of land area that can be utilised, (b) diversification of the productive activity on a crop farm and (c) intensification, i.e. by raising livestock value of output and hence total production per hectare of agricultural land increases. The latter involves increased inputs of labour and/or capital and may be achieved by increasing the stocking rate, increasing yield per head of livestock or changing to a more intensive production system. Scope for extending production onto unused, virgin land is limited since there is little remaining that is usable. There is also limited scope for increasing stocking rates under pastoral systems, since pastoralists already make effective use of available grazing.

Livestock production systems are broadly categorised into i) 'grassland-based' pastoralism and ranching ii) 'mixed-farming', either rainfed or irrigated, and iii) 'landless', mainly pig and poultry production systems. These are listed in order of increasing intensity. The 'landless' production systems are largely responsible for the rapid growth in average meat supply per person in the developing countries, poultry production having doubled over the last 10 years. Reproduction and growth rates are faster in pigs and poultry than in the ruminant species of livestock. However, housing

and hand feeding increase capital requirements and labour costs. Yields per head of these species and of cattle, in developing countries, are well below those in developed countries. Increases depend upon improvements in animal health, nutrition, breeding and management.

The 'landless' livestock production systems represent labour-using technology, in that labour requirements per hectare (devoted to feed production) are higher than for other systems. Conversely, the use of animal draught power is labour-saving, in reducing hand-labour requirements particularly at peak work periods. Use of the plough may allow a larger proportion of the farmed area to be cultivated each year, to increase cropping intensity.

Mixed crop-livestock production systems are important as the source of the bulk of ruminant livestock production and the home of the majority of the world's poor. Complementary relationships exist with livestock, fed on crop by-products and other plant material, contributing draught power, manure, additional sources of food and income, savings and buffer against risk. As intensity and livestock numbers rise, crop-livestock interactions become increasingly competitive, for the use of land and other resources. There is little, or no, interaction between crops and supplementary, landless livestock systems.

Landless livestock systems provide most of the world's production of pig and poultry meat. The majority is produced in developed countries and from large-scale commercial enterprises, now spreading in the developing countries. These products make up two thirds of all meat production world-wide, while, in the developing countries, poultry meat now accounts for more than half of all meat produced. Ruminant fattening is less important. Concerns arise regarding limited benefits to the rural poor, risks of environmental pollution and use of cereals to feed animals. Poor producers may participate, possibly by co-operation or vertical integration. Use of feed-grains does not compete directly with human consumers, while pig and poultry production converts feed efficiently and provides a cheap source of animal protein.

Inter-regional differences in livestock production systems depend upon agro-ecological features, human population density and cultural norms. A comparison of the main developing country continents, shows that Sub-Saharan Africa, Latin America and the Near East, with reasonably large areas of land per person engaged in agriculture, have a greater proportion dependent on grassland-based, ruminant livestock systems than do the more densely populated, land-scarce, regions of South and East Asia. Nonetheless, in all the continents listed, most of the agricultural population are engaged in mixed farming systems. These are mainly rain-fed in Africa and Latin America but, in South and Eastern Asia and the Near East, about half are irrigated. Poultry production is a key enterprise in Latin America, particularly Brazil, and in East and South East Asia, mainly China which is also a major pig producing country. South Asia is the largest milk producing region.

Analysts have suggested that production systems intensify and evolve, from pastoral livestock keeping to specialist crop production, then to mixed farming and eventually to independent crop and 'landless' livestock systems. The change from pastoralism to cropping is seen as a land-saving technology, or the substitution of labour for land. The move to mixed farming is capital using and land-saving; capital is substituted for land. Animal draught power, as an innovation, involves the substitution of capital for labour. Industrial development also affects technological change in agriculture, in different ways. In the Americas and Oceania industrialisation occurred while population was sparse; labour-saving mechanisation technology change was induced. In Japan industrial innovations occurred with a dense rural population, and therefore a land-saving bias, with improved seeds and agri-chemicals, was induced.

Institutional changes

Institutions are the formal rules and laws, together with the informal norms of behaviour and conventions, which govern access to resources, transactions between individuals and group activity within organisations. The New Institutional Economics deals with decision-making under uncertainty, subject to 'bounded rationality'. Property rights include private, communal or State ownership or open access. Livestock are generally privately owned, but for land and other natural resources, private freehold tenure is only one alternative.

Transaction costs involve search for information, bargaining, contracting, monitoring and enforcing the outcome. Governance structures, ranging from individual spot market transactions to repeated relational contracting, possibly within unified business firm, co-operative group or farm household. If special assets are specifically needed for the transaction, if outcomes are uncertainty and the transactions likely to be repeated, formal contracting should result in lower transaction costs than individual spot market transactions. Contracts are often negotiated under 'information asymmetry' where the 'agent' providing a service, often has more information than the 'principal' for whom it is provided. Adverse selection arises if unsuitable agents are selected, and moral hazard if the agent does not properly fulfil the terms of the contract once it is agreed.

Institutional change may have a critical influence on economic development. In a 'closed' traditional village society, transaction costs are low, being based largely on relational contracting. New market institutions are needed to facilitate trade with the wider national and world economy and to enforce impersonal contracts. Historical stagnation and contemporary under-development in developing countries, are attributed to the lack of effective institutions.

Open access to pasture-land may lead to over-grazing and degradation. Private or communal ownership are preferable options. Private ownership gives individual security of ownership and incentive for conservation. However, communal ownerships can provide similar incentives under effective co-operative organisation. The enclosure of common land, to provide individual title involves high transaction costs of measurement and enforcement and possibly an unjust re-allocation of resources. The high transaction costs of settling disputes between pastoralists and cultivators, over crops damaged by livestock, are avoided by adopting mixed farming systems. Share-cropping, or the care-taking of livestock, is a form of risk-sharing between the owner and the user of the resource.

The farm household is a unit of production and consumption. Property rights and transactions, within the household, are governed by local cultural institutions. Intra-household transactions involve both co-operation and conflict. Levels of interpersonal contact and altruism are higher than in most other organisations. Land use rights, livestock and knowledge, inherited from the previous generation, provide for the establishment of new livestock enterprises. Some property transfers occur at marriage. Women rarely hold rights to land but may own small-stock such as goats or poultry or have rights to use the products. Child nutrition may be improved. Overall work burdens generally exceed those of men, and women are often at a disadvantage in intra-household disputes.

Once a livestock enterprise is established, replacements are generated by reproduction. However, initial establishment or system change requires saving, inheritance or borrowing. Borrowing of livestock, or credit in kind, may be offered in an emergency or as development aid. Heifer in trust schemes provide an in-calf heifer to the farmer on condition that one, or more, of the female calves are returned to the project pool, for distribution to other farmers. Rural credit facilities for cash loans

are generally poor, due to high transaction costs environmental and market risks of non-repayment, lack of suitable collateral or of insurance facilities.

Labour hire for the care of livestock is usually based on long-term contracts to avoid problems of uncertainty, performance monitoring, and asset specificity. Care-taking represents a risk-sharing alternative. There is less need for skilled and trusted workers in intensive, automated poultry production systems, so casual hired labour is adequate. Reliable input delivery systems for pre-mixed concentrate feed and day-old chicks are needed, together with assured market outlets. These conditions, and economies of scale, may be achieved by vertical integration of producers with input suppliers and marketing agencies. Similar input supply and marketing issues arise in the case of smallholder dairying. Vertical integration may be achieved through dairy producer co-operatives.

Animal health services are important in reducing losses due to animal disease. Technologies for disease control and cure are known, but delivery problems arise. Budget constrained Government Veterinary Departments have achieved some control of a few critical diseases, and served the larger commercialised producers. Recent budgetary constraints have caused cut-backs and pressure for privatisation. The 'public good' nature of disease control inhibits full privatisation. Private practices are only viable in areas of intensive livestock production due to high establishment costs and uncertain demand. Competition from continuing public service veterinarians is a further disincentive. Para-veterinarians may be employed to complement professional services.

Technological change plays a key role in agricultural development. The invention, innovation, diffusion chain involves many links. New technologies may be transferred from overseas, generated at international research centres or developed domestically by privately or publicly funded research. Private-sector research is done by farmers and by agri-business but since knowledge is a public good, public sector funding is also needed. Research prioritisation should be guided by demands of producers, processors and consumers for new technology. Farming Systems (and Farmer Participatory) Research provides for assessment of producer objectives and constraints and for testing of research results, but is costly per farm. Additional assessment is desirable, possibly involving cost-benefit analysis.

Development of market infrastructure and institutions is essential for economic growth. Meat, milk and eggs cost more per unit of energy than staple crops, so consumption is low in poor developing countries. Rising incomes and populations result in rapidly increasing demand. Market demand is concentrated in urban centres and transport costs, for perishable livestock products from remote production areas, are high. So too are costs of manufactured inputs. Peri-urban producers are at an advantage. Pig and poultry meat can be produced commercially more cheaply than other meats, so markets for these products derived from 'landless' systems are growing rapidly. Economies of scale in processing and marketing may be derived by vertical integration of smallholder producers with large-scale urban-based processors and input suppliers or by producer co-operatives. Similar issues arise for intensive smallholder milk producers, who have formed dairy processing co-operatives in countries like India. Parastatal abattoirs often operate below capacity and, following structural reform, many have ceased operation.

A transformation of developed country agriculture occurred towards the middle of the 20th Century, through the widespread introduction of industrial inputs of mechanical power, fertilisers and other agro-chemicals; liquid fuel and electricity replaced human and animal draught power, while fertilisers reduced the need for animal manure. Change was slower in the developing countries, where use of animal draught is still common since higher cost, labour-saving technology is less appropriate. Use of fertilisers, mainly nitrogenous, has spread rapidly, though again more slowly in

developing countries where organic manure is still important for maintenance of soil fertility.

Growth of markets and international trade

Agricultural markets have expanded with the growth of international trade over the last 50 years. Trade in LPs, though increasing, represents only a small proportion of the total by value, and 80% is between developed countries. In recent years developing countries, as a group, have switched from being net exporters to being net importers of agricultural produce including all livestock products. Milk is the largest imported item by weight, while imports of poultry and pig meat are growing fastest. There are differences between continents and countries, with South Asia and Latin America and the Caribbean being net exporters, the former of buffaloes and their meat in particular, and the latter of poultry meat, cattle and honey.

Patterns of trade reflect international differences in comparative advantage. Every country benefits, under free trade, by producing goods for which it has a comparative advantage (or low opportunity cost) and importing other goods. Patterns of comparative advantage, and trade, shift over time with changes in production technologies and consumer preferences. They are also influenced by trade regulations.

Tariffs, or taxes on imports, are imposed along with other trade barriers, by the European Union, the USA, Japan and other countries, both developed and developing. In the developing countries, trade barriers against manufactured inputs raise costs to farmers. Trade barriers against imports of livestock products, support domestic producers in Europe, the USA and Japan, but make it difficult for producers in other countries to compete. Associated 'dumping' of low-priced surplus beef in West Africa, in the early 1990s disrupted local trade. However, low-priced exports of surplus skimmed milk powder to India contributed to the growth of the local dairy industry. The Lomé/Cotonou Agreement of the EU sets low concessionary tariff rates for certain African, Caribbean and Pacific (ACP) countries.

The World Trade Organisation (WTO) aims at promoting a phased reduction in trade barriers. Developed countries, like Australia and New Zealand where trade barriers and farmer support are already low, are predicted to benefit most. Developing country exporters may also gain, other than those currently benefiting from the Lomé/Cotonou Agreement. Tariff barriers remain high and the WTO is criticised as failing the poorer nations. However, the overall gains from trade liberalisation for developing countries are expected to be small.

Sanitary and phytosanitary (SPS) measures, aimed at protecting human, animal and plant health, affect trade flows. Rules imposed by the developed countries act as barriers to exports from poorer countries with lower SPS standards. The SPS Agreement of the WTO is aimed at harmonising different national standards. For developing country exporters to developed countries, the high cost of meeting the required SPS standards may be justified. For others, although the protection of human and animal health is important, somewhat lower standards may be appropriate for trade with other developing countries. Consumers in developed countries increasingly seek assurance of ethical methods of production concerning the environment, animal welfare or intellectual property rights. These issues and their impacts on trade are also subject to international negotiation.

Promoting livestock development

The need for increased livestock production is pressing, given the rapidly growing demand for animal products and the important contribution of livestock to the incomes and welfare of the rural poor. Additional physical, or financial capital is needed for the introduction of a new livestock enterprise, but thereafter replacements may be home bred. Human capital in the form of husbandry knowledge and skills is also needed. Technological innovations should be appropriate to the resource base, while access is needed to market outlets and input delivery systems.

There is limited scope for increased offtake from grassland-based systems. Options for welfare improvement include provision of water supplies and drought relief. Mixed crop-livestock systems contribute most to ruminant production and income for the rural poor. Nutrient recycling and other beneficial crop-livestock interactions arise, though individual ownership of land and enclosure may be needed to confine livestock and protect crops. Options exist for technical improvements in animal health, nutrition and production systems. The latter may involve greater specialisation, for instance into dairy farming, with the introduction of exotic breeding material.

Poultry and pig production systems are the most intensive and fastest growing sources of meat. They are now more important than ruminant meats in developing country diets. Much of the growth derives from large-scale, commercial production companies in peri-urban locations. Concerns, over competition with poor livestock producers, reliance on feed grains, loss of genetic diversity and environmental pollution, must be recognised. However, these systems are the most economically efficient and cheapest sources of animal protein. There is considerable scope for import substitution and saving of foreign exchange. Improvements to traditional 'backyard' systems are needed, together with development of an institutional framework to promote equitable contracts between commercial processors and smallholder producers and joint action by smallholders in establishing processing and marketing facilities. Similar issues arise in relation to smallholder dairy development.

Livestock development policies include trade and pricing policies, to encourage the developed countries to reduce trade barriers, to reduce domestic protection of industrial sectors and to make limited use of subsidies and taxes. Subsidies may be used for disaster relief or to promote use of innovations. Taxes may be used to recover costs publicly financed services. Institutional development requires strengthening of rural roads and communications, property rights and contractual agreements, and organisations for the provision of credit, animal health services, and other inputs. Dissemination of timely market information is desirable and promotion of links between producers and processors or of producer groups for processing and marketing.

The decline in funding for livestock research must be reversed. More research is needed on animal and veterinary public health, forage crops and the utilisation of crop by-products, improved husbandry and production systems and possibly on breeding. In addition, socio-economic research is needed into existing production systems, and institutions for land tenure, credit, labour hire, input delivery and product marketing together with methods of research prioritisation. Increased funding for well-designed policies for trade, pricing, institutional development, research and technological change should yield substantial returns in terms of growth in agricultural and national income, saving of foreign exchange and rural poverty relief.

1. INTRODUCTION

Role of agriculture in securing livelihoods, generating employment and income

In terms of the number of people employed, agriculture is the most important industry in the world. The estimated agricultural population, defined as all persons depending for their livelihood on agriculture, hunting, fishing or forestry, of over 2.5 billion, makes up 42 per cent of the total. In the developing countries, over 50 per cent of the population depend upon agriculture. Although the proportion is decreasing, as a result of rural-urban migration, the absolute numbers securing their livelihoods from agricultural production are still increasing in the developing countries. Within this group, only in Latin America and the Caribbean have the numbers in agriculture declined over the last decade (Table 1). In the 'transition economies' of the former Soviet Block, which in this study are not included among the developing countries, agricultural populations are falling rapidly.

Table 1: *Agricultural populations in developing countries*

	Developed Countries	Develop-ing Countries	Latin America & Caribbean	Sub-Saharan Africa	North Africa & Near East	South Asia	East & South East Asia (incl. China)*
Agricultural population as % of total (2001)	7.3	51.5	20.4	63.5	32.1	53.7	59.3
Annual growth (%) of agricultural population (1991-2001)	-2.9	0.6	-0.8	1.8	0.5	1.0	0.2
Annual growth (%) of non-agricultural population (1991-2001)	0.8	2.9	2.3	4.4	3.2	3.0	2.7
Agricultural population as % of total (2010)	5.5	46.5	16.3	58.3	27.3	49.0	53.9

* Note: Numbers dependent on agriculture in China, and hence in this group, reached a peak in 1999 and have declined thereafter.
Source FAOSTAT 2003

Consideration of these statistics suggests three reasons why agriculture plays a critical role in economic development and improvement of the general welfare of the whole population. First, given that the agricultural population forms such a large proportion of the total, national average income per capita must be strongly influenced by income levels in agriculture. Any improvement in agricultural labour productivity must be reflected in a rise in national income per capita. This last measure is still seen as a key indicator of economic growth and development. Other key indicators, such as improvements in nutrition, health and education facilities and life expectancy, are closely related to average per capita income.

A second need for agricultural growth and development is to provide livelihoods for the still increasing numbers of people dependent on agriculture in most of the developing world. As the agricultural population and labour-force grows, in relation to limited resources of land and capital, diminishing marginal and average returns

might be expected. In order to avoid diminishing returns and at least maintain existing levels of productivity per person, some combination of land expansion, capital investment and technological change is needed.

A third need is for agriculture to produce a growing marketed surplus to feed the rapidly expanding and urbanised, non-agricultural population and to provide raw-materials for industrial development. Failure of agricultural production to keep pace with the growth in demand must result in increases in agricultural imports, and falling self-sufficiency, or rising prices for food and other agricultural products. In either case, there will be a serious brake on industrial expansion because of the adverse effects on the balance of payments or the inflationary pressures of rising food and raw material costs.

The movement of labour out of agriculture is an essential feature of economic development. The associated rural-urban migration has accelerated in recent decades, particularly in the developing countries. Thus agriculture may be seen as contributing to industrial growth by providing a source of cheap labour. Furthermore agricultural surpluses, extracted by Government policies or by private saving, have provided much of the capital for industrial development, while agricultural exports earned the necessary foreign exchange to import industrial raw materials. In addition, agricultural incomes are a source of effective demand for domestically manufactured consumer goods. These linkages may become less important as the balance, between agriculture and other sectors of the developing country economies, changes.

Agriculture and rural poverty alleviation

The importance of agriculture in economic development goes beyond its contributions to growth in national income, the livelihoods of rural people and meeting the nutritional requirements of increasing populations. Agricultural development is also seen as having a key role in the reduction of poverty. This follows from the knowledge that a majority of the poor in most developing countries (with the exception of countries in Latin America) live in rural areas and that food prices are a major determinant of the real income of both the rural and urban poor.

Following a series of international conferences proposing targets for the reduction of poverty, over the previous decade, The United Nations General Assembly (UN 2001) adopted a set of eight Millennium Development Goals. The first of these goals was to halve, between 1990 and 2015, the proportion of people whose income is less than US$1 a day and the proportion of people who suffer from hunger. It is estimated that, globally, 1.2 billion people are in extreme income poverty, as defined by the US$1 limit, and 75 % of these work and live in rural areas (IFAD 2001). More than two thirds of the poor live in Asia, with nearly a half of the total in South Asia alone. About a quarter of the total number live in Sub-Saharan Africa.

Agriculture is the main source of livelihoods for the majority of rural people in developing countries. (Agricultural population equals 87% of the rural population: FAOSTAT 2003). It follows that most of the extremely poor people are mainly dependent on agriculture. The land-less and casually employed farm labourers are almost everywhere among those most likely to be poor. Female headed households are often among the poorest in much of the developing world although less so in Asia. Activities are diversified with many supplementary off-farm activities. None the less the rural poor, in all developing countries, depend extensively on crop and animal production and related activities for their livelihoods. Improvements in agricultural productivity offer the most direct route to the relief of rural poverty. Despite the global objective of halving poverty levels by 2015, the share of development

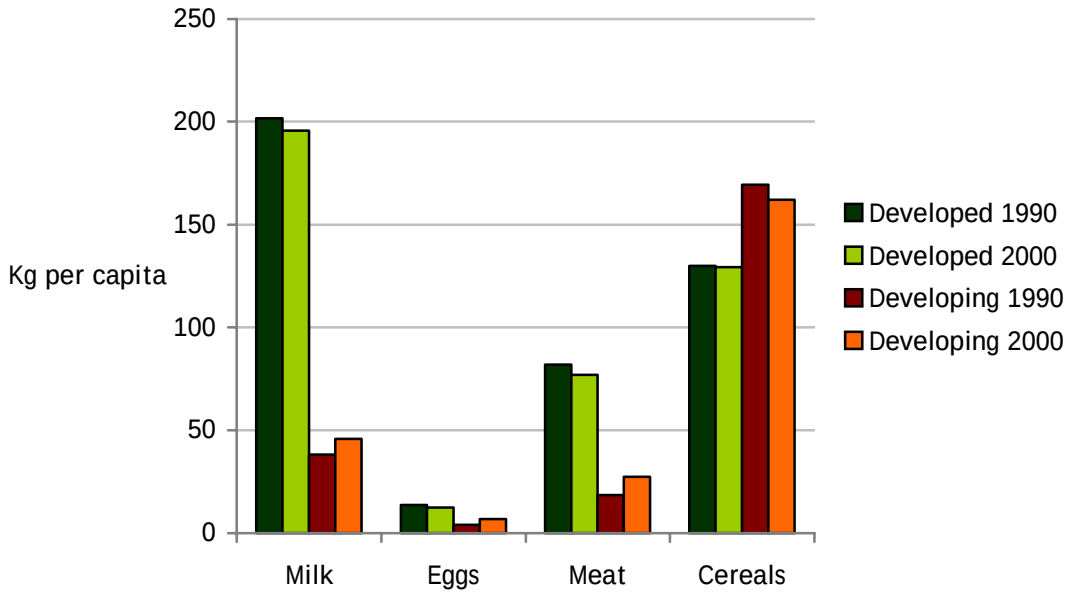
assistance going to agriculture has fallen from about 20% in the late 1980s to 12% in 2000 (IFAD 2001).

Livestock, development and poverty alleviation

Livestock and livestock products (LLPs) are estimated to make up over half of the total value of agricultural gross output in the industrialised countries, and about a third of the total in the developing countries (Bruinsma 2003, Chapter 4). The global importance of livestock and their products is increasing as consumer demand in the developing countries expands with population growth and rising incomes. This growth in consumption is reflected in improvements in the average human nutritional status due to the intake of animal protein. The resultant changes have been dubbed 'the next food revolution' and the growth in developing country consumption of animal products is predicted to continue at least until 2020 (Delgado *et al* 1999, and 2001).

Livestock products such as meat, milk and eggs are more costly, per tonne and per unit of food energy, than staple crop products, so diets in most developing countries generally include lower levels of intake of animal products than those in the developed, or industrialised, countries (see Figure 1). To some extent, the lower levels, of meat, egg and milk use, are compensated for by higher levels of cereal supply and consumption per person. However, as incomes rise, in the developing countries, consumers seek more variety and better quality foods in their diets. Hence demand for livestock products rises rapidly, an effect which is also driven by quite rapid growth in the number of consumers. However, in many of these countries, domestic production has failed to keep pace with the growing demand so imports of livestock products have increased.

Figure 1: *Per capita annual supply of livestock products & cereals 1990 & 2000*



Source: FAOSTAT 2003

The developing countries, as a group, are now net importers of all livestock products, with dairy produce as the largest item, while imports of beef, pig and poultry meat are growing rapidly (imports of poultry meat to developing countries quadrupled

between 1989 and 1999) (Upton 2001, Upton & Otte 2002). The widening gap between consumption and production within the group of developing countries presents a challenge. Given the strategic importance of food supplies, the major economic contribution of the agricultural sector in most developing countries and the foreign exchange costs of imports, greater self-sufficiency in animal products is likely to be a significant policy goal. Increased efficiency of domestic livestock production should, at least, slow the rate of import growth.

Other non-food products, such as wool and hides and skins, are important in some countries for domestic use or for export. For both wool and hides and skins, the developing countries, as a group, are net importers. Where these products are important to the national economy, similar arguments to those made for milk, meat and eggs, apply.

Apart from the importance of animal production to national economies in contributing to national income, improved human nutrition and foreign exchange, earned or saved, livestock play an important role in contributing to rural livelihoods, employment and poverty relief. Under many grassland-based systems, usually where alternative forms of land-use are uneconomic, livelihoods are largely dependent on livestock production. Increases in productivity, though difficult to achieve, have a direct impact on household incomes and the incidence of poverty. The landless poor, who are able to acquire livestock, are enabled to satisfy immediate cash and food needs. Because animals gain in value over time they may provide a route into owning other types of asset.

In mixed and integrated farming systems livestock contribute to both intensification and diversification of income streams. The majority of the world's rural poor depend on such systems (Thornton *et al* 2002). Complementary relationships between crops and livestock may be exploited, through nutrient recycling, with animals feeding on crop residues, and returning manure to the soil. Not only is additional income earned from livestock products but also benefits may be derived from increases in crop yields. Draught animals may also contribute to expansion of crop production, resulting from the saving in labour requirements per hectare of crops.

Livestock embody saving and may provide a reserve against emergencies. If an urgent need for funding arises, for a special occasion or a disaster such as a drought, animals may be sold to raise the needed money or slaughtered and consumed to provide food energy and protein. Risks are mitigated by combining crop and livestock production, since the livestock may provide the means of subsistence if crops fail. Both as a store of savings and as a risk reserve, small-stock (sheep and goats or poultry) have advantages over larger animals (cattle or camels) in terms of greater convenience and security. In many societies, livestock also serve social and cultural functions. They may have special roles in religious ceremonies and other social institutions, and provide a quantitative measure of family status.

In summary, livestock have an important role to play in national economic development, and within the agricultural sector of the developing countries. Livestock make a large and growing contribution to the nutrition of expanding populations, and contribute to the trade balance. Livestock-crop interactions are important in integrated mixed farming systems in much of the developing world. Furthermore livestock production provides employment and livelihoods for many of the world's rural poor. However, there are major differences between the agro-ecological and economic environments in different parts of the developing world, between animal species, between production systems. Changes have also occurred over time. These issues will be explored in more detail in the following sections.

2. DIVERSE AND CHANGING ROLES OF LIVESTOCK

Livestock as capital investment

Livestock are capital assets (see Box 1). The family flock or herd is a capital stock, or endowment, resulting from past productive activity, which will increase household income above that derived from the inputs of land and labour. The associated institutional concept of 'property' will be discussed below. For present purposes it is assumed that the family or household is a unified decision-making unit, which has control of the livestock and rights to the livestock products. Capital accumulation, by raising livestock, is an obvious method of increasing farm productivity and incomes.

Box 1: *Livestock as Capital Assets*

A capital asset is something that has been produced but has not yet been used up. It should produce a return, in terms of increased income, or welfare, in the future. Livestock fit this definition; they have been produced and should yield returns in the future, directly in the form of meat, milk, eggs, wool or hides/skins, and indirectly through manure or draught power used in raising income from crops.

Investment is the acquisition of capital assets. It necessitates saving, or foregoing current consumption. The consumption foregone may be agricultural produce such as eggs kept for hatching, or animals retained for breeding, leisure when a shed or kraal is built by family labour or money. The money used to purchase animals or equipment might otherwise have been used to buy food or other consumer goods. If the asset is acquired on credit, then someone else has done the saving and may require 'interest' to be paid on the loan.

Investment in livestock has very low transaction costs, once the first breeding female has been acquired, and mated, since flock or herd growth follows from reproduction.

In recent literature, especially that concerned with the environment and sustainable agriculture, the total capital stock is sub-divided into five types: natural capital, social capital, physical capital, human capital and financial capital. This typology is useful in distinguishing the full range of capital resources needed for development, loosely summarised as follows:

- Natural capital: natural resources of land, water, wild plants, animals and fish;
- Social capital: the institutional framework to facilitate social transactions;
- Physical capital: the physical output of human productive activity in the past;
- Human capital: the stock of accumulated skills and knowledge of individuals;
- Financial capital: stocks of money or sources of funding.

Some authors include livestock, as items of 'food (both farmed and harvested or caught from the wild)' as natural capital (Pretty 1999). However, in this paper, livestock are treated as physical capital, as suggested in Box 1. It may be noted that, where investment in livestock is an innovation, new human capital is needed in the form of knowledge and skills in animal husbandry.

A further important distinction, at least within physical capital, is that between durable, or fixed, capital and circulating, or working, capital. The definitions relate to the length of the production cycle, which within agriculture is usually assumed to be a year. While durable assets have a working life of more than one production cycle, circulating capital is used up and replaced within the cycle. Hence most animals used for breeding are items of durable capital. Stocks of concentrate feeds, on the other hand, are circulating capital as are the reserves needed to sustain the labour force and pay for animal health services. The need for circulating capital is sometimes forgotten in planning livestock projects and other investments. The circulating capital requirement per head of a particular livestock species depends upon the type and frequency of produce off-take. For example milk is produced every day, and its value may be set against the accumulated cost of circulating capital. Hence the peak circulating capital requirement is much lower than that for a beef animal, the product of which is obtained only once at the end of its life.

Although durable capital, in breeding animals and the like, has a life of several years it is eventually 'used up' and needs to be replaced, if production is to be sustained. Averaged over the life of the asset, the replacement cost, or annual loss in value, is known as 'depreciation'. Some investment is needed to cover the depreciation of capital assets. The surplus of investment over the cost of depreciation represents growth or 'capital formation'. On the other hand, whilst growing to maturity livestock may gain, or appreciate, in value. These changes in value, depreciation or appreciation, must be taken into account in assessing production and productivity of livestock enterprises.

Thus investment in livestock involves both circulating capital to cover costs of feeds, labour and animal health inputs, and durable capital costs of depreciation and interest on borrowed funds. Even if the animals had been raised by members of the household, family or friends, the saving involved has a cost. Despite these costs, investments are made in the expectation of increasing household production and income to earn a surplus, over all these costs; often expressed as a percentage of the cost of the investment, and known as the return on capital. Examples of estimated rates of return, for investments in livestock, are given in Box 2.

Box 2: *Examples of Return on Capital from Livestock*

Quite high, though variable, rates of return on capital have been estimated for livestock production. A study of 'backyard' production of dwarf goats and sheep, in South West Nigeria, showed average annual rates of return for goats of 34%, and for sheep of 55% (Upton 1985). However, sensitivity analysis showed that at high levels of mortality, recorded for goats in some villages, losses were made and returns were negative. Risk of loss appeared lower for sheep.

For local pigs in the scavenging pig production system prevailing in Haiti, the returns on capital invested was estimated to fall between 30% and 70% respectively under pessimistic and optimistic assumptions about 'flock productivity' (Otte, 1997)

Investment in cattle, in Lesotho, was estimated to earn a 10% rate of return (Swallow & Brokken 1987). Over the same period bank accounts were losing 10% annually because of inflation. It could be argued therefore that the real rate of return on investment in cattle was 20%.

Livestock, diversification, extending and intensifying production

Investment in livestock may raise agricultural production and rural incomes to yield a return on the capital invested in various different ways. These include livelihood diversification, extending the land area utilised or intensifying land use. These are three of the five 'main farm strategies to improve livelihoods' recommended in a FAO/World Bank publication (Dixon *et al* 2001). The other two suggested alternatives are to seek increased off-farm income in other non-agricultural activities, or to leave agriculture altogether.

Diversification implies an adjustment to the farming system, usually by introducing a new productive activity such as a dairy unit on a holding previously used only for growing crops. Not only does this add to total farm production and household income, but also may alleviate risk. Provided that the yields of crops and livestock are not positively correlated, diversification should reduce the overall inter-year variation in household incomes.

Investment in livestock may allow extension of the land area utilised, either by grazing previously unused areas or by using animal draught power to extend the area under cultivation. Beneficiaries of land reform may be able to expand crop production in this way. Otherwise, scope for expansion of the agricultural frontier is limited except for parts of Latin America and Sub-Saharan Africa and some countries of East Asia. However, as the agricultural frontier is pushed outwards, onto less and less productive land, the benefits of expansion are reduced. In much of Sub-Saharan Africa, the area suited to cattle production is restricted to the semi-arid zones by the presence of the tsetse fly in more humid areas. At the same time there are conflicting aims of conserving the natural environment, vegetation and wildlife of some non-agricultural areas.

Given the limited scope for expanding the area of land used for agricultural purposes, the best alternative is to intensify, or increase production per hectare. Intensification generally involves increased inputs per hectare of labour and/or capital and may be associated with a change in the technology used. The introduction of livestock necessarily involves capital investment and a resultant increase in production value per hectare. Additional labour may also be employed in tending the animals. Extra production is derived directly from the livestock in the form of meat and other products, but also indirectly through the complementary effects of animal draught and manure on cropped area and yields.

Intensity of livestock production depends upon *inter alia* a) the stocking rate, b) choice of system and animal species, and c) yield per head (Upton 2002). Growth in livestock production and farm-household incomes can be achieved by increasing stocking rates, changing to more intensive production systems or improving reproduction rates, live-weight gains, and milk, egg, or other product yields. The stocking rate, expressed as the number of (tropical grazing) livestock units per hectare, is an indicator of the intensity of use of grazing or rangeland.[1] This measure is therefore only of use in relation to grassland-based systems, such as pastoralism or ranching, where over-stocking may possibly lead to irreversible rangeland

[1] The standard livestock unit is usually a milking cow, while sheep and goats are valued at 0.125 of a unit. There are two features that complicate the definition of carrying capacity, or maximum sustainable stocking rate. One is the extreme inter-year variability of rainfall, and hence of herbage production, in the semi-arid regions where grassland-based systems are prevalent. The other is the practice of seasonal transhumance between wet-season and dry- season grazing areas. In the light of the risks associated with the first of these features, some range scientists recommend a conservative management strategy of restricting the stocking rate to the level sustainable in the driest of drought years. The result would be wastage of forage surplus to livestock needs in every other year. A more opportunistic strategy of a stocking rate which cannot be sustained in the driest of drought years, but which makes fuller use of the available forage in most other years, is probably adopted by most pastoralists and can be justified economically (Sandford 1983).

degradation. The effect of land tenure on stocking rate will be discussed later under institutional issues.

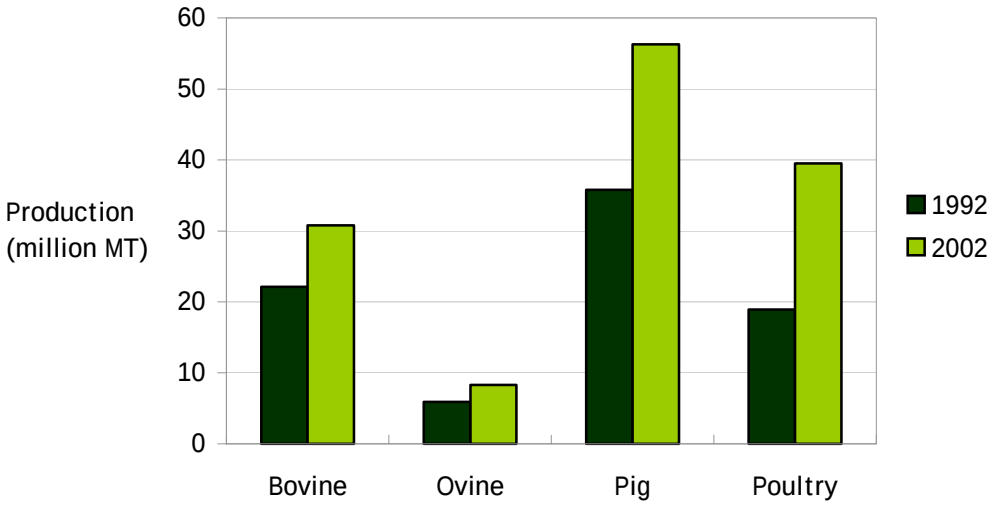
Livestock production systems vary widely between different parts of the world, and differ substantially in their use of land. For purposes of discussion the global classification system devised by Seré and Steinfeld (1996) may be used. Three main categories of production system are identified, namely (i) 'grassland based systems', including pastoralism and ranching (ii) 'mixed-farming systems', subdivided into rainfed and irrigated sub-categories and (iii) 'landless livestock production systems' largely pigs and poultry but also including landless ruminant systems. The numbers of rural poor associated with these systems have been estimated in a recent ILRI study (Thornton *et al* 2002).

Different production systems are associated with different livestock species or types. Grassland-based systems are entirely dependent on ruminant livestock, such as camels, cattle, sheep and goats, which can readily digest green forage. At the other extreme, most landless systems in the developing world are based on pig or poultry production. These three main types of system may be ranked in order of increasing intensity. Grassland-based systems are generally the least intensive (or most extensive), with fewer than 10 livestock units per hectare. Labour inputs, and product output, per hectare are quite low in comparison with most mixed farming and intensive systems. Mixed farming systems are intermediate in intensity while the landless systems are the most intensive. For the latter type, land area is not an immediate or direct constraint on production or the use of other inputs. Thus intensity of production may be increased by switching from pastoralism, through agro-pastoralism to mixed farming or by switching from mixed-farming, through zero-grazing of dairy cattle or fattening stock to more intensive landless systems.

Changes are occurring in patterns of livestock production, and consumption, globally and in the developing countries, towards more intensive production systems. These trends are illustrated by the more rapid growth in production of pig and poultry meat in comparison with that of ruminant, bovine and ovine[2] meat, as shown in Figure 2. Over the last decade, bovine and ovine meat production increased by about 40%, pigmeat production rose by nearly 60% while poultry meat production doubled.

[2] 'Bovine meat' includes that of both cattle and buffaloes, 'ovine meat' includes that of both sheep and goats.

Figure 2: *Meat production in developing countries by species 1992 & 2002*

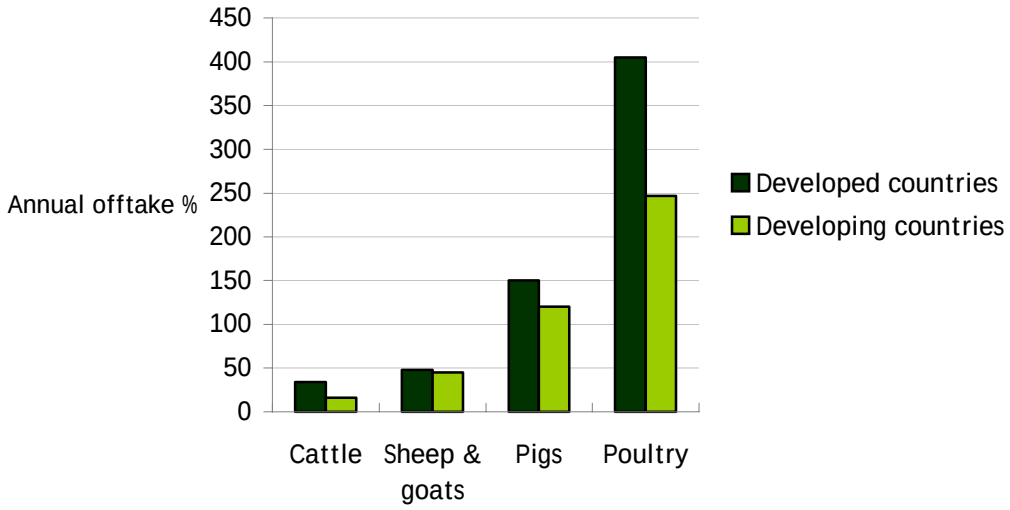


Source: FAOSTAT 2003

The landless pig and poultry production systems are largely responsible for the rapid growth in average meat supply *per* person in the developing countries. The quantities of pig and poultry meat in the average diet of people in developing countries now exceed the quantity of bovine meat. It should be noted, however, that the very high estimated growth rate and current level of pig-meat consumption in China have a major influence on the average for all developing countries and doubts have been raised regarding their reliability (Bruinsma, 2003).

Pig and poultry production is not only more intensive than ruminant meat production, in its use of land, productivity is also greater because of higher reproduction and growth rates. A crude comparison of the productivity of the different livestock species, derived from FAO statistics, are presented in Figure 3. Production is measured by the number of animals/birds slaughtered in 2000 plus the increase, or minus the decrease, in animal/bird population between 2000 and 2001. This adjustment for changes in population is a crude method of allowing for stock depreciation or appreciation. Productivity is then estimated by the number slaughtered as a percentage of the population recorded in 2000. This simple comparison serves to emphasise the greater reproduction and growth rates of the 'landless' livestock species. Poultry are also more efficient than other livestock as converters of feed grain into meat. In developed countries poultry require 2 to 2.5 kg of grain to produce 1 kg of meat or eggs. The feed requirements for pigs and grain fed ruminants are much higher per kg of product.

Figure 3: *Relative productivity of different livestock species 2000-2001*



Source: FAOSTAT 2003

The increase in production per hectare, associated with a change to a more intensive livestock system, is at the expense of increased inputs of labour and capital. Fences are needed to prevent crop damage by livestock, while some animals may be permanently housed. Confinement of the animals facilitates the management of nutrition, breeding and health, but increases the labour requirement for feeding, watering and husbandry of the livestock. Apart from the capital embodied in the animals, additional investment is needed in providing fencing, housing and specialised equipment for feeding and other activities. Special equipment is needed for animal slaughter and meat processing, or for milk cooling and processing. There are economies of scale in the provision of such processing services and the associated marketing of the produce, and possibly the supply of inputs of genetic material (e.g. day old chicks or semen) or concentrate feeds. This suggests the need for either co-operative group activity or vertical integration of smallholder producers with a large scale processing and marketing organisation.

Within any one livestock species and production system there is considerable scope for raising yields in the developing countries. The comparison of average off-take rates in the developing countries with those in the developed countries, as shown in Figure 3, serves to illustrate this point. Yield increases may be achieved by improvements in animal health and nutrition and in the longer term by selective breeding or cross-breeding. Proper control of these measures requires careful management and facilitated by improved housing. Financial yields, or revenues, are dependent on effective marketing of the produce.

Animal draught as labour-saving technology

The introduction of livestock on a cropped farm, or a change in the production system, may be viewed as an innovation, or change in technology. Capital is invested to raise the productivity of both land and labour. The effect may be neutral, meaning that the labour use per hectare is unchanged, or there may be a bias in the direction of using more, or less, labour per hectare than before. If more labour is used, the innovation is said to be 'labour using' and 'land saving'. Where the introduction of livestock increases the intensity of land use, it follows that the innovation is 'labour-

using'. Although the area of land is not reduced, the input of land *per unit of product output* falls. In this sense the effect may be viewed as 'land-saving' or as 'the substitution of labour, and capital, for land'.

Labour-using innovations, of this nature, are appropriate and beneficial in situations of high rural population density, such as those found in parts of South and East Asia. They are beneficial in creating productive employment and generating additional income from a limited natural resource base. The 'landless' production systems may provide income and employment for rural people without access to any land.

At the lower rural population densities found in parts of Sub-Saharan Africa and Latin America, labour-saving and land-using technology may be appropriate. The use of animals for draught power is such a technology. Studies have shown that cultivation, with animal power or tractors, produces little or no improvement in crop yields in comparison with hand-cultivation. The main benefit is to allow a larger area to be cultivated per household or per unit of labour. In this sense, it is a labour-saving and land-using technology. A recent estimate suggests that about half of the total cropped area in developing countries is cultivated using animal draught power (Bruinsma 2003, Chapter 5).

The limited scope for further expansion of the area of land used for agricultural purposes was discussed above. This suggests that there is limited scope for further expansion of the use of draught animals. However, in many situations their use was established long ago, when there were still extensive areas of unused land available. The practice has continued despite the exhaustion of supplies of unused land. In South and East Asia draught buffaloes and cattle are widely used in intensive irrigated farming systems. Two or more crops are produced annually and motive power requirements are high.

Alternatively, it is argued that cultivation using animal draught is introduced when human populations are still relatively sparse and rely on rotational bush fallowing to restore soil fertility. As the population pressure increases, it becomes necessary to increase crop production by reducing the area under rotational fallow. This raises the motive power requirement, for which animals are used to substitute for hand labour (Boserup 1965, Pingali, Bigot & Binswanger 1987). A study in the West African Savanna showed no difference in average labour productivity between farms using animal draught and those using hand labour. However the use of animal draught was found to raise the return per day of labour at peak work periods, when the labour constraint is critical (Delgado 1989). The spread of animal draught use to the more humid zones of Africa, is largely precluded by the tsetse fly/ trypanosomosis challenge.

The provision of animal draught power competes, for capital and other resources, with meat and milk production. Thus there are incentives to limit the number of animals used per work team, to hire draught oxen or buffaloes where possible and/or to use dual-purpose, female animals for draught and breeding and some milk (Matthewman 1987). As demands for livestock products grow in relation to those for crops, producers in some areas may switch to tractor use for field mechanisation and to specialise in meat or milk production.

Crop-livestock interactions

Crop and livestock interactions occur directly in mixed farming systems from which the bulk of global ruminant livestock production is obtained. Recent estimates suggest that 65% of all beef, 69% of all mutton and 92% of cows' milk is produced from mixed farms (FAO 1996). In addition 84% of the world's rural poor depend on these systems (Thornton *et al* 2002). The useful complementarities between crops and livestock

have already been mentioned. Apart from the draught power inputs to crop production by the cattle, buffaloes or camels, all livestock can contribute to the nutrient cycle by feeding on plant material and returning plant nutrients, in manure, to the soil. Only ruminants can convert fibrous material in grass, browse or forage, which may have no other use, into valuable products. In addition livestock complement crops in providing food and income for the household, risk reduction through diversification and a form of savings.

Complementary interactions between crops and livestock mean that increases in livestock production may be accompanied by increased crop production. This situation may arise where livestock are largely supported on crop residues and by-products or waste land, so little or no cultivated land is devoted to fodder production. Research devoted to improving the quality of crop residues, such as the treatment of straw, and the better utilisation of crop residues may extend the livestock carrying capacity without reducing crop production. The application of animal manure to the crop-land and possibly the use of animal power may contribute to the expansion of cropped area at the expense of fallows or directly to increased crop yields. As a result production from both crops and livestock is increased.

However, as the intensity of land use rises, with increased livestock numbers, a point will be reached when some land must be dedicated to producing livestock fodder. Where the fodder crop, or grass ley, forms part of a rotation to ensure sustainability of the system, the crop-livestock complementarity remains. In other cases, production of fodder crops competes with food and cash crops for the use of land. However, the competition between crops and livestock for labour may be less direct, for instance livestock may need more care and supplementary feeding and watering in the dry season when few crops are growing. Overall if household income is increased and risks of losses are reduced, by keeping livestock fed on forage crops, it follows that the extra benefit (marginal product per hectare) derived from forage production is at least equal to that from food or cash crops.

The relationship between crops and 'landless' livestock production systems within a mixed farm may be described as 'supplementary'. If the animals are fed entirely on household-waste or purchased feed there is really no competition for land, the livestock enterprise adds to, or supplements, the income from crop production, with little or no interaction between the activities.

Landless systems and the use of feed-grains

Landless production systems are the source of most of the world's poultry and pig meat production and hence of global meat supplies. It is claimed that China raises more than half the total world pig population and a significant proportion of all poultry[3]. Even when China's production statistics are omitted, as possibly being inflated, pig and poultry meat each account for about a third of all meat produced world-wide. The developed countries dominate world livestock production from landless systems, but even within the developing country group, excluding China, pig and poultry meat makes up more than half the total meat produced (Bruinsma 2003). In addition some beef and mutton is produced from intensive feedlot operations, the former mostly in North America and the transition states of Eastern Europe. Sheep and goat fattening under landless conditions occurs in the Near East and in much of Africa. Cut-and-carry, zero-grazing dairy production systems frequently practiced in

[3] Most of China's production is derived from small-scale 'backyard' production systems combined with crop cultivation (In 1997, 67.5% of rural households kept pigs, but only 0.2% had more than 51 pigs. National Agricultural Census Office of China 1997).

peri-urban and urban areas are similar in that hand feeding and disposal of manure are involved.

Small-scale backyard pig and poultry systems are common in many parts of the world. There is scope for intensification and a change to more 'open' systems with the introduction of housing, the purchase of concentrate feeds and the sale of produce. Increases in scale and capital investment allow improved housing, mechanisation and automation of feeding, watering and husbandry, the introduction of exotic breeds, specially formulated concentrate feeds and veterinary drugs. Production of poultry and pigs in the developed countries is concentrated in large-scale commercial units and their application is spreading in peri-urban areas of the developing world, particularly in Asia and Latin America.

The importance of landless poultry and pig systems in meeting growing demands for livestock products in human diets, and some of the reasons for their importance were discussed above. There are three potential areas for concern over the growing importance of such systems. First there may be few advantages to the rural poor. The main beneficiaries are the relatively higher income consumers and commercial producers, processors and traders. Second there are environmental problems of manure disposal, pollution and loss of bio-diversity resulting from increasing dependence on a narrow range of hybrid breeds. The third is the extent to which staple cereal crops are used for animal feed.

The use of purchased cereals and oilseeds for feed allows separation of crop production and use. These concentrate feeds are less perishable and easier to transport than the livestock products. Even if several kg of concentrates are needed to produce one kg of meat, it is still cheaper to establish the production system near the market and to transport the feeds to the animals. Hence most of the intensive landless systems are established in peri-urban regions, in the vicinity of markets in centres of high human population density. Concentrate feeds may be produced from the wider hinterland or imported from overseas. It is estimated that about 40% of the net exports of cereals from developed to developing countries are feed grains for livestock (Bruinsma 2003, Chapter 3).

For the world as a whole, it is estimated that the 657 million tonnes of mainly coarse grains, making up 35% of all cereal use, are fed to animals. Most of these are used in the USA and other developed countries. None the less increasing amounts are being fed to intensively managed livestock in developing countries, as poultry and pig production increases. Over the last decade, the increase in cereal use for feed has been more gradual than expected, partly because of a reduction in intensive livestock production in the transition economies, partly because of high cereal prices in the EU and partly because of increasing efficiency of feed conversion. Poultry are very efficient feed converters, requiring only 2 to 2.5kg of feed per kg of meat produced and even less per kg of eggs. Pigs require 2.5 to 4 kg of dry matter per kg of pig meat, while concentrate fed ruminants require considerably more feed per kg of meat.

The argument that cereals are fed to intensively raised livestock at the expense of hungry people is not valid. If the cereals were not fed to livestock, it is unlikely that the poor and under nourished would benefit as less cereals would be grown. A further argument is that cereal use as feed acts as a buffer against price fluctuations as livestock producers will reduce use in times of shortage and high prices. The global problems of poverty and malnutrition cannot be solved by changing consumer food preferences. Landless production systems provide an efficient and relatively low cost means of meeting much of the growing demand for livestock products. At intermediate levels of intensity they can provide employment and income to the landless resource poor. Greater participation may be encouraged by improving credit facilities and promoting co-operative production, processing and marketing or vertical

integration between large scale processors that supply hybrid or cross-bred stock and concentrate feeds, and buying the product from smallholder producers.

Diversity of livestock systems, the impact of climate and human population density on their world-wide distribution

The choice of livestock production system varies between different countries and different regions within countries. It is influenced by agro-ecological features, particularly climate and topography, human population density and cultural norms, such as avoidance of pig meat in Islamic society, and of beef in India and very limited milk consumption in East Asia. On the basis of climatic differences, the four main categories of livestock production system, grassland based, mixed rainfed, mixed irrigated and landless, may be further sub-divided into arid, humid and temperate zones. These three zones are defined as follows:

- arid, and semi-arid; average length of growing period of less than 180 days,
- humid and sub-humid; average length of growing period of more than 180 days,
- temperate/tropical highland; average growing-season temperature between 5^{o}C and 20^{o}C or one month or more with average (sea level) temperature below 5^{o}C.

Although livestock production systems vary considerably between regions within countries, some broad differences may be identified between continents and linked with the availability of natural resources. This analysis is restricted to grassland-based and mixed farming systems, since landless systems are largely independent of the natural resource base and climatic conditions. Results are given in Table 2.

The data provided in the first four rows of Table 2, on land availability per head of the agricultural population and the proportion of cropland which is irrigated are derived directly from the FAOSTAT database (FAOSTAT 2003). These figures reveal striking differences, between continents, in agricultural population density and the importance of irrigation. The remaining six rows of the Table are taken from a GIS mapping study of poverty and livestock systems in the developing world (Thornton *et al* 2002). The country membership of the different continental groups differs slightly from that used in FAOSTAT, but the broad estimates will serve to illustrate the pattern of livestock production systems. The three rows recording extent of climatic zones, is based on the mapping of livestock systems by land area, whereas estimates in the last three rows give the proportions of the total population engaged in each type of farming system.

Table 2: *Land use per head of agricultural population, distribution by agro-ecological zone (AEZ) and proportion of poor within livestock production systems*

	Developed countries	Developing countries	Sub-Saharan Africa	North Africa & Near East	South Asia	East & South East Asia (incl. China)	Latin America & Caribbean
Land area ha / head	56.48	3.16	6.69	10.31	0.62	1.41	19.02
Cropped land ha / head	6.59	0.35	0.44	0.77	0.28	0.21	1.47
Permanent pasture ha / head	12.47	0.92	1.87	3.54	0.03	0.49	5.56
Prop. of crop land irrigated %	10.7	23.9	5.9	30.2	38.5	31.8	11.7
Land by AEZ							
Arid area % of total		46	63	88	76	12	31
Humid area %		30	31	0	21	23	46
Temperate area %		24	6	12	4	65	22
Percentage of poor within production system							
Grassland-based systems		4	11	9	1	1	6
Mixed irrigated systems		40	1	30	55	31	7
Mixed rainfed systems		42	70	40	38	33	57

Sources: FAOSTAT 2003; Thornton et al 2002

In Sub-Saharan Africa, agricultural population density is relatively sparse, so that land endowments per person are quite good. However, much of the land is classified as arid, and only a very small proportion of the crop land is irrigated. Grassland based ruminant production is prevalent in the arid/semi-arid areas but most people are supported by, and most ruminant meat and milk is produced from, mixed rainfed farming systems. Mixed farming is practised in both arid and humid regions along with some in the temperate highlands of East Africa. There is some limited development of pig and poultry production, particularly in peri-urban areas. Overall levels of production and consumption *per capita* are low and improving rather slowly.

In contrast South Asia, including India, is densely populated, with very limited land resources per person depending on agriculture. Much of the land area is arid or semi-arid. However, a high proportion of the crop land is irrigated. Thus virtually all the ruminant livestock production is derived from mixed production systems, irrigated and rainfed. Little meat is consumed but milk production and consumption have grown rapidly: India is now the world's largest milk producer. Poultry meat production and consumption have also grown rapidly from a fairly low base.

The land resource availability per person in agriculture in East and South East Asia, including China, is similar to that in South Asia, the only difference being that most of the land area is classified as 'temperate'. Most of the livestock are produced on

mixed irrigated and rainfed farms, but the main species are pigs and poultry rather than ruminants. Milk production and consumption are very low. However, the production and consumption of pig and poultry meat and eggs are high and growing fast, although the quantities are possibly exaggerated in the Chinese statistics.

Land resources per head of agricultural population, in Latin America and the Caribbean, are higher than in other parts of the developing world. This low agricultural population density is linked with higher than average levels of urbanisation and per capita incomes. Only about a third of the land supporting livestock systems is arid. The extensive grassland of the 'pampas' allows production of ruminants, mostly ranched cattle. Nonetheless, rainfed mixed farming systems are the source of most of the ruminant production. Landless poultry and pig production is expanding rapidly, particularly in Brazil. Overall livestock production and consumption are considerably higher than in most developing countries, and are increasing quite rapidly.

Land areas per person dependent on agriculture, in the Near East/ North Africa, are high but the climate over much of the region is arid or semi-arid. A substantial proportion of the crop land is irrigated. The large areas of 'permanent pasture' carry ruminant stock, mostly sheep and some camels. The majority of ruminant stock are raised, however, on mixed farms, many of which are irrigated. No pigs are kept but landless poultry production systems are expanding in number. Livestock products make a relatively small contribution to human diets, but the contributions from milk and poultry meat are increasing.

The linkage between human population density and choice of livestock production system has been analysed in an evolutionary sense (Birner 1999, McIntire *et al* 1992). Agricultural development is seen as a series of changes, from pastoral livestock keeping to crop production, followed by the re-introduction of livestock in integrated mixed farming systems and then ultimately to specialised independent crop and landless livestock production systems. The process is driven by human population growth (Boserup 1965).

At the lowest levels of population density, extensive production systems are appropriate. These might include forest-fallow, shifting cultivation, particularly in humid zones (Boserup op cit), but elsewhere in both tropical and temperate regions, grassland-based pastoralism may be the most appropriate system, as the one yielding the highest return to labour. Historical examples include Northern India in Vedic times, Northern Europe at the time of the Roman Empire and the American West in the 19th Century (Birner 1999). As population density increases both food needs and labour availability per hectare increase. To meet the increased food needs, a change in production technology from pastoralism to crop cultivation is necessary. This requires increased labour inputs but raises productivity per hectare. Thus a labour-using, land-saving technology is induced.[4] This is the first critical phase in livestock development.

Initially, complementary interaction between crops and livestock may be exploited, as outlined earlier. Associated institutional changes will be discussed in Section III. Insofar as the livestock, a form of capital, contribute to increased production per hectare, the technology may be seen as capital-using and land-saving (or the substitution of capital for land). However, as human population density, and the required intensity of production, increases still further, crop-livestock competition for the use of land will arise. It is suggested that this occurs when the main constraint on

[4] Birner (1999), refers to the change as the substitution of labour for land.

livestock numbers is no longer fodder availability in the dry season, but availability of grazing land during the cropping season (McIntire *et al* 1992).

A further stage is reached, as the population dependent on agriculture and the intensity of production increase still further, when there is an incentive to introduce animal draught, as a largely labour-saving technology (or substitution of capital for labour).

Whilst this evolutionary analysis may be helpful in promoting understanding of the historical development of the more densely peopled countries of the world, it fails to take proper account of industrialisation and the impact of markets and economic development on capital investment and production technology. As discussed earlier, growth in per capita incomes is associated with increased demand and prices for livestock products relative to those for crops. Hence there are incentives to increase livestock production at the expense of crops and to concentrate on the marketed products. At the same time substitutes become available for livestock inputs to mixed farming, such as artificial fertilisers and tractors in place of manure and draught power.

These changes resulting from industrial growth and development have occurred at different stages in the process of increasing intensity of land use in different parts of the world. Whereas industrial development occurred in countries of Western Europe and Japan at high levels of population density, it occurred in Oceania, and North and South America while populations were quite sparse. Thus the development and adoption of different sorts of agricultural technology were 'induced' in different parts of the world. In Japan, where agricultural population density is high, the emphasis has been on land-saving technologies, such as improved seeds, the use of agro-chemicals and intensive landless livestock production systems. In contrast the USA have substantial land resources per head of population. The emphasis there has been on labour saving technologies. Mechanisation has been important, first with animal draught and later with tractors and other machinery, allowing extensive cereal production (Hayami & Ruttan 1985). In addition extensive ranching to raise ruminant livestock, with a high level of capital input per person employed, remains a viable production system in the Americas, Australia and New Zealand.

In reality there are wide differences between countries in the agro-ecological environment, the economic infrastructure and the social and cultural history, which preclude the application of a single model of livestock development to all cases. However, this analysis does serve to emphasise that the choice of technology and production systems is guided, as a rational response, by the relative resource scarcity, between land, labour and capital. It also provides support for the idea that research and development should be directed at finding technologies which are appropriate to the agro-ecological, economic and cultural environments and farm household objectives and constraints.

3. INSTITUTIONAL CHANGES

Relevance of the New Institutional Economics

It is increasingly recognised that the process of development is strongly influenced by institutions, which are "the humanly devised constraints that structure human interaction. They are made up of formal constraints (e.g. rules, laws, constitutions), informal constraints (e.g. often unwritten norms of behaviour, conventions, self-imposed codes of conduct) and their enforcement characteristics." (North 1994). Rules governing access to resources, both between and within households, transactions between individuals and collective action are examples. Organisations are the subset of institutions associated with group or communal activity. They include farmer associations, co-operatives, other clubs and societies, farm households, commercial firms, Local Government and the State.

Much recent analysis of institutions and institutional change is based on the concepts and approaches of the New Institutional Economics (NIE). These theories differ from neo-classical economics in their emphasis on decision making under uncertainty, not only about the natural environment but also about how other individuals and organisations will behave. Thus rational search for 'the optimum' or best decision is constrained by the lack of perfect information and the time and costs involved in the search; so decisions are made under so-called 'bounded rationality' (Simon 1961). Some of the uncertainties are due to the different alternative institutions defining 'property rights' while the lack of perfect information imposes the 'transaction costs' of search and negotiation.

Resource ownership implies a socially respected set of property rights, such as the rights to use, manage, derive income, exclude other potential users, be paid compensation for use or damage and to dispose of the resource. Associated responsibilities include care and maintenance of the property and compensation for damage that might be caused to others. Four main types of property regimes have been identified by Swallow & Bromley (1995), namely:

a) Private, or individual, ownership

b) Common, or communal, ownership

c) State ownership

d) Open access.

Debates over the relative merits of these alternative forms of property rights usually relate to natural resources (natural capital), such as land, water, forests, permanent pastures and wild-life. Despite the widespread belief that private, individual ownership is the best means of promoting efficient use and conservation of any resources, the process of privatisation of natural resources may prove difficult and involve high transaction costs. The assignment of property rights affects the bargaining powers of members of society and therefore the distribution of income and wealth. The notion of private rights on the original and costless gifts of nature may be socially unacceptable. Furthermore, the costs of delineating, registering and enforcing individual rights may prove prohibitive. Such resources are known as Common Pool Resources.

In contrast livestock, like other items of physical capital, result from past productive activity. Costs of production have been incurred so such assets are more likely to be socially accepted as private property of the individual person or household. The rights

to the benefits derived from livestock production provide the incentive for the necessary saving or borrowing for investment.

All property transfers and indeed all transactions in goods and services, by barter or by formal market exchanges, involve costs. These 'transaction costs', which are distinct from the costs of production and delivery, include the following:

- Search for information about potential contracting parties, and the quality and price of the resources to be exchanged;
- Bargaining to determine acceptable terms and conditions for the exchange;
- Defining the terms of the contract;
- Monitoring to ensure that contracting partners are abiding by the terms of the contract;
- Enforcing the contract and collecting damages where the partners fail to observe their contractual obligations.

These costs, though difficult to measure, are believed to have a major influence on the development of institutions and organisations (Williamson 1985). There is a range of different ways in which transactions may be conducted, called 'governance structures' by Williamson (op cit). At one extreme is the simple 'spot' market, or barter transaction. Alternatively transactions may be pre-arranged through contracts. Some contracts are relational, in the sense that they are embedded in a long-term personal relationship between the contracting parties who know and trust each other. The ultimate form of relational contracting occurs when the transactions take place within a single unified organisation, such as a business firm, a co-operative association or a farm household. Non-relational contracts involve reliance on a third party (e.g. a legal assessor or an elder statesman) to adjudicate in cases of dispute. The type of governance structure adopted is likely to be influenced by the characteristics of key transactions.

Transactions differ in three key characteristics, a) asset specificity, b) uncertainty and c) frequency. The first of these refers to situations where one or both of the parties, involved in the transaction, has invested in specific assets. The assets may be items of physical capital, such as livestock, specialised buildings and equipment, or human capital such as special skills in animal husbandry. For such assets, the investment cannot be recovered in a use other than that originally planned. Apart from imposing limits on the owner's choice of productive activity, it also limits his or her choice of trading partners. While simple spot market transactions are adequate where production involves few specific assets and there is little uncertainty, for more complex and uncertain transactions with greater asset specificity some form of contracting is needed to reduce transaction costs. If contracts are only needed occasionally then formal non-relational contracts are appropriate. However, with frequent contract use, relational contracts are likely to incur lower total transaction costs. In some cases this may involve the establishment of an organisation under unified management.

Another feature of many contractual arrangements is that of 'information asymmetry', which means that one of the contractors has more information than the other. This may be associated with opportunism, also described as 'self-interest seeking with guile'. In such a situation, the uninformed party is referred to as the principal, while the better informed party is called the agent. This terminology suggests that the principal is hiring goods or services from agents who are the providers. For example this may apply to a farmer who hires in land, labour, capital assets or market services. However, the effects of information asymmetry are best illustrated by the case of insurance services, where the principal is the provider and the agent is protected by the insurance. *Ex post* opportunism, known as 'moral

hazard' occurs when the 'agent' fails to care properly for property if it is known that any losses will be fully compensated. *Ex ante* opportunism, known as 'adverse selection', the only agents seeking insurance are those most at risk. This raises the average expected compensation payments and therefore the annual premiums that must be charged. Both forms of opportunism raise the associated transaction costs.

The NIE conceptual framework has been used to explore the historical process of institutional change necessary for economic development to occur (North 1990). In a traditional 'closed', or self-sufficient, village community transaction costs are low. People are linked through kinship and other personal ties so that information, about the activities of individual community members, is widely and freely available. Social structures, such as elders and other respected leaders and cultural behavioural norms provide for the enforcement of agreements and the resolution of disputes. However, for economic development to proceed, people need to trade with others, often strangers from outside the village community. The more complex and impersonal are the trading links, the higher are the transaction costs. Thus for economic change and development to occur, a society must adapt existing institutions, or create new ones, that will permit anonymous, impersonal market exchanges across time and space. An important element is to establish enforceable and efficient property rights and contractual agreements. It is argued that "the inability of societies to develop effective, low cost enforcement of contracts is the most important source of both historical stagnation and contemporary underdevelopment in the Third World." (North 1990, p54).

Institutional innovations are induced by changes in the economic environment and the technology of production. Some institutional changes are adopted communally on a voluntary basis, others are imposed by those with political or economic power. Governments have an important role in promoting, and in some cases creating, appropriate institutions to provide for effective, low-cost enforcement of contracts, thereby reducing transaction costs.

Changing patterns of land tenure

Changes in land tenure institutions are often quoted as examples of induced institutional innovations which are induced by changes in relative resource scarcity and production technologies. The Second Enclosure Movement in England represents a classical illustration. The issuance of the Enclosure Bill facilitated the conversion of communal pasture and farmland into single, private farm units, thus encouraging the introduction of an integrated crop-livestock 'new husbandry' system, based on 'innovations in crop rotation, utilizing the new fodder crops (turnip and clover) in response to rising food prices.' (Ruttan & Hayami 1998).

Box 3: *The 'Enclosures' in England*

This term is applied to the take-over of land that was previously common property and enclosing it with fences or hedges and ditches. The First Enclosure Movement of the Sixteenth Century involved the, often illegal, conversion of the peasant's cultivated land into privately owned grassland for sheep raising. The incentive came from the growing demand for wool. The Second Enclosure Movement, in the second half of the Eighteenth Century, had legal backing and was less unpopular than the First, since by then the rural population density had fallen greatly and it allowed the introduction of improved farming methods.

Open access to land is only likely to occur in situations of low population density, with surplus, hitherto-unused land. It may also apply on State owned land, which for political reasons has been declared open and freely available to the general public. The institution of open access can only provide for extensive forms of land use such as nomadic pastoralism or long-fallow shifting-cultivation. However, to justify investment in digging wells, improving pasture or planting crops, the user needs some means of excluding others. The key weakness of this system is the so-called 'Tragedy of the Commons'[5] (Hardin 1968), originally expressed in terms of the incentive for individual livestock keepers to increase the numbers of stock carried, irrespective of the potential damage caused by overgrazing and rangeland degradation. Although this argument was overstated in ignoring the costs associated with the purchase and maintenance of livestock, the lack of incentives for conservation of any kind is a serious drawback. Inevitably pressures grow for institutional change, towards communal or individual resource ownership.

The conclusion of the 'Tragedy of the Commons' argument is that individual, private ownership is the most desirable form of land tenure since it promotes efficient and sustainable land use. With security of tenure, owners have the incentive needed to invest in conservation and land improvement. With ownership rights to sell or rent-out land, its use will be allocated to those most able to use it productively. In contrast, individual members of a community with common property rights cannot normally sell or rent-out a personal share of the resource. The incentive to conserve or invest in improving the resource is possibly lower than for private property. If some members choose to be 'free riders', in shirking responsibility for conservation, rangeland and soil conditions may deteriorate. Even if agreement is reached communally, to restrict grazing of common pasture, an incentive remains for individuals to free-ride, by keeping too many animals while relying on others to behave more responsibly. Hence it has been assumed that for land, although possibly not for other natural resources such as water supplies, individual private ownership is the preferred option. Communal tenure is then seen as an intermediate stage, in the process of institutional change towards individual private ownership, associated with increasing rural population density and intensification of land use.

A critical phase in agricultural development may arise where the cultivation of crops and the raising of livestock begin to compete for the use of land. In particular conflicts arise where pastoralist livestock cause damage to cultivators' crops. This is the classical 'externality' problem, whereby the 'social cost' of damage to the cultivators' crops is not necessarily borne by the pastoralists (Coase 1960). In all such cases the external costs are reciprocal. While the pastoralists' livestock cause damage and costs to the cultivators, the cultivators impose a cost on the pastoralists in excluding livestock from grazing over the whole area. On this basis it is argued that 'if rights are fully specified and transaction costs are zero, voluntary bargaining between agents will lead to an efficient outcome, regardless of how property rights are initially assigned' (Coase 1960 op cit). This argument offers some support for private ownership, although the assumption of zero transaction costs is clearly false. Thus private owners of crop-land may provide crop by-products or the grazing of post-harvest stubble to pastoralists, in exchange for cash or manure and perhaps the services of draught animals. However, merger of crops and livestock under unified ownership in the same farming system, is another alternative, which minimises transaction costs. The widespread existence of integrated crop and livestock production reflects the advantages of this system in many situations.

[5]Some have argued that this should be described as the 'Tragedy of Open Access'. However, although under effective communal management the problem may be avoided, the dangers are present under communal ownership.

In much of the developing world, communal land tenure has existed for many generations. It is associated in particular with pastoral livestock production in arid and semi-arid zones. However, in much of Sub-Saharan Africa, crop-land is also held under this form of tenure. User rights are allocated to individual cultivator families, but individual rights of transfer of the land are excluded. Similar forms of tenure were widespread in the early stages of European economic development, and some areas of common grazing-land remain there today. The survival of communal forms of land tenure suggests not only that the 'Tragedy of the Commons' and free-riding have been avoided, but also that in some circumstances this form of tenure may have advantages over individual private ownership.[6]

The dangers of free-riding are avoided through long-established or re-negotiated agreements to co-operate, necessarily involving a reasonable level of trust of other members of the community, and possibly the threat of social sanctions against breakers of agreed rules, for instance regarding the number of animals carried on communal pasture or watered at key watering-points. Conditions which are likely to contribute to the sustainability of common property include the following. First exclusion of non-members must be enforceable. Second membership and the associated rights and responsibilities should be clearly defined and understood by all members. Co-operation is facilitated if all community members live in the same locality. The organisation may be explicit and formal, but is often implicit, informal and culturally embedded. In some cases governance is by democratic users' group, in others it is hierarchical under local leaders.

A major reason for the survival of communal ownership are the acute problems and resultant high transaction costs of defining and enforcing private rights to them. This is linked with the extended scale of the natural or man-made resource system, which makes exclusion of potential beneficiaries difficult and costly. Thus the enclosure and re-allocation of common land to private individuals necessitates land survey, definition of boundaries of individual holdings and the means for enforcing exclusion of others. Legal enforcement involves establishing a land registry and the issue of titles. In comparison with common property, comparatively more claims must be assigned and defended. The sum of all these costs may exceed the perceived benefits of privatisation, particularly in semi-arid areas under extensive pastoral livestock production. A further major cost, caused by the enclosure of common grazing land to form ranches, is due to the prevention of transhumant movements of livestock in search of dry-season water and grazing. In more favourable climatic zones, rural population growth, intensification of production, and increasing competition for resources between crops and livestock, raise the potential benefits of private ownership and may then provide the necessary incentives for institutional change.

A further social cost of privatisation is that the fairness implicit in communal land ownership may be lost. Under a communal ownership regime, all members of the community are entitled to a share in the productive use of the resource. The enclosure of individual private holdings, either by the force of law or by direct action of powerful private individuals, is quite likely to result in displacement of some of the previous joint owners and unequal land allocations between individual households. In particular it affects the distribution of wealth and income between crop cultivator and pastoral livestock keeper, the outcome depending upon the relative power and influence of the two parties. In England the Tudor enclosures involved the abolition of the 'common field system' of cultivation, with the associated displacement of labour, mainly to provide pasture land for sheep. In Sub-Saharan Africa, however, the privatisation of land for cultivation generally displaces communal grazing of natural

[6] For deeper discussion of the issues surrounding common property regimes see Bromley (Ed.) 1992, particularly Chapters 2, by C. Ford Runge and 13, by Elinor Ostrom; also Swallow & Hazell 2000.

rangeland.[7] Apart from the injustice of unequal land distribution, farmers with large land holdings make less productive use of the land than do small farmers, with a consequent loss of overall productive efficiency.

Share-cropping is a form of land tenure, widely used in South Asia and some other parts of the world. The landlord is the owner, while the tenant pays an annual rent for the use of the land as an agreed share, typically half, of the value of the crop produced. The care-taking of private property in the form of livestock raises similar issues. Initially economists argued that share-cropping must lead to inefficiencies in resource allocation since the tenant, receiving only half of the product, will apply sub-optimal levels of labour and other inputs.[8] However, the New Institutional Economics theory suggests that this form of tenure is essentially a system of risk sharing. It is intermediate between a system of labour hire, by the landlord who bears all the risk of losses and land rental by the tenant who also supplies the labour and bears all of the risk (Hayami & Otsuka 1993).

Intra-household rights and responsibilities: gender issues

In the discussion above and in much of the literature on agricultural development, the farm household[9] is regarded as the basic social unit for the allocation of property rights, the organisation of production and consumption and the conduct of transactions with other parties. The household is conventionally conceived as a social group, resident in the same home, sharing meals, pooling resources, and making joint or co-ordinated decisions regarding production and consumption. The 'New Farm Household Economics' broke new ground in analysing the integration of production and consumption decisions particularly those relating to the trade-offs between home consumption and marketing of food and between labour and leisure (e.g. see Barnum & Squire 1979 or Low 1986).

The intra-household distribution of assets, income, work and decision-making responsibility, excluded from such studies, is important in relation to livestock production. In fact, the household is an organisation, linked with the institution of the marriage contract, one of its functions being to reduce the transaction costs of the frequent, asset-specific and often complex interactions between members (Pollack 1985).

The allocation of property rights and transactions within the household are governed by social institutions forming part of the local culture. Wide differences exist in these institutions between different cultures, while changes occur over time, for instance in gender relations. None the less some generalisations are possible regarding the intra-household distribution of rights and responsibilities, using the tools of the New Institutional Economics.

In some respects households are similar to other types of organisation, in which individuals voluntarily surrender their freedom of action by pooling their resources, such as common property ownership groups. Hence, some intra-household behaviour may be explained using the theories of co-operative group activity, particularly inter-personal bargaining. Opportunistic behaviour is limited, between members, by intimate social contact, and shared norms and values. Nonetheless individual

[7] For further discussion see McCarthy *et al* 2000.

[8] Profit is maximised if labour is used up to the point where the value of the marginal product is equal to the wage rate. If the farmer only receives half of the marginal product, the value will be equated with the wage rate at a lower level of labour input.

[9] The problem of defining household boundaries, particularly acute in Sub-Saharan Africa, is ignored in what follows.

objectives may differ and such differences must be resolved through a process of 'co-operative conflict.'

Households differ from other organisations in the high levels of interpersonal contact and altruism for other family members, particularly for dependants, such as children, the aged and the sick. Although dependants contribute no resources, they are still supported from the common pool. Furthermore, property rights are transferred from generation to generation, through the institution of inheritance, with no reciprocal payment being made other than the support provided to the older generation.

Inherited property includes land, or rights to the use of common land, and other common pool resources. Livestock and other physical capital assets are also transferred through inheritance. So too is human capital, partly through the transfer of indigenous knowledge and experience from parents to children and partly through investment in education and training. The inheritance of foundation stock and the necessary skills have been the means by which many livestock enterprises have been established. The age at which property is inherited affects the income distribution between different age groups in society. The distribution of wealth and income is also affected by whether there is a system of primogeniture, and whether there is a gender bias only allowing male descendants to inherit property.

Some property transfers take place at marriage, although these are transactions between households, rather than between generations. In some cases, for instance in India, a substantial dowry is provided by the bride's parents. In contrast the practice in some African countries is for the bridegroom's family to pay a 'bride-price', often in the form of livestock[10]. These informal institutional arrangements are important in providing the basis for establishing a flock or herd of livestock. They have parallels in aid programmes for restocking or providing foundation stock for incipient livestock keepers.

Women rarely hold property rights or usage rights in land (see Box 4). In both traditional inheritance systems and in many land reform and settlement schemes, land rights are generally transferred to males as the 'head of household'. Female headed households, resulting from death or extended migration of the husband, or divorce, generally control less land than male headed households (IFAD 2001). In contrast women often independently own small livestock, such as goats in West Africa (Okali & Sumberg 1986) and 'backyard' poultry in many developing countries. Such livestock scavenge or are fed on household waste, at negligible cost. Though subject to disease and other losses, they provide a valuable supplementary income source. It is estimated that 70 percent of the world's rural poor are women, for whom livestock represent one of the most important assets and sources of income (DFID 2000).

[10] These are long established cultural norms which impose 'bounds' on rational behaviour, about which much anthropological literature exists. It is not easy to explain the 'rational' basis for the difference, unless wives are more highly valued, where 'bride-price' is paid, as contributors to the labour force and bearers of children.

Box 4: *Women's Limited Access to Land*

Limitations on the rights of women to own land are a major cause of poverty, in female-headed households and in other households that do not pool the farm income. Such discrimination also restricts allocative and productive efficiency. Many instances may be cited. In South Asia land is rarely inherited by women although legally eligible (Agarwal 1994). Widow-headed households in parts of India, suffer extreme poverty (Drèze & Srinivasan 1995). In much of Sub-Saharan Africa land use rights are rarely allocated to women. For instance, in Mashonaland, Zimbabwe communal land is allocated only to married men and inherited by their sons (Ncumbe et al 1997). In the Near East women's property rights are influenced by the institution of purdah. Land reforms in Latin America have been relatively ineffective in raising women's control over land (Deere 1987).

Individual ownership of livestock does not necessarily imply unrestricted rights of use of the produce. For instance rights to consume the produce may be attenuated by social consumption norms, such as responsibility for meeting the consumption needs of the whole household or a custom precluding women from eating eggs or chicken meat (see Birner 1999 p.54). In general large livestock, cattle, buffaloes and camels, are seen as the individual property of males or as common pool resources for the whole family. Other organisational issues arise, within the household, in relation to the division of labour, distribution of household income and roles in household decision-making. These are all largely determined by established norms and customs which influence, and are influenced by, relative bargaining power within the household.

Gender bias is often perceived in the division of labour within the household, although it may also reflect comparative advantage. Men and boys are generally responsible for herding ruminant herds and flocks, and for managing plough teams. Women are often responsible for milking and calf rearing and food preparation, processing and marketing. Overall women carry a heavier work burden within the household, being responsible for child-bearing and housekeeping as well as assisting with crop and livestock production and marketing. Women generally have less opportunity for off-farm work, other than that of processing and marketing farm products (Low 1986).

Household income and responsibility for meeting needs may be unevenly distributed. Women are often responsible for providing for basic subsistence needs, while men deal with marketed products. Thus in cases where women have access to home-produced milk or eggs there is often evidence of improved child nutrition (Kennedy & Peters 1992, Quisumbing *et al* 1995, Tangka, Jabbar & Shapiro 2000).

Within the constraints imposed by traditional behavioural norms and customs there is still scope for bargaining between household members. Both co-operative altruism and conflict are likely to be involved. In bargaining, women are often at a disadvantage, first because they have less power, due to the social structure, less property and possibly fewer contacts and less information than men, and second due to their weaker break position, or threat point. If conflict should lead to the break-down of a marriage, the female 'divorcee' is often in a less favourable position than the male (Sen 1990).

Acquisition of foundation stock and the use of credit

A major advantage of livestock as a form of capital investment, is that replacements are generated naturally by reproduction. In traditional systems, the foundation stock

are inherited, or received as gifts from friends or relatives. In some rural communities, livestock may be lent to destitute households by those that are more prosperous. The borrower is then allowed to keep a proportion of the offspring, for example every second calf. However, the launch of a new livestock enterprise, or the introduction of new genetic material, requires funding, either from domestic resources or by using credit. In addition, investment may be needed in specialised buildings and equipment and funding to cover circulating capital needs. Poor households may need assistance, from Government or other outside agencies in raising the necessary funding.

Under some international and non-government organisation aid programmes, for instance when re-stocking after drought, foundation stock may be provided free of charge to selected households. However, the recipient has reciprocal responsibilities to care for the animals properly, and there is often a requirement that the aid recipient should return one or more of the offspring to the project. This effectively increases the resources of the donor agency and extends the number of households that can be assisted. Thus most aid programmes bear similarities with credit institutions.

Many dairy development projects are based on 'credit in kind', as in the 'heifer in trust' schemes. Under such schemes, an in-calf heifer is provided to the farmer, together with technical advice and assistance. Repayment is made by returning the first heifer calf born to the project pool. In some cases interest is paid, in that more than one calf is returned to the project pool. Problems in repayment may arise if several successive bull calves are born, if abortions occur or the original heifer dies before delivering a calf. Arrangements may be made for repayment in cash, in the event of such problems. However, arrangements usually include an element of risk sharing between the scheme management and the farmer. Heifer in trust schemes have been widely adopted with reasonable success in promoting smallholder dairy production. Similar arrangements were made for the introduction of dual purpose goats under the 'Small Ruminant CRSP' schemes.

Weaknesses, or 'market failure', in the provision of rural credit have been widely discussed in the literature on economic development (e.g. Besley 1994). Problems arise from the environmental and market risks surrounding agricultural production and their impact on borrowers' ability to repay loans. There is also a situation of information asymmetry between lender (the principal) and borrower (the agent), as the lender often lacks knowledge of the borrower's reliability (adverse selection) and is unsure as to whether the loan will be used wisely (moral hazard). One solution to the repayment problem is to have the borrower put up a physical asset as collateral that the lender can seize if the borrower defaults. Poor and particularly landless households have few assets that can be offered as collateral, while poorly developed property rights make appropriating assets in case of default difficult. Livestock may themselves serve as collateral in some circumstances although there are risks surrounding the health and survival of animals. Facilities for insurance of livestock and/or rural household incomes are rarely available, partly because producer risks are covariant as when a disease epidemic occurs, and partly because of the information asymmetry problem outlined above. However, some insurance schemes are in operation in Asian countries, such as India (FAO 1992). It should also be noted that poorly developed communications and other services, together with the remoteness of many rural areas lead to high transaction costs in rural credit markets (Box 5).

Box 5: *Rural Credit*

Limited access to credit and savings facilities, in rural areas, has long been seen as a constraint on agricultural and rural development. Rural moneylenders, may be the only source, limited to short-term loans and charging high interest rates. Many governments have intervened to provide subsidised credit to rural areas. Such schemes have fallen out of favour, as only benefiting the larger, wealthier producers and being prone to high levels of default on repayment and operating at a loss. The development of financial intermediation by self-sufficient micro-finance institutions is seen as a more promising alternative. Based on the model of the Grameen Bank in Bangladesh, and often launched by NGOs, these organisations provide facilities for small-scale saving and group lending, often to women's groups. In cases such as the Grameen Bank, repayment rates have been high and the organisation has proved economically viable and self-sustaining. Information on performance in other cases is still being gathered (Hulme 2000).

Contractual arrangements

Labour hire is only likely to be resorted to by the non-poor, or possibly very labour-scarce female-headed households. Information asymmetry exists between the employer and the hired worker, who is the agent. The spatial dispersion of agricultural work, for crops and grazing livestock, leads to high costs of monitoring worker performance. At the same time the dependence of animal production on biological and unpredictable environmental variation makes it difficult to assess the worker's effort by results. Animal husbandry involves special knowledge and skills, which are human capital assets specific to the stockman. In these circumstances of uncertainty, problems of performance monitoring, asset specificity and continuous husbandry activities, relational contracts are likely to incur lower transaction costs than occasional casual labour hire. Temporary, casual labour employment is only suited to seasonal tasks such as sheep shearing. This explains the traditional and continuing institution of hiring regular stockmen and women on long-term, or 'permanent', contracts to care for livestock (Hayami & Otsuka 1993).

Alternative contractual arrangements include forms of share contract between livestock owner and herdsman. The system of 'care-taking' of animals, has similarities with share-cropping, in that risks are shared between owner and user. The relationship often exists between crop farmers, who also own livestock and pastoralist (e.g. Fulbe or Maasai) herders. Animals are lent, or rented-out, to the herder in return for a payment of a share of the offspring. A share of the milk is rarely included, possibly because of the problems of monitoring yield. Care-taking is intermediate in the allocation of risk, between the alternatives of the hiring out of animals for a fixed charge, for instance in the case of draught oxen, or of hiring in labour for a fixed wage.

The agency problem in hiring labour is less serious in the case of intensive landless livestock production systems, particularly poultry production. Since the whole flock is kept in one place, while the environment and feeding regime are automatically controlled, there is less need for skilled and trusted workers. However, there is a need for regular and reliable supplies of pre-mixed concentrate feeds, and genetic material, such as day-old hybrid chicks. Similarly the producer needs an assured market outlet for the produce, possibly involving processing as in the case of broilers, in which there are obvious economies of scale. Here again relational contracts are needed through backward integration with input suppliers, and forward integration

with processors and marketing organisations; in short, some form of vertical integration is appropriate. For example, it is estimated that in the U.S.A. 99% of broilers are produced under contract to the major companies supplying the market, or on farms owned by these companies (Goodwin, Madrigal & Martin 1996).

The structure of these intensive livestock industries may be explained in terms of differences in returns to scale and the most efficient size of operation between productive activities. The biological processes of plant and animal growth and reproduction, require attention and individual care. Returns to scale are limited and the most efficient size is at individual farm level. However, for processing and marketing operations there are substantial economies of scale and a much larger size of operation is more efficient. Similar arguments apply to the production and delivery of farm inputs. Contract farming is a means of integrating smallholder producers with large-scale, often private and commercial, processing and marketing companies that may also supply key inputs.

Similar issues arise in the case of intensive dairying, even for smallholders. The system is generally based on cross-bred cows, involving repeated inputs of exotic bulls or semen. Purchased concentrates may be used, while organised processing and marketing are needed to extend milk sales beyond the local village boundaries. Producer co-operatives, such as those established under India's 'Operation Flood' programme, have been used in many countries to provide for relational contracting in the dairy industry, to realise economies of scale and to reduce risk and transaction costs.

Animal health services

The control of animal disease and the provision of animal health services have an important impact on livestock productivity and the risks of loss. It is estimated that up to 30% of livestock production in developing countries is lost as a result of disease (FAO 1990). In addition, routine disease control adds to the cost of production. For smallholders and pastoralists, losses due to animal disease may prove disastrous. Technology is available for the control or treatment of many tropical livestock diseases but the delivery of veterinary services is beset with severe institutional problems.

Among livestock keepers, there have long been traditional healers practising ethno-veterinary medicine. However, over the last century, scientific research has led to the development of new methods of disease control and possibly even eradication. Governments have established publicly funded Veterinary Departments for the delivery of services by trained veterinarians. Provision of free services has always been subject to budgetary constraints, and only reached the more intensive and commercialised producers. During the past two decades many developing country governments, faced with increasing foreign debt and shortage of government funds, have experienced increasing pressure both domestic and international, to reduce Government spending, to recover costs from users and to switch to private service provision where possible (Leonard 1993). The scope for reliance on private markets is limited by the 'public goods' nature of some veterinary services and by associated externalities, economies of scale in delivery and transaction costs (Holden, Ashley & Bazeley 1996) (Box 6).

Box 6: *Public Goods*

These have the characteristics of non-exclusion, in that fee-riders cannot be prevented from benefiting, and non-rivalry, meaning that use by one individual does not reduce the supply to others. In these circumstances it is difficult for a private supplier to recover the cost of providing the public good by charging the beneficiaries. Animal health services, which provide public goods, include vaccination and vector control, disease surveillance, diagnostic support, quarantine and internal movement control, drug quality control and meat inspection. Unlike private goods, such as clinical treatment, drugs and vaccines, public goods are unlikely to be provided by the private sector.

The related externality problem occurs where actions by an individual producer, such as vaccination or quarantine of animals, may yield benefits to, or impose costs on, other producers. By definitions these effects are not reflected in market prices. Where significant externalities exist, state or collective action is needed to impose controls or arrange suitable compensation.

Economies of scale result from the high costs of training professional veterinarians and of establishing and equipping a veterinary practice. In addition, travel costs to points of service delivery are likely to be high, especially in sparsely populated pastoral areas. The average cost per visit must diminish as the number of visits, per clinic, increases. The implications are that:

- private individual veterinarians may have serious difficulty in raising the necessary funding to establish a practice,
- where livestock population density and intensity of production are low, there may be insufficient demand for services within a reasonable travel distance to justify the necessary investment,
- even where intensity of livestock production is sufficient to justify private provision of animal health services, the demand is unlikely to provide employment for more than one veterinary practice; in the absence of competition an animal health service provider has monopoly power.

Transactions between livestock producers and animal health service providers occur occasionally and unpredictably, are asset specific, in terms of both physical and human capital, complex and risky. Transaction cost theory suggests that contracts between provider and user are more appropriate than reliance on spot markets. Given the monopoly power of the service provider, and the information asymmetry where livestock keepers may not be able to judge the quality of veterinary drugs or the advice they purchase[11], external monitoring and control is desirable, provided by the State or the veterinarians' professional association.

For all these reasons public sector involvement, in the delivery of animal health services, is essential. In addition public sector intervention may be needed, to promote poverty alleviation, for instance by supporting animal health improvements among poor livestock producers. However, in view of the inadequacies of existing publicly funded veterinary services and the lack of adequate finance, delivery must rely increasingly on privatisation and cost recovery from livestock producers (James & Upton 1995).

[11] The moral hazard problem arises in that the veterinarian (the agent) may supply sub-standard advice, drugs or vaccines without the livestock keeper (the principal) being aware of the possible variation in quality.

The establishment of private veterinary practices has been encouraged in Kenya and other countries, with the establishment of licensing procedures and a special fund to provide credit. Private practices have been established in areas of relatively intensive dairy production and appear financially viable. In addition, government veterinary services already charged users for drugs and some services, such as treatment of individual animals. Thus although the service is provided by the public sector it is financed privately by cost recovery from livestock producers. In addition public sector veterinarians often undertake private service provision in their own time, but making use of equipment and facilities provided by the state. In a sense the service is subsidised but it allows the government employee to earn a 'rent' over and above the basic salary. These activities represent market competition for veterinarians contemplating establishment of a wholly private practice, and a further disincentive in addition to the initial high cost (Otieno Oruko, Upton & McLeod 2000).

Para-veterinarians are animal health service providers who have been trained in the basics of animal health care, at a lower and less rigorous level than professional veterinarians. They often live within the community served, so transport and transaction costs are minimised, and they are paid less than the professional veterinarians and are better able to win farmer confidence. Hence cost saving is possible where essential services can be provided by para-veterinarians. They provide valuable contributions, in delivering drugs and vaccines, within national government and NGO veterinary services, under the general supervision of professional veterinarians. Some may wish to establish themselves in private delivery of animal health services. However an appropriate formal institutional framework, is often lacking. Ideally they should be formally licensed and their activities subjected to quality assessment, complementing the services of professional veterinarians rather than competing for business.

Collaboration and group action by livestock keepers, in principle, offers major benefits in the delivery of animal health services. Public goods, such as the control of disease vectors or even local eradication, may be delivered by communal action. Alternatively, the programme may be delivered by the Government with cost recovery from collective subscriptions. Economies of scale are derived, which may facilitate contracting with a veterinary service provider, which would not be possible for individual livestock owners. Examples are given by Holden, Ashley and Bazeley (1996 op cit).

Research and development

Technological change has played a key role in generating agricultural growth and development. In the past, revolutionary changes in the productivity of land and labour were associated with the introduction of the plough, later the seed drill and rotational fodder production, later still mechanical power as a substitute for animal draught and chemical fertilizers to replace farmyard manure. The results of animal breed improvement have also been highly important. The process of technological change may be divided into three main stages; invention, innovation and diffusion. However, there are often many more stages leading to a usable invention; including basic, applied and adaptive types of research. An institutional framework is needed to facilitate transactions between different agents in the research and development (R&D) chain, or 'knowledge generation and distribution system'.

The origins of the chain may lie in the distant past, when very basic research was done, but each new programme or project builds on the existing knowledge. The chain leads through applied and adaptive studies, development and testing, and extension to the final users; producers, processors and the consumers of farm products. Many technologies are introduced from other countries, under so-called

'technology transfer'. Adaptive research and testing is generally necessary before extending such technology to crop and livestock producers[12].

Many agricultural innovations, in the past, were developed and spread through private enterprise, some by the farmers themselves, others such as machinery and fertilizers by industrial enterprises. Public sector involvement in agricultural research is largely confined to the last century, with most rapid expansion during and after the Second World War.[13] However, over the last two or three decades, the widespread drive for privatisation has been extended to research and development activity, including that for agriculture. Against this a strong case can be made for the continuation and expansion of publicly funded R&D.

Research and development is a form of capital investment, much of the output being new knowledge, which ideally should be treated as a public good. The essential characteristic is that of non-exclusion (Box 5); to achieve maximum benefit from new knowledge it should be made publicly available. Cost recovery from users is then difficult. However, some forms of research output are embodied in new forms of physical capital, as in the case of genetic material, balanced concentrated feeds, drugs, vaccines, machinery and equipment. These are typical private goods which can be sold at a price which incorporates a share of the costs of the research. Hence there are roles for both public and private sector investments in agricultural R&D, with private research investment being concentrated at the applied, near-market, end of the chain. Empirical evidence of high rates of return to agricultural research in developing countries has been used to infer serious under-investment in publicly funded research investment (Thirtle & Echeverria 1994).

Private sector research is largely justified and prioritised in terms of financial return on the capital invested. Since the products of publicly funded research are non-marketed public goods, this assessment criterion is not available. None the less public sector investment, in agricultural R&D, competes for scarce development funding and resources with other important areas of investment, such as communications, water supplies, education, and public health. Some form of assessment and prioritisation of research programmes is needed to guide allocation of funds.

An important element of the prioritisation process must be an assessment of the 'demand' for alternative types of innovation. Transaction costs, relating to the transfer of information between researchers on the supply of new technologies and potential users on the demand, are high. Transactions are highly asset specific, with uncertain outcomes, and are likely to be repeated. The same is true of information transfers between researchers at different stages in the chain. Relational contracting is appropriate, with close contacts between researchers and farmers. Given the dispersed nature of agricultural activity, there are difficulties in organising effective linkages.

Farming systems research (FSR), of which livestock systems research is a sub-set[14], was introduced in the 1970s at CGIAR centres and in national agricultural research systems (NARS) as a means of bringing researchers and farmers together for the transfer of information. The formal procedure involved classification of systems and identification of the target group, then diagnostic survey, using rapid rural appraisal

[12] The multi-laterally funded Consultative Group for International Agricultural Research (CGIAR) centres conduct applied research to produce technologies for adaptive research, testing and distribution by National Agricultural Research Systems. The International Livestock Research Institute (ILRI) is the only GCIAR centre devoted to research on livestock production and health.

[13] Publicly funded agricultural research may have started in China in the 10th Century (IFAD 2000).

[14] For all mixed farming systems, the farming systems approach is more appropriate, to take account of crop-livestock interactions.

methods, to identify farmers' objectives and constraints, leading to the design of appropriate technology and on-farm testing. Appropriate technology, in this context, is biased in the direction of saving the most limiting factor. Thus a land-saving bias, associated with technologies for intensification, is appropriate in densely populated Asian countries, but less so in Africa and Latin America. However, even where land is not the most limiting constraint, labour-saving, mechanisation is only appropriate where wages are high in relation to the cost of capital.

There are several advantages of farming systems research, over the top-down technology transfer approach. It brings researchers and farmers together and ensures that proposed innovations are focussed on farm household needs and objectives, and are therefore more likely to be accepted and implemented. The approach also takes account of the inter-relatedness of the many components of a farming system. This has the beneficial side-effect of promoting collaboration between biological and social scientists in diagnosing constraints and designing improvements.

Some observers argue that although the FSR approach involves survey of farm household needs, it does not go far enough in promoting farmer participation in the research and development process. Farmer participatory research (FPR) is proposed as a collaborative research activity, drawing on the farmers' knowledge of indigenous technology, developed and adapted to meet local conditions and to overcome constraints, together with their readiness to experiment with potential innovations on their own account. Involving resource poor farmers in controlling the research agenda should help in promoting a sense of collective identity, which over time can lead to empowerment.

Although these methods represent a significant advance over the more traditional, transfer of commodity and research-station based research, they are complementary to, rather than substitutes for, the latter. The use of rapid rural appraisal (RRA) methods of data gathering are supposed to limit costs. However, given that the studies are very locale and time-period specific, and ideally involve interdisciplinary teams of biological and social scientists, with the additional skills needed for integrating and communicating with farmers, the costs per farm household are high. Most such studies have been supported by foreign aid. An institutional framework is needed to provide for the scaling up and sustainability of farm and village level studies. At the same time there is a need for better communication of research findings in both directions between on station researchers and farming systems teams.

Within the research organisation, socio-economists have several key roles. They are needed not only as participants in farming systems research teams but also to conduct studies of the wider institutional, market and trade environment and assess policies for development. In addition they have an important role in research assessment and prioritisation. For major research programmes and projects *ex-ante* assessment is needed to determine whether the investment is justified and *ex-post* monitoring and evaluation is desirable to guide future research.

Cost-benefit analysis is an appropriate tool for assessing and ranking alternative investments, in livestock research as in other areas. However, in the case of research there are large risks of failure to produce a result which is useful and attractive to farmers and uncertainties about the rate of adoption. Probability estimates must be built into the main analysis. The technology development cycle and its costs and benefits are complex and difficult to evaluate objectively. They are likely to include the costs of the research programme, including field testing and the distribution over time, the likelihood of achieving the primary research objective within a specified time period, the predicted impact on household incomes for those that adopt, the time profile of adoption, the ultimate numbers of adopters, impacts on overall production and how these will affect market prices. For products consumed domestically, an increase in market supply is likely to result in a price fall. The gain

to consumers is measured by the change in 'consumer surplus'. Hence the costs of the analysis itself are likely to be high so that full cost benefit analysis may only be justified for large programmes and projects. None the less some economic assessment is useful in determining all research allocations even fairly minor projects. Scoring methods, using subjective judgements of some of the variables listed above have been applied (e.g. by Kenya Agricultural Research Institute, KARI 1991).

4. GROWTH OF MARKETS AND INTERNATIONAL TRADE

Product markets and the scope for more varied diets

Market institutions are essential for the exchange of goods, and services and have existed, in some form, in all societies. Yet even today, in many rural areas, markets are poorly developed, reflecting the limited infrastructure of roads, railways, general communications and lack of appropriate market institutions. Markets are incomplete and traditional farm families have to consume, trade or sell most of their products locally. Improvement of market institutions allows greater scope for specialisation and division of labour, increases in productive efficiency and growth of producer incomes.

Markets for livestock and their products allow specialisation in production and exchanges with producers of staple food crops and other commodities. Most farm and pastoral households, while continuing to produce some of the family's subsistence requirements, are also engaged in production for the market. In comparison with staple food crops, livestock products such as meat, milk and eggs are more costly to produce per unit of food energy. As a result livestock products generally provide a very small proportion of the dietary energy intakes of the poor. "In Europe in the early nineteenth century, most of the population were poor and got 70 per cent of their calorific intake from cereals and roots. With the increase in incomes in the nineteenth and twentieth centuries, the consumption of livestock products rose until in the 1980s they provided one third of all calories in most developed countries" (Grigg 1993). Today, average consumption per head, of most livestock products, in developing countries is a fraction of that in the developed countries, as shown in Figure 1 above.

As incomes rise, so too does the consumption of livestock. Thus meat, milk and eggs are preferred goods with a relatively high income elasticity of demand, measured as the percentage increase in quantity demanded in response to a one percent rise in income. Whereas the income elasticity of demand for cereals in developing countries have been estimated at below 0.25 or even negative in some cases, that for most livestock products is closer to unity (Sarma 1986). This is reflected in the rapid growth of consumption, of milk, eggs and meat per capita in the developing countries, by 2 percent, 4 percent and 6 percent respectively per year, shown in Figure 1. In the industrialised countries where consumption levels are already close to saturation, income elasticities for livestock products have fallen and may even be negative. The fast growing demand for livestock products, in developing countries, requires a corresponding increase in marketed production in order to avoid shortages and rising consumer prices.

Urban growth and commercialisation

The process of urbanisation is associated with industrial development and growth. Communications are facilitated and transaction costs are reduced by grouping workers into firms, while there are benefits from economies of scale and agglomeration. The rapid growth of non-agricultural populations, reflecting the process of urbanisation, was illustrated in Table 1.

Towns and cities are market foci, where demand for most products is concentrated, as is the supply of manufactured goods and public services. The main consumer markets for livestock products are found in these market centres, while livestock production, particularly grassland-based ruminant keeping, is dispersed in remote areas. Large animals may be moved large distances, on the hoof, but may lose condition as a

result. However, small animals, and products such as meat, milk and eggs are all perishable and bulky, and therefore costly to transport. Thus prices for livestock and livestock products are much lower in remote production areas, than in locations close to the main markets. Peri-urban producers have a clear advantage due to their market proximity, but may create problems of waste disposal and environmental pollution. Costs of produce marketing, and of input delivery, are lower than those for more remote rural producers. Small-scale producers are at a particular disadvantage, due to the high unit costs of moving small consignments.

The increased global reliance on pig[15] and poultry meat for dietary animal protein was emphasised earlier (Figure 2). The higher reproduction rates and the intensity of these production systems allow poultry meat, in particular, to be produced more cheaply than the ruminant meats in similar systems. Furthermore poultry production, and that of pigmeat, lend themselves to industrial-type commercial production, with vertical integration between input supply, production, processing and marketing. Processing and marketing agencies then benefit from economies of scale. Such integrated commercial systems are generally established in peri-urban zones. Benefits are derived from production located near to processing and marketing centres and sources of supply of inputs for intensive production, such as pre-mixed feeds, veterinary services, drugs and genetic material. Such systems are criticised as competing unfairly with smallholder poultry and pig producers. However, integration may be, and is, achieved in many countries, by local farmers producing under contract to the processing and marketing company (e.g. Jamaica Broilers, see Abbott, 1987 pp. 74-78).[16] Alternatively, economies of scale in processing and marketing, of both products and inputs, might be achieved by farmer co-operation and group activity.

The benefits, of processing livestock products deserve mention. The marketing problems associated with the perishable nature of livestock products, such as meat, milk may be alleviated by chilling and hanging of meat, plucking and eviscerating broiler chickens, processing of by-products, cooling and pasteurising or souring of milk. Further processing of meat may involve drying, salting or smoking, while milk can be processed into dried milk powder, butter, cheese, and yoghurts. Such processes extend the potential shelf life of the product and may facilitate transport, although the cost of refrigerated transport per tonne–kilometre is much higher than that of ordinary transport. However, this is counterbalanced by the considerable value added, per tonne of produce, by processing. All these operations require capital equipment and are subject to economies of scale. Pecuniary economies, in the form of higher prices, also result from bulk selling. This benefit also applies to the grading and packing of eggs (FAO 2003). In remote rural areas, where road and rail communications are poor, few processing facilities are available. For meat, milk and eggs the market area is limited to the village locality.

As suggested earlier smallholder dairy production, using grade cattle and paddock- or zero-grazing qualifies as an intensive system. The system is generally based on cross-bred or exotic cows, involving repeated inputs of exotic bulls or semen. Purchased concentrates may be used, while organised processing and marketing are needed to extend milk sales beyond the local village boundaries. For this system peri-urban locations for milk production, and large-scale processing, are economically

[15] The increase in pigmeat production and consumption, in the developing countries, has occurred particularly in China, East and South East Asia and to some extent in Latin America and the Caribbean. This commodity is largely excluded from the Moslem World for cultural reasons.

[16] Supermarkets are of increasing importance in shortening the market chain from producer to consumer of meat, dairy products and eggs, in both developed and developing countries. Producers or their organisations may enter directly into supply contracts with the supermarket chains.

advantageous. However, there are growing concerns regarding the build up of environmental pollution associated with intensive livestock production in the vicinity of urban areas.

The minimum efficient size of milk pasteurisation and processing plants is large in relation to available milk supplies in the local 'milkshed' and consumer demands. Thus many large plants that are established, operate at well below optimal capacity, especially in the dry season when milk production declines. In remote rural areas, where the cost of delivery to a large processing plant cannot be recovered, there is a need for intermediate, low-technology treatments. Processes such as the production of soured milk, or 'mala', are cheap and can be managed by the farmers themselves. Raw, un-pasteurised milk will normally be boiled before drinking. Local manufacture of cheese, extends the 'shelf life' and lowers the transport costs of the product. However, there is a need to develop new markets for processed dairy products. A study in Kenya found that small-scale (average 5 employees) dairy processors were operating, but only in and around urban centres, where products could be sold on the streets, to hotels or to supermarkets (Brouder 2003).

Many African, and other, Governments have intervened in the meat marketing chain by establishing or taking over abattoirs and meat processing facilities for domestic and export markets. The aims have been to control and stabilise prices, increase offtake from rangeland-based ruminant livestock and promote carcass grading and quality control. Some were established as statutory monopolies and were able to control prices, in early days in Kenya and in Botswana at high levels to benefit large-scale commercial producers, but in Tanzania to hold prices down for the benefit of urban workers and consumers (Sandford 1983). In many cases abattoirs operated at well below capacity and sustained operating losses. In the process of structural reform and market liberalisation many such parastatals have ceased operation. The Botswana Meat Commission has been relatively successful in supplying beef mainly for export. However, it is dependent on the Government for financial support to maintain disease control measures and for negotiating price concessions, in terms of reduced tariffs, with the European union. Producer co-operatives have been launched for meat marketing, but generally have not survived (e.g for the Zambian experience see Moll & Dietvorst 1999).

Producer co-operatives for the processing and marketing of milk have proved viable and sustainable in high income countries of northern Europe, North America and New Zealand. Co-operative dairies have also been established in developing countries, the supreme example being the Anand Milk Producers' Union Ltd. (AMUL) type co-operatives that are the basis of India's 'Operation Flood' (see Doornbos & Nair 1990). A producer-based organisational structure is adopted, with village level primary producer societies, delivering milk to district unions for processing and product manufacture, that in turn are grouped into state level federations charged with co-ordination of marketing functions. None the less the spread of the organisation, from Anand in Gujarat State to the rest of the country, has been promoted by the Government of India through the National Dairy Development Board and supported with international finance and food aid, mainly dried skimmed milk powder. Although the programme has been criticised, results are impressive. Average levels of milk consumption per head in India have risen steadily since 1970 while import substitution has taken place. India is now self-sufficient in milk and basic dairy products and produces more milk than any other country in the world.

African countries, such as Kenya and Tanzania have attempted to establish national dairy producers' organisations but with less apparent success. The Kenya Co-operative Creameries (KCC) originally established by European settlers but later serving as a monopsony buyer, has suffered financial difficulties in recent years, and since price de-control has handled a declining proportion of national milk production.

Industrialisation, machinery and fertilisers

The 33 year period from 1927 to 1960 saw a global population increase of 50 %. It is suggested that the necessary increases in world food supply were largely obtained through the introduction of industrial manufactured farm inputs, including machinery, fertilisers, herbicides and pesticides (Evans 1998). These developments had important effects on crop-livestock interactions. This period also saw a growing divide between the industrialised countries where these new farm inputs were increasingly adopted and the developing countries, where industrial inputs are less easily afforded and are often inappropriate.

Over the period, farm mechanisation resulted in the substitution of liquid fuel and electricity for human and animal draught power as the main source of energy. In North America, Western Europe and other developed countries, tractors, combine harvesters and other self-propelled machines had replaced horses almost entirely. Rural electrification also allowed mechanisation of many on-farm processing operations. These labour-saving innovations released farm workers many of whom moved into industrial occupations. Some yield improvements may have resulted from greater timeliness of field operations, while land which might otherwise have been used to produce feed for draught animals was released for food or cash crop production. Capital investment per farm household was substantially increased. As a result agricultural production became highly dependent on external energy sources and sensitive to changes in supply and prices.

In most developing countries, the lower cost of labour relative to that of capital makes investment in tractor mechanisation uneconomic. In the fertile areas of Asia, population density is too high and farm sizes too small, to justify mechanisation beyond the possible use of two-wheeled hand tillers. Even in more sparsely populated areas of Africa and Latin America, agricultural labour is not so scarce as to justify widespread mechanisation. Human hoe cultivation and animal draught power are likely to remain important methods of crop production in many developing countries. Foreign aid and domestic policies to promote tractor mechanisation, in the 1970s, are widely thought to have been misguided and may have encouraged farm-size expansion and displacement of tenant smallholders. However, while field cultivation by tractor may be uneconomic on smallholdings, mechanisation of power intensive operations like milling, threshing, chopping, crushing sugarcane or pumping water may be more readily justified.

Over the same 33-year period, rapid growth in the use of nitrogenous and other fertilisers substituted for farmyard manure in the maintenance of soil fertility, and enabled farmers to abandon mixed crop-animal husbandry systems, such as the Norfolk four-course rotation. The introduction of chemical herbicides and pesticides also reduced the need for rotational cropping. It is estimated that by the late 1980s nitrogenous fertilisers provided about 50% of the total annual nitrogen flux in global cropland, while animal wastes provided less than 9% (Smil 1991). In developing countries relative prices may make fertilisers less attractive. An estimated 70% of total fertiliser inputs, in developing countries, are derived from animal manure (Fresco & Steinfeld 1998). However, the new high yielding varieties of maize, wheat and rice, contributing to the 'Green Revolution', require fertilisers to reach their potential yields. The structure of many tropical soils is poor and therefore likely to benefit from application of farm yard manure even where fertilisers are also used.

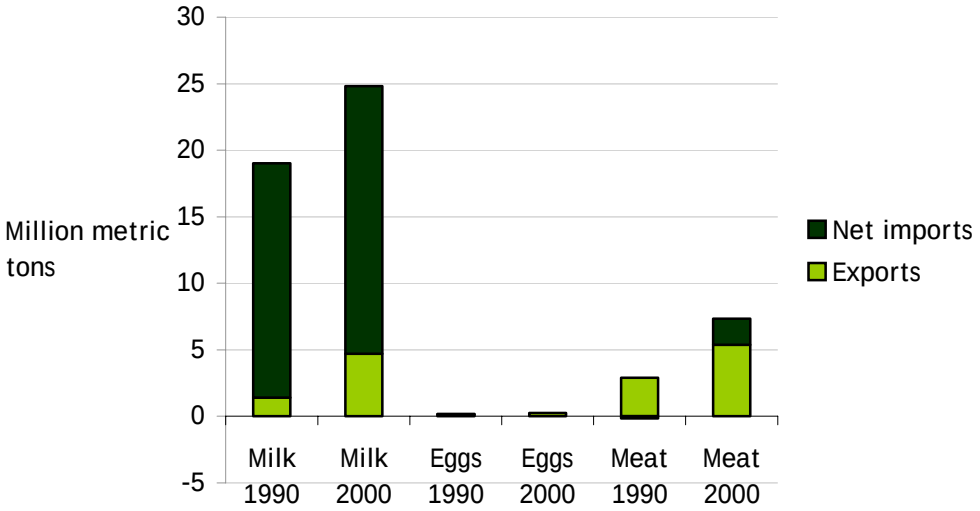
Trade in livestock and livestock products

International trade in livestock products represents a further expansion of market boundaries (for fuller discussion see Upton 2001, Upton & Otte 2004). Cross-border trade in live animals has occurred ever since national boundaries were defined.

However, only since the introduction of steam ships with refrigeration, towards the end of the 19th Century, has international trade in livestock products grown, along with that of cereals and other commodities. Imports of meat to the United Kingdom were drawn initially from North America, then from Argentina, Uruguay and Australia. The growth in total trade, has accelerated over the last 50 years, but trade in agricultural products has grown more slowly and declined as a proportion of the total. Trade in livestock and livestock products (LLPs), although growing, represents only about one sixth of the total value of agricultural trade.

Within this broad context, the developed, OECD member countries are responsible for over 80% of world trade in LLPs. Over the past 50 years, the developing countries have, as a group, changed from being net exporters of agricultural produce to net importers from the developed countries. For LLPs, the developing countries are net importers of all categories and, for dairy products and meat, imports are growing to meet the increasing demand (see Figure 4). Imports of dairy products have grown at 2.4 percent annually and in 2000 represented nearly 12 percent of total supply of these products in the developing countries. Net imports of eggs have declined and represent a very small fraction of total supplies. Imports of meat have grown by two and a half times over the decade (nearly 10 percent annually) and in 1999 represented over 5 percent of total supply of meat.

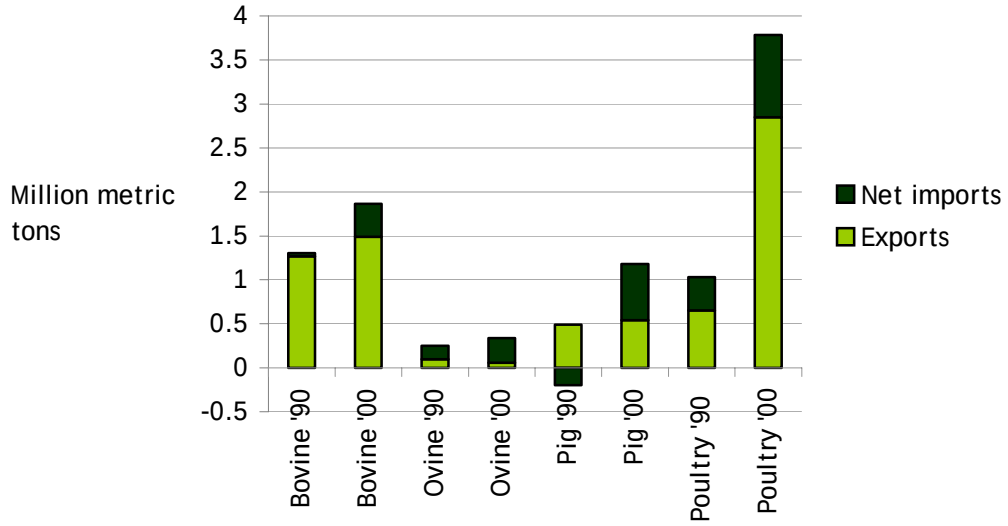
Figure 4: *Imports of livestock products to developing countries 1990 & 2000*



Note that the total height of each column equals the gross imports, as exports plus net imports.

There has been a major shift in the composition of trade in meat towards pig and poultry meat, as shown in Figure 5. In developing countries as a whole, imports of pig meat have tripled (nearly 12 percent growth annually) but still contribute only two percent of supply. Imports of poultry meat have increased by four and a half times (by nearly 16 percent annually), make up 13.5 percent of total supply and exceed imports of all other types of meat put together.

Figure 5: *Imports of different types of meat to developing countries 1990 & 2000*



Source: FAOSTAT 2003

The increased reliance on meat from, largely grain fed, pigs and poultry runs counter to the argument that it is cheaper to raise livestock domestically on imported grain, rather than to import the livestock products. This follows because the transport cost per tonne of grain is much lower than that for meat (Cunningham 1992). However, 'there is a discernible shift in trade from cereals to livestock products' attributed, in part, to technological and organisational improvements in intensive livestock production in the developed countries, making it more profitable to convert cereals into meat domestically and to export meats rather than cereals (OECD 1998). This conclusion is reached despite the difference in transport costs. Nonetheless imports of feed grains remain important, especially in Latin America and South East Asia, as well as in the Transition Economies.

Within the group of developing countries (listed in Annex 1), there are big differences between member countries. Many are net exporters of some LLPs and substantial trade occurs between developing countries. A summary of an analysis of net trade in LLPs by continents and by commodities, is presented in Table 3.

This analysis helps to illustrate the variation between members of the developing country group. Two of the continental groupings, South Asia and Latin America and the Caribbean are overall net exporters of LLPs. Furthermore, Sub-Saharan Africa and East and South-East Asia with China are net exporters of some LLPs. In most cases the export trade is dominated by a single, large country, as shown in the last row of Table 3. In addition, there is considerable trade between individual countries within each continent. Of particular note is the trade in live ruminants from the tsetse-free but poor, Least Developed Countries of the African Sahel to coastal West African countries and to East African states (de Haan, van Ufford & Zaal 1999).

Table 3: *Net trade in livestock and livestock products by continent*

	Sub-Saharan Africa	**Near East and North Africa**	**South Asia**	**East & South East Asia (incl. China)*.**	**Latin America & Caribbean**
Net trade in LLPs overall	Net importer	Net importer	Net exporter	Net importer	Net exporter
Main net imports, by value	*Cattle* Beef *Poultry-meat* Milk Eggs	Cattle Sheep & goats Poultry-meat Hides & skins	Wool	Cattle Beef, Lamb Wool Hides & skins	Pig-meat Beef
Main net exports, by value (Principal source country in parentheses)	Sheep & goats (Sudan) Camels (Somalia)	None	Buffaloes (Pakistan) Buffalo-meat (India)	Pigs (China) Poultry-meat (Thailand) Rabbit meat (China) Honey (Vietnam) Eggs (Malaysia)	Cattle (Mexico) Poultry-meat (Brazil) Honey (Brazil)

Source FAOSTAT 2003

The existing patterns of trade have evolved as a result of both market forces and the regulatory barriers imposed by governments and international agencies. In the absence of barriers, free trade should lead each country to produce the combination of products in which it has a 'comparative advantage', and to exchange some of these for other commodities that are cheaper to import. Thus, the resultant pattern of trade should reflect international differences between countries in the costs of production, resulting from differences in technology and in resource endowments.

Box 7: *Gains from Trade*

'Comparative Advantage' for production of a given commodity means that the opportunity cost per unit of output value is lower than that for other commodities; opportunity cost being the value of alternatives foregone. Free trade in international markets is therefore predicted to lead to a welfare optimising distribution of production and consumption between countries, with all commodities produced at minimum cost (where costs include those of transactions and transport).

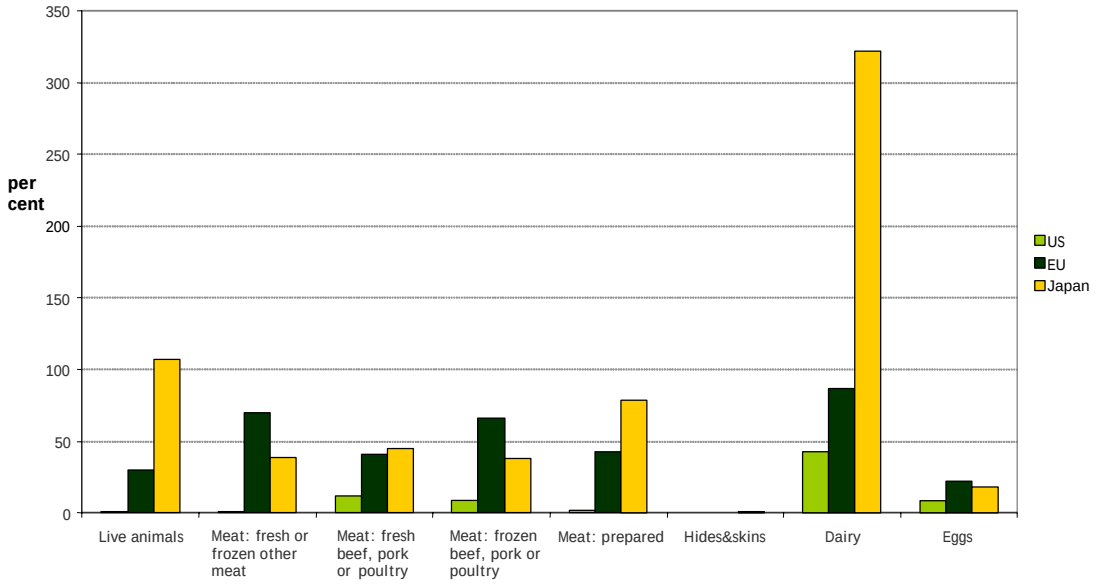
Increased trade is expected not only to increase incomes and consumer choice but also to reduce unemployment and promote economic growth. International capital mobility may reduce the impact of differences in the capital resource base. Furthermore, the general contacts made through trade contribute to the diffusion of modern technologies from the developed to the less developed countries.

Impact of trade regulation

Trade barriers, such as tariffs, or taxes on imports, raise prices received by domestic producers and generate Government revenue, but consumers suffer from the price increases. In general the welfare losses to consumers exceed the gains for producers and the Government so a net loss in social welfare results. Apart from these effects, the rest of the world suffers from the resultant distortion of international trade. Such protective barriers have been used, by developing countries, to promote industrial development, as part of an inward-looking, import-substitution strategy for development. They distort relative prices in domestic markets, particularly by raising costs of purchased inputs in relation to product prices. Such price distortions discourage agricultural production and exports (Kreuger, Schiff & Valdés 1988, Bautista & Valdés 1993).

Tariffs and other forms of protection, such as import quotas, variable import levies, and export subsidies, have long been used by the European Union[17], the USA, Japan and other developed countries to support domestic farmers and livestock producers. Current levels of tariffs in the EU, USA and Japan for key LLPs are shown in Figure 6. All these policies raise the costs of food to domestic consumers or taxpayers. Tariffs and variable import levies raise the costs of imports, import quotas are barriers which maintain domestic prices above the free-trade level and export subsidies encourage exports and reduce domestic supplies again raising the domestic prices. All these barriers make it difficult, for producers in other countries, to compete in world markets and, with cheap imports, in their own domestic markets. A good example is the Common Agricultural Policy of the European Union (EU) which has provided financial support and price stabilisation for European farmers, but at the expense of depressing and destabilising world prices.

Figure 6: *Average tariffs on livestock products in the US, EU and Japan*



Source: Economic Research Service, USDA 2001

[17] Formerly the European Economic Community until 1993

In the past the European Community (EC) was guilty of 'dumping' meaning the disposal of agricultural surpluses, resulting from producer support, at artificially low prices. This practice was prevalent in the 1980s by which time the European Community had accumulated large stocks of beef and dairy products through intervention buying. Impacts on recipient countries were mixed. Cheap sales of beef from the European Economic Community to coastal West African Countries, in the early 1990s, covered a large proportion of their demand (60 percent of the beef supply for Ghana and 40 percent of that for Côte d' Ivoire) and caused a serious fall in exports from the Sahelian Countries to the Coast (Van Ufford & Bos, 1996). However, low priced exports of dried milk, from the EC and the World Food Programme, to India, provided the basis for the success of 'Operation Flood' in the development of the dairy industry.

Under the Lomé Convention, signed in the late 1970s, favoured treatment was offered to 70 African, Caribbean and Pacific Ocean (ACP) States. It was replaced in 2000, as an interim measure by the Cotonou Agreement. The Lomé Convention provided for the stabilisation of export earnings and a significant reduction of tariffs on bananas, sugar, rum and beef and veal from the ACP countries. Botswana, Namibia, Zimbabwe, Madagascar, Swaziland and Kenya have benefited from the beef protocol.

The World Trade Organisation (WTO) replaced the General Agreement on Tariffs and Trade (GATT) in 1995 after the Uruguay Round of negotiations. The main objective remained the phased reduction of trade barriers. Under the Agreement on Agriculture, signed in 1994, these aims of trade liberalisation were extended to the agricultural sector. Major global economic benefits were predicted from the increased trade resulting from implementation of the Agreement on Agriculture. Numerous studies predict that the main benefits, in terms of increased exports and world prices, would accrue to developed countries, such as Australia and New Zealand, which currently provide little or no financial support to their farmers and livestock producers (World Bank 2001, Anderson *et al* 2000, USDA 2001). Developing country exporters of livestock products, such as Uruguay, Brazil, and Thailand stand to gain also. However, ACP countries such as Botswana, which are net exporters, may lose because the basis for preferential treatment under the Cotonou Agreement will no longer exist. The modest increase in prices of livestock and other food products, though improving incentives for domestic producers, may exacerbate food security problems for the majority of net food importing, developing countries (Bruinsma 2003, Chapter 9).

Hitherto, there has been limited progress in reducing protection of domestic producers in the developed countries. Although policies in the European Union and North America have shifted away from trade distorting price supports, the overall level of protection remains high, as shown in Figure 6. The Doha Round of WTO negotiations, launched in November 2001 has served to demonstrate the wide diversity of levels of commitment to trade liberalisation. The 2003 meeting in Cancún, Mexico, planned to deal specifically with developing country trade, broke up without reaching an agreement on trade reform. However, it has been agreed that 'Special and Differential Treatment' should be applied to developing countries, requiring less rapid policy changes on their part. Since these countries start from low levels of farmer support, this concession provides little real benefit.

Critics have suggested that the WTO, Agreement on Agriculture has 'institutionalised' the production- and trade-distorting policies of the developed countries, without addressing the fundamental concerns of the developing countries (Green & Priyadarshi 2002). Others emphasise the damage done to developing country producers by the agricultural and trade policies of the developed countries (Binswanger & Lutz 2000). Whilst there is a continuing need for pressure on the developed countries to reduce levels of tariffs, farm support and export subsidies on LLPs as on other agricultural products, the benefits to developing countries are predicted to be limited. First, few

developing countries have a comparative advantage in producing meat; the main current exporters are listed in Table 3[18]. Second, the poor communications, market infrastructure and information systems, in many developing countries, effectively insulate small-scale domestic producers from world markets. Third, Government policies in developing countries, such as continuing effective taxation of agriculture, or trade barriers to protect industrial manufacturing, also limit producer response to price increases resulting from trade liberalisation (World Bank 2001).

Animal health and food safety regulations

Developing country access, to the large markets of the OECD member states, is increasingly influenced by rules relating to food safety, plant and animal health, the environment and animal welfare. With rising per capita incomes, demands grow for food safety, ethical methods of production, animal welfare and environmental amenities. Sanitary and phytosanitary (SPS) issues are a common cause of trade disputes, seen by some developing countries as disguised measures of protection. While, consumers in developed countries, demand high food quality and safety as well as protection of animal and plant health, standards in the developing countries are usually lower. Implementation of animal and plant health, and food-safety, standards are constrained by resource limitations in general, including deficiencies in infrastructure, technology and skills. The costs of meeting SPS requirements for exporting livestock and other products to developed countries are very high. For Argentina to meet SPS requirements on meat, fruit and vegetables cost US$82.7 million between 1991-96; upgrading of slaughterhouses in Hungary from 1985-91 cost US$41.2 million (Finger & Schuler1999).

The SPS Agreement of the WTO (1995) is aimed at harmonising the health and safety standards applied internationally in line with the recommendations of the International Office of Epizootics (OIE), the International Plant Protection Convention (IPPC) and the Codex Alimentarius. This involves recognising the equivalence of different measures giving the same level of protection, allowance for adaptation to regional conditions, use of risk assessment to establish the appropriate level of protection and establishment of a formal framework for consultation and dispute settlement. Thus the SPS Agreement serves to regulate and resolve international differences resulting from the standards of food-safety and disease control, demanded by developed country consumers. It provides a forum for dispute settlement, but financial, legal and technical support may be needed by developing countries to negotiate settlements.

For prospective developing country exporters, the cost of meeting these standards remains a problem. However, a strong case can generally be made for policies aimed at improving hygiene and the health of livestock, crops and humans. Obvious economic benefits are derived from improvements in animal and crop health, while food safety is a desirable goal, contributing to human health and welfare. Developing countries, seeking only to trade among themselves, may be well advised to accept less stringent SPS standards, providing levels of disease control and food safety below those recommended by the standard setting bodies recognized under the WTO agreement. None the less, there is a strong case for harmonisation and co-ordination of agreed standards within trading groups of countries.

Non-health related quality standards for traded produce are covered under the Agreement on Technical Barriers to Trade (TBT) and the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). The former allows a country to impose

[18] It should be noted that none of these are members of the Least Developed Country group. Most are Middle Income Countries.

'legitimate' quality standards on imported food provided that this is not aimed at protecting domestic producers. The latter has been applied in relation to genetic material but generally to plant genes rather than those of animals. Other issues such as environmental impact of productive activity and animal welfare are likely to be increasingly important in future international trade negotiations. However, unlike impacts on food safety and disease risk, that are subject to the SPS Agreement, the impact of method of production on the environment, or animal welfare, cannot be measured by inspection and quality assessment. For this reason they are less easily subjected to WTO regulation. International agreements relating specifically to these issues, such as Multilateral Environmental Agreements (MEAs) may be more appropriate. At the same time voluntary labelling and assurance schemes regarding methods of production, might allay concerns of importers and assist in promoting exports.

5. PROMOTING LIVESTOCK DEVELOPMENT

What needs to be taken into account?

Livestock production makes an important contribution to economic development, rural livelihoods, poverty alleviation and meeting the fast growing demand for animal protein in developing countries. The case for promoting increased livestock production is pressing given the rapidly growing demand for animal products, and the global aim to halve, by 2015, the proportion of the world population living in abject poverty, most of whom are dependent, at least in part, on food and income derived from livestock. The landless and rural women are important sub-groups of the rural poor likely to benefit from livestock development. Meeting these needs for promoting livestock production "while, at the same time sustaining the natural resource base (soil, water, air and bio-diversity), is one of the major challenges facing world agriculture today" (Bruinsma 2003, Chapter 5).

Livestock are self sustaining capital investments, since replacements may be bred and reared within the flock or herd. However, establishment of foundation stock, breed improvement or purchase of specialised equipment involves new investment from outside the system. Traditional foundation stock may be inherited or transferred at marriage, but where re-stocking is needed, following drought, disease outbreak or other disaster, or for innovations, such as new livestock enterprises, upgrading of stock, or change of system, funding is needed. For the poor, lacking the necessary finance, paucity of credit facilities is a serious constraint. Credit-in-kind, such as that provided by 'heifer in trust' schemes, may alleviate the problem. However, additional circulating capital is likely to be needed with the introduction of intensive livestock systems, requiring purchased inputs. Vertical integration with large-scale processor, marketing agencies may allow inter-linkage of credit provision with other services, while independent producers must still rely upon informal local sources.

Successful implementation and spread of innovations in livestock production, requires an increase in human capital in the form of new knowledge of appropriate husbandry and management methods. Farmer participation in testing and development, together with effective extension support, is essential for the successful introduction of new livestock enterprises or methods of production.

There is a need to ensure that proposed new technologies are appropriate, that they accord with the producers' objectives and constraints and match with consumer demands in accessible market outlets. Sustainability of a livestock development project must depend upon availability of inputs, particularly fodder resources, but also delivery systems for concentrate feeds, genetic material (e.g. male breeding-animals, semen or day-old chicks) and disease control measures. The physical infrastructure of roads and other communications has an important influence, but an effective and appropriate institutional framework is a prerequisite.

While these broad generalisations apply to all types of livestock production system, there are such large differences between them in terms of physical, social and market environments, that different policies are needed for promoting development. Grassland-based, mixed farming and landless systems, in developing countries, are discussed separately in more detail.

Extensive, grassland-based systems remain in the arid and semi-arid regions of Sub-Saharan Africa, Latin America, the Near East and Central Asia, as the only feasible form of agricultural land use and source of livelihood for the local population. The climate is harsh and rainfall is very unreliable. Ruminant livestock are kept to produce milk and meat for consumption and sale. There are risks of land degradation

and loss of pasture species due to open access to rangelands. However, with effective communal ownership and control, apart from dangers of drought, sustainable production *is* possible. Delivery of animal health and other services is difficult in remote pastoral areas[19] but local markets for milk and meat operate effectively other than in periods of severe drought, when meat prices collapse while grain is scarce and expensive. Ruminant livestock production and numbers of poor people deriving livelihoods from this system are small, in relation to those for other systems, and probably declining. Husbandry, production and marketing methods are generally effective and scope for increasing offtake is limited. Possible options for welfare improvement include provision of water supplies and measures for drought relief.

Ranching, practised in parts of Latin America as in land-rich developed countries of North America and Oceania, is capital-using and labour-saving when compared with pastoralism. Few of the poor are supported by this system but a substantial marketed surplus of meat is produced, some for export. Attempts to replace pastoral systems by group ranching, in East and Southern Africa, have had little success.

Mixed crop-livestock farming systems in the humid, sub-humid and temperate regions of all the main continental blocks, makes the main contribution to ruminant livestock production and livelihoods for the rural poor. These more favourable climates permit food-crop production and further intensification by the introduction of livestock. Irrigated systems, involving buffalo in place of cattle, are prevalent in Asia. Complementary relationships and nutrient recycling, based on crop products fed to animals and manure returned to the soil are beneficial, while diversification provides a buffer against risk and livestock serve as a form of savings.

Smallstock, such as poultry, sheep and goats, are more likely to be owned by the poor, particularly women, since they cost less to purchase, are of a more convenient size for home consumption or for sale in times of distress and reproduce and grow faster. They may survive by foraging on harsher terrain and vegetation than cattle. In much of Africa larger stock are excluded by the prevalence of trypanosomosis. Investment in fencing or housing for livestock is likely to be needed to protect crops from damage. Changes in land tenure institutions may be required to permit enclosure of what was previously common land. With increasing stocking intensity, competition grows for land, between fodder and other crops or for cereals and oil seeds between animals and humans. In either case the value added by raising livestock is generally sufficient to justify the incremental costs.

Ruminant livestock may be kept mainly for meat, for milk or for both or, in the case of sheep, for wool. Commonly traditional breeds are dual-purpose but overall productivity increases are generally sought by breeding for specialised production of meat or milk. Specialised milk production generally yields more than enough for consumption within the family and markets must be found. Co-operative group action may be needed for processing and marketing, or delivery to a large commercial dairy. The availability of animal draught power is often listed as an additional advantage of mixed farming. However, only the large ruminants are suitable for use as draught animals, while production of draught power competes with milk and meat production. The main benefit in Asia appears to be the saving of labour in major field operations and transport. In parts of Africa and Latin America, where land is less scarce, animal draught may allow an increase in the frequency of cultivation. Provision of animal health services, with cost recovery, may be feasible and sustainable in areas with a high livestock population density particularly where productivity is high. Services may be extended to areas of less intensive livestock production with the employment of para-veterinarians. There is much scope for productivity improvement through

[19] Public goods such as infectious disease surveillance and control must never the less be provided, particularly in border areas.

research and development in animal health, nutrition, adaptive breeding, and switches in production system.

The landless production systems, particularly pig and poultry enterprises, are potentially the most intensive since their expansion is independent of the area of land available to the farm household, if household wastes or purchased feeds are used. They are the fastest growing source of meat worldwide and in the developing countries. These systems are found in all parts of the world, although production is concentrated in the industrialised countries. Within the developing country group, they are most important in the land-scarce countries of East and South East Asia with China and the Near East, although poultry production is fast expanding in Latin America. Systems vary from traditional 'backyard' production to large-scale industrial type systems most common in the developed countries. These large systems are increasingly being established in peri-urban areas of developing countries, with advantages of greater productive efficiency from use of hybrid stock, pre-mixed concentrate feeds, low transaction costs through vertical integration, together with economies of scale in processing and marketing. Dangers of disease outbreaks are increased by keeping large numbers of birds or other animals in close proximity but delivery of animal health care and general hygiene are facilitated in these circumstances.

The spread of intensive, commercial poultry and pig production systems is viewed with alarm, in some quarters, as only benefiting large scale producers and middle-class urban consumers, creating water and air pollution, reducing bio-diversity by the dependence on exotic hybrid stock and relying on feed grains and oilseeds which might have contributed directly to human diets (Cox & Varparma 2000, Fresco & Steinfeld 1998, Durning & Brough 1991). Against these arguments must be set the fact that poultry and pig production are the most economically efficient enterprises, or cheapest sources, for meeting human needs for animal protein. Increased production in the developing countries promises to reduce the growth of imports and save scarce foreign exchange. Profitability depends on the price of feed grains, which make up a major part of the costs of production. Debate surrounds the relative costs of importing poultry and pig-meat versus the importation of the necessary feed grains. Increased productivity of both intensive livestock and cereal systems will benefit the national economy. Controls may be needed to limit pollution and loss of bio-diversity. It is important for small-holder producers to participate in the spread of poultry, and possibly pig, production, by the promotion of semi-intensive methods of production and vertical integration with processors and marketing agencies, which might be achieved through co-operative group action.

Similar issues arise in relation to intensive smallholder milk production. Animals are housed and may be zero-grazed and fed some concentrates, cross-breeding with exotic breeds is commonly practised and there are economies of scale in processing and marketing dairy products. Producer co-operatives have been successful for processing and marketing in some countries.

Trade policies to protect domestic producers in developed countries, lower the prices on world markets, particularly for beef and dairy products. Pressure is being applied, through the WTO, for reduction of these trade barriers, since despite benefiting developing country consumers, they create unfair competition for their producers. However it is predicted that the effect of the complete removal of such barriers would be small. Non-tariff barriers, such as sanitary (SPS) regulations imposed by developed countries, are likely to become increasingly important. Compliance raises costs for developing country exporters, for which foreign aid may be justified. There are national and global benefits to be gained from improved SPS and other quality standards for both exporters and importers.

How can it be done?

In the face of the fast growing demands for livestock products in developing countries, there are opportunities for major gains to be derived from improvements in the productivity of livestock systems. Increases in domestic livestock production contribute to growth in national income, reduced dependency on imports with savings in scarce foreign exchange, and, in rural areas, additional employment, improved livelihoods and poverty alleviation. There is considerable scope for improvements in livestock production and productivity, but increased funding will be needed. The current decline in development funding for agriculture must be reversed. It will require more resources to be provided by national governments, but also increased bilateral and multilateral aid and technical assistance.

Development policy instruments fall into three main groups:

- price policies, including trade and exchange rate policies,
- institutional policies and
- promotion of technological change.

Price policies are the responsibility of national governments, although they may be influenced by international agencies, such as customs unions, the World Bank or the WTO. However, institutional and technological changes are introduced not only by national and local governments but also by private individuals or associations and Non-Government Organisations.

Price policies fall into four main categories of (i) trade policy, (ii) exchange rate policy, (iii) tax and subsidy policy, (iv) direct interventions such as floor prices and fixed prices. Trade policy, for the developing countries, should include continued pressure, through international fora such as the WTO, on developed countries to reduce tariffs and other barriers aimed at supporting their own producers. Possibly greater benefits might be achieved by reducing levels of protection for industrial sectors within the developing countries, as such protection raises input costs and effectively taxes agricultural producers. Overvaluation of the exchange rate, that is of the domestic currency, had similar adverse effects. However, there are fewer cases of this problem following the imposition of Structural Adjustment regimes, over the last twenty years. Taxes and subsidies and direct market interventions by government are also less common today, having failed to bring lasting benefits and possibly having contributed to the international debt crisis. There remains a case for limited use of subsidies for disaster relief and to promote the use of beneficial new inputs, such as vaccines or drugs. Alternatively moderate taxes on livestock producers might be used to recover costs of providing public goods such as disease control or eradication programmes.

Policies for the promotion of appropriate institutions can have a major impact on livestock projects. The authors of a review of about 800 livestock development projects found that most had failed to bring about significant sustainable improvements in livelihoods of the poor. They conclude that 'The key lesson to emerge from our review… is the importance of institutions in defining the success of pro-poor measures.'(LID 1999). Benefits would accrue to livestock producers, as to all members of society, if along with improvements to the physical infrastructure of communications and transport routes, electricity and other services, the institutional infrastructure of law and order, respect for property rights and contractual agreements with legal support. In relation to grassland-based and mixed-farming systems, strengthening of property rights in land and water supplies may bring major benefits. Legal methods, of excluding non-members of the community from enjoying common property rights, prevent inter-community strife and regression of rangeland

use to one of open access. Secure property rights provide incentives for land conservation and improvement.

Institutional development is needed for the provision of credit, animal health services and genetic material, for example by artificial insemination. The introduction of new technology must be accompanied by the development or strengthening of the institutional framework needed for its implementation. The other key area, where institutional change is essential for the success of livestock development projects and programmes, is that of marketing, including transport, processing and selling. As there are economies of scale in these marketing activities, large commercial operations are most likely to be cost-effective. However, because of the high transaction costs of individual spot market sales by small-scale producers to processing marketing companies, there is a need for formal contracting or vertical integration. In negotiating contracts, small-scale producers are in a weak position, lacking market power and information on patterns of supply, demand and prices. Thus in promoting institutional development, there is a need for dissemination of market information, and encouragement of co-operative group action and participation by small-scale producers to strengthen their bargaining position. This might result, as in the case of the Indian dairy industry, in producer co-operative unions managing the processing and marketing operations. Additional benefits may be achieved by the development of linkages between different input markets, and between product marketing agencies and the delivery of inputs.

Technological change may be promoted by supporting research and development and the dissemination of information, or extension, to farmers. Public funding for agricultural research, and particularly that for livestock research, has declined over recent decades, within both the international CGIAR System and in most nations. Since much research output provides public goods private sector funding is limited. The decline in public sector and NGO funding must be reversed to allow faster growth in livestock production for economic development. National agricultural research systems are expected to concentrate effort on the adaptive and applied research, development and testing end of the chain. An appropriate institutional framework must be developed to integrate a farmer participatory systems approach with science based adaptive and applied research, necessitating collaboration between producers, and natural and social scientists. The national research organisation must take responsibility for research prioritisation, ensuring that it is appropriate for relative resource availability, taking account of the needs of the poor, and co-ordinating donor assistance.

Areas of research deserving attention include animal and veterinary public health measures and disease control, improvements in forage crops and utilisation of crop by-products, and improvements in husbandry and management of production systems. Local breed improvement is a long-slow process and increases in production are generally more readily achieved by cross-breeding with, or adopting, exotic breeds. Equally important is the need for socio-economic research into the institutional framework for the allocation of natural resources, credit, and labour hire, the delivery of inputs and the processing and marketing of livestock products. Research is needed to describe and analyse the strengths and weaknesses of existing institutions and to propose and test alternatives for improvement where necessary. In addition socio-economists are needed to contribute to the research prioritisation process, by assessing likely costs and benefits of proposed research projects.

What could the benefits be?

The primary benefit to be derived from increases in livestock productivity is a sustainable improvement in the livelihoods of livestock producers, many of whom are resource poor, many of these being women and some of whom are landless. Some of

the benefits will be reflected in improved levels of nutrition, while increases in market sales will provide income for other uses.

Increases in domestic production and supply of livestock products may result in falling prices. This will benefit consumers and accelerate the growth in demand. However, the fall in price is unlikely to be large enough to cancel out the benefits to producers of the increases in productivity. The main effect for most developing countries will be the substitution of domestic products for imports. This effect will bring additional benefits by saving scarce foreign exchange.

Improvements in animal and veterinary public health not only save farm costs and increase productivity and incomes, but also reduce risks of losses and, for those countries producing more than enough for home consumption, improve access to world markets.

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APPENDIX: DEVELOPED AND DEVELOPING COUNTRIES

The broad classification of countries into developed and developing categories, is widely used in UN publications (A full listing is given in Bruinsma 2003). The developed countries comprise (a) the high income, industrial countries of the Western Europe, North America, Oceania, Israel, Japan and South Africa and (b) the transition economies of Eastern Europe and Central Asia. The former group of industrial countries broadly co-incide with membership of the Organisation for Economic Co-operation and Development (OECD).

The developing countries include the mostly low income countries of Sub-Saharan Africa, low- and medium income countries of Latin America and the Carribbean, low-, medium- and high-income countries of the Near East and North Africa and low- and medium-income countries of South Asia and East Asia. Thus, there is a wide range of average per-capita income levels within the developing country category. Two important sub-classes of the developing country category, namely the 'least developed countries' and the 'net food-importing developing countries' are subject to special trade concessions under the WTO.