



guidelines

GUIDELINES FOR THE PREPARATION OF LIVESTOCK SECTOR REVIEWS



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LIVESTOCK SECTOR REVIEWS

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Recommended citation

FAO. 2011. *Guidelines for the preparation of livestock sector reviews.*

Animal Production and Health Guidelines. No. 5. Rome.

Acknowledgement

Particular thanks are due to Anni McLeod for her help and advice throughout the drafting process. Useful suggestions were also provided by Simon Mack and other members of the Animal Production and Health Division of the FAO. Advice was kindly given by Cornelis De Haan and Jimmy Smith of the World Bank while field-related information was provided by officers of the Animal Production and Health Division and by Clare Narrod and Derek Baker of International Livestock Research Institute. Thanks are due to Bruce Cottrill of ADAS UK Ltd. who contributed the Annex on livestock feed balances, originally drafted by Roger Lough. Inputs to this Annex were also provided by Harinder Makkar and these are gratefully received. Thanks are also due to the FAO officers who reviewed drafts of the document. Claudia Ciarlantini and Carmen Hopmans together with Carol Johnston carefully edited and polished the presentation of these guidelines and their assistance is appreciated.

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ISBN 978-92-5-106910-3

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Glossary

Asset specificity: Assets are items of value possessed by an agent in a market transaction. If the assets, of one or both the agents in the transaction, are specific to a particular industrial sub-sector, there is an incentive to ensure secure contracts for future transactions. This might be the case for specialist dairy farmers and the milk processors with whom they trade. The assets, cows and pasteurising equipment, might prove valueless if the trade should fail.

Coding: Use of a system of numbers, or other symbols, to represent and replace categories of textual descriptive data, in order to facilitate recording and quantitative analysis.

Collateral: Property pledged by a borrower to provide security to, and protect interests of, the lender.

Competitiveness: The extent of market competition between participants in the market.

Contract: A binding agreement between two or more parties, that may be informal 'a gentleman's agreement' or legally enforceable.

Equity: Justice according to natural law or right: fairness. Alternatively it may be used to describe the value of capital assets owned net of borrowing.

Excludability: A beneficial good or service, access to which may be denied for some individuals or groups in society.

Fitness traits: Characteristics of animals, of interest to humans, associated with viability, adaptation to the local environment and reproduction.

Focus group: A number of people (stakeholders) gathered together to discuss information relating to specific issues and participant attitudes, so that others may benefit from their opinions and assessments.

Food security: Food security, at the individual, household, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and *nutritious* food to meet their dietary needs and food preferences for an active and healthy life (FAO 1996). At the national level, physical access depends upon production, imports or food aid. Economic access refers to purchasing power, depending upon adequacy of incomes and the relative levels of food prices.

Free riding: A situation where independent, rational individuals can ride free, relying on the generosity or abstinence of others, for instance in grazing their cattle on common land, using public water supplies or depending on the sanitary measures taken by other livestock keepers.

Governance: The institutional and organizational framework within which transactions are conducted.

Gross margin: The gross margin of an enterprise is equal to its gross output less its variable costs. Gross output includes the market value of produce retained by the

farm household. The variable costs must a) be specific to the enterprise and b) vary in proportion to the size of the enterprise (e.g. per head of livestock).

Gross output: (Also referred to as gross income). The value of the product output of a farm enterprise, over an accounting period (usually a year) whether the produce is sold or not. For livestock the output is net of the value of any animals purchased or obtained as gifts. The value must be adjusted for changes in inventory valuations, for instance the depreciation of breeding livestock, or appreciation of growing stock.

Herd growth model: A mathematical equation system in which the herd structure is described by the numbers of animals in each age and sex cohort. Annual transition probabilities, for the birth-rate, transfers between cohorts, mortalities and off-take rates, are applied to determine the change in herd structure and numbers each year and hence the growth of the herd over time.

Institutions: These make up the set of political, social and legal 'ground rules' that govern social relationships. Formal institutions include laws and policies regulating behaviour at local, national, and international levels. Informal institutions include social customs and conventions that may be deeply embedded in a person's culture.

Insurance: A contract whereby one party undertakes to indemnify another against loss by a particular contingency or risk, in exchange for regular payment of an annual premium.

Investment: Investment is an addition to the stock of capital. The cost or effort involved in making an investment represents a saving, or current consumption foregone. The usual aim of investment is to increase future production and income by more, in total, than the original investment cost. The surplus, over and above the cost of the investment, is known as the 'return on capital'.

Livelihood: The means, usually productive employment, by which persons or households support themselves.

Livestock Units: Livestock units, used for aggregating the numbers of different categories of livestock, are usually derived in terms of relative feed requirements. Conversion ratios are generally based on metabolisable energy requirements, with one unit being considered as the needs for maintenance and production of a typical dairy cow and calf.

Market chain: A series of linked intermediary traders between the producer, of livestock or other commodities, and the final consumer. The series is also linked back 'upstream' from the producer to the input suppliers. Branching may occur at any stage of the chain.

Micro-finance: This term refers to the large-scale provision of small loans to low-income people, an established example being the Grameen Bank in Bangladesh. A more commercially oriented micro-finance approach has since been developed, still focused on the poor but with more emphasis on the provision of savings services as well as loans. A key innovation of micro-finance is the use of joint group liability, such that if one member of the group defaults the entire loan is considered to be in default.

Model: A simplified, usually mathematical, representation of reality, designed to reflect those features of a farm household, market chain or other system that are of most importance in the context of a particular study.

Moral hazard: This is a form of ex-post opportunism, meaning the incomplete or distorted disclosure of information as it affects behaviour, after a contract has been agreed. It arises because of 'information asymmetry' between two contractors, the 'principal' and the 'agent'. Examples may be the livestock insurance provider and the policyholder or the employer and the hired worker. In either case the 'agent', with the security of a contract, and without careful supervision by the 'principal' may become careless in the health care of their animals or the standards of their work.

Off-take: The number, live-weight or value of animals removed from a herd/flock, per year, for home consumption, sale or as a gift to another person. Together with animal mortalities due to disease or old age, they account for the total annual exits from the herd/flock.

Opportunity cost: The cost of any choice measured by the value of the most rewarding alternative foregone.

Organization: An administrative and functional association or society, such as a business firm, a club, a village, or a co-operative. The membership rules and procedures are part of the institutional environment for the members.

Production: The quantity or value of the commodities produced.

Production traits: Characteristics of animals, of interest to humans, associated with the products derived from animals, and therefore with rates of production, such as milk yield or live-weight gain.

Public good: A pure public good is both non-exclusive and non-rival. Hence free-riding is possible and private investors are unlikely to be able to charge for its use. It follows that public sector intervention is likely to be needed for its provision, if this is shown to be justified.

Rivalry: Rivalry in benefiting from the consumption of a good, implies that consumption by one person prevents anyone else from consuming it, as would be the case with a cup of milk. In contrast a non-rival good, such as a zone from which an infectious livestock disease has been eradicated, benefits many owners at the same time.

Risk: Risk is a measure of the effect of uncertainty on the decision-maker. There are differences of opinion as to how risk should be measured. Some argue that it is the variation or instability of outcomes (pay-offs) while others claim that it is the possibility of disaster or ruin. In both cases risk depends upon the value of the outcome and the probability of its occurrence. Most decision-makers seek to limit their exposure to risk. They are 'risk averse'.

Scoping: Project scoping is a brief analysis and review of what the project will involve, what the risks and possible difficulties are, and how the work should be organized and implemented.

Stakeholders: A stakeholder is a person, or an organization, that has a particular interest in a private, public or non-governmental sector policy, programme or project. The interest may derive from being a potential beneficiary, an ordinary member of the community likely to be affected, an organizer, administrator or facilitator, a donor, the Government, a

Non Government Organization, a Community Based Organization or a researcher. Anyone may choose to be a stakeholder, but resource limitations require that judgements must be made on the relative importance of different individuals and organizations.

Stocking rate: This is measured by the population density, of ruminant livestock, per hectare of agricultural land. The livestock population may be given in (Grazing) Livestock Units, to allow for differences in feed requirements between bovine animals and small ruminants. Livestock population density may then be related to total agricultural area or, for pastoral systems, to the area of rangeland grazing.

Transaction costs: These are the costs of exchanging goods and services, which can arise in three broad areas; a) gaining information on potential buyers or sellers, b) negotiating contracts and c) monitoring and enforcing the implementation of the agreement. Their level is influenced by the choice of market institutions.

Value added: For a particular industry, such as agriculture, value added is equal to the value of its output minus the value of intermediate inputs it buys from other industries. Value-added, in turn, is equal to the payments to the factors of production (land, labour and capital) employed in the industry.

Value chain: A set of generally applicable, interrelated activities, common to a wide range of productive enterprises. A value chain can be defined for a company or an industry. The concept gained wide acceptance after it was described by Porter (1985), who differentiated between the primary activities needed to produce and market a product and the supporting services. The goal of these activities is to create value added. Any or all of them may be vital in developing a competitive advantage.

Vertical integration: The process by which several steps in the **production** and/or **distribution** of a **product** or **service** are controlled by a **single company** or **entity**. The main aim is to reduce transaction costs by incorporating input suppliers, backward integration, or by joining with major retail outlets, forward integration.

Preface

Demand for livestock products has grown rapidly in recent decades in response to increases in human populations, particularly urban dwellers, and in their incomes. This 'livestock revolution' has generated steadily increasing levels of livestock production, making this sub-sector one of the fastest-growing in agriculture. Furthermore there is increasing recognition that livestock provide a vital contribution to livelihoods, income and nutrition of the rural poor.

However, most of the developments in livestock production and marketing have resulted from private investment, frequently in high-density large-scale commercial systems. With little or no public sector regulation these developments may force competing small producers out of the market. In addition the increase of animal population densities associated with growing livestock production has been linked with environmental problems of land degradation, soil, water and air pollution, and reduction in biodiversity, together with increased risk to human health resulting from animal diseases.

For these reasons, and the relative neglect of livestock development in past national decision making, there is now an urgent need for increased public sector investment, institution building and regulation of the livestock sub-sector (FAO 2009, World Bank 2009). National or regional policies require careful planning and design, for which a key first stage is the preparation of a Livestock Sector Review (LSR). Forms of LSR are also needed to support requests for donor funding of specific projects, or to plan effective policy responses to climatic, disease or conflict-related emergencies. Many such reviews have been conducted but there are inconsistencies in their purposes, scales, contents, levels of detail and support for policy recommendations. Generally applicable guidelines for the gathering of relevant information and preparation of livestock sector reviews have been lacking. The intention of the present exercise is not to impose prescriptive rules but rather to provide indications of tried and tested approaches, analytical tools, contents, and delivery methods for the presentation of livestock sector reviews.

Positioning

These guidelines share some features in common with the Livestock Sector Investment Planning Tool (LSIPT), which is being developed by FAO, the World Bank, CIRAD (Centre de coopération internationale en recherche agronomique pour le développement) and governments in sub-Saharan Africa, under the ALIVE Partnership for Livestock Development, Poverty Alleviation and Sustainable Growth (PPLPI 2006). The aims of the LSIPT are more specific than those of the present guidelines, in being designed for use in sub-Saharan Africa, yet more ambitious in ‘establishing coalitions for change’ and ‘to reposition the African livestock sector in development agendas’. While there is complementarity in content between the two, the aims of these guidelines are to provide an aide-memoir or checklist rather than a detailed toolkit, and they are intended for use in any part of the developing world and not only in response to requests for livestock sector reviews for inclusion in Poverty Reduction Strategy Papers.

Other decision support tools for livestock policy planning have been developed within the Livestock Information, Sector Analysis and Policy Branch (AGAL) of FAO’s Animal Production and Health Division. The Livestock Environment and Development (LEAD) group can provide the following tools: livestock and environment toolbox, participatory land use planning, the livestock development planning system (LDPS²), manure management options for confined pig production in rapidly growing economies, nutrient balance model, fossil fuel in livestock systems and global livestock densities, the last using Geographical Information Systems (GIS) technology. The Pro-Poor Livestock Policy Initiative (PPLPI) also has the following decision-support tools: Ex-ante tool for ranking policy alternatives (EXTRAPOLATE), Integrated poverty assessment for livestock promotion (IPALP) and the technology impact and policy impact calculation model (TIPI-CAL v 4.0). Also of value are mapping systems and atlases such as GLiPHA (Global Livestock Production and Health Atlas) and GLIMS (Global Livestock Impact Mapping System). None of these tools alone provides the basis for a livestock sector review. Nevertheless, several of them can provide for deeper analysis of some elements of the review.

Target audience and content

This set of general guidelines for the preparation of Livestock Sector Reviews is intended to assist livestock policy advisers in FAO or other organizations in this activity. The intended audience includes:

- Recruiting officers responsible for drafting Terms of Reference for reviews;
- FAO consultants who would appreciate a checklist;
- Young professionals;
- Other livestock or social science professionals who have not previously conducted a sector review.

The document consists of five main chapters.

1. The purpose of livestock sector reviews: reconciling different social objectives, review requirements and resource constraints
2. Core content of the review: key components and recommendations
3. Analysis of specific issues: specialist topics not included in all reviews
4. Conclusions: future investment and policy options and action plans
5. Data, information and analytical tools: covering data recovery and methods of analysis

The recommended sequence of activities, contents of the review and data sources represent comprehensive standards to be aimed for. In practice, many review studies are concerned only with a particular livestock enterprise, such as poultry production, or a particular institutional or technical innovation. Results are often required urgently so planning is subject to time constraints. A less extensive review is then justified and appropriate. More generally, clients for livestock sector reviews and team members are faced with paucity of reliable data, in addition to financial and human resource limitations. Expert judgement is needed, by both clients and review team members, in balancing review requirements and recommended review standards, against resource limitations, in the preparation of livestock sector reviews.

Chapter 1

The purpose of Livestock Sector Reviews

POTENTIAL AIMS OF THE REVIEW AND POTENTIAL CLIENTS

The request for a livestock sector review generally stems from a policy maker's recognition that information and guidance are needed for livestock sector planning. For instance, the review may be needed for:

- developing a national (or regional) livestock development strategy
- promoting incorporation of livestock in a Poverty Reduction Strategy Paper (possibly complementing use of the Alive toolkit in African countries)
- requesting donor funding for a livestock project
- providing background information for planning emergency response, or
- contributing to a thematic review of a wider development-policy issue.

The development of a national livestock strategy, with or without particular emphasis on poverty relief, may well include all livestock species and production systems. Note also that livestock cannot be viewed in isolation. Most livestock production systems are incorporated in mixed crop-livestock systems while, through input and product market chains and domestic resource allocation, the livestock sector is linked with the whole national economy. However, in some cases the review may be focussed on particular sub-sectors of the livestock industry, such as the dairy or the poultry sub-sectors.

Where the aims are more specific, as in requesting donor support for a particular project, or for planning emergency response, the review is more likely to be directed to a particular type of livestock production system. A livestock sector review intended only as a contribution to a wider thematic policy review, will be focused more narrowly on the relevant aspects of the livestock sector.

The clientele for such sector review studies normally consists of the government agents engaged in national development planning. However, professional and financial assistance may be provided by international support agencies, international non-government organizations (NGOs) and national NGOs. These other organizations, in providing support, also become clients for, or sponsors of, a review report even though planning strategies are the responsibility of national government agents.

The basic purpose of a livestock sector review is to describe and analyse the structure, conduct and performance of the livestock sector and its associated programmes and policies. However, this analysis should be motivated by the aim of identifying the strengths and weaknesses of the sector and the associated programmes and policies. Together with assessment of the prospective threats and opportunities, the findings should indicate

promising future investment options. This does not require detailed project appraisal at the review stage, but does provide for the essential scoping of recommended investment options.

ROLE OF THE PUBLIC SECTOR

For several reasons, the unfettered private market development of the livestock sector is unlikely to make adequate provision for selected social and environmental goods and services. One reason is the need for ‘public goods,’ such as the provision of roads, law and order, border quarantine or food-safety inspection, from which anyone can benefit without paying¹, so there is no incentive for private provision. Policies for the prevention of epizootic animal diseases fall under this heading.

Poverty relief is an important social goal that may require public sector intervention, for instance where the benefits of economic growth are not spread equitably. Provision for this objective may be categorised as a ‘merit good’. Its importance is agreed internationally in the Millennium Development Goals and promoted in Poverty Reduction Strategy Papers.

Another area of ‘market failure’ results from ‘externalities’, which are costs or benefits borne by others who are not party to a business transaction. Thus a livestock producer who adopts bio-secure practices provides external benefits to the neighbouring producers in terms of reduced animal disease risk. Environmental impacts of livestock keeping, such as land degradation, soil, water and air pollution and loss of animal biodiversity, are seen as external costs of intensive livestock production.

Market imperfections may arise, such as through the emergence of large scale monopolistic traders, with power to adjust prices to their own advantage. Poor communication facilities and limited access to information may result in information asymmetries, between livestock producers and market traders, or between input suppliers and livestock keepers. Exploitation of these variations in market power provides opportunities for inequitable inflation of marketing margins.

Public sector intervention is needed for all these reasons, and to provide for the co-ordination of input supplies, such as that of veterinary services and market facilities, with the distribution of producers. Intervention may involve capital investment in infrastructure, and expenditures on grants or subsidies. However, much can be achieved by development of improved institutions and by regulation. All these approaches require funding from the public budget or from donor aid. Hence any livestock sector strategy or programme is also an item of public expenditure. A livestock sector review should therefore also serve as an exercise in Agricultural Public Expenditure Analysis (World Bank and DfID 2010).

NATIONAL DEVELOPMENT GOALS

The aims or ‘target values’ of the strategies, or programmes, being reviewed, are supposed to contribute to the achievement of higher, national level, social welfare objectives. Apart from the two key objectives of ‘economic efficiency’ and ‘distributional equity’ there are others which are of public concern. These are discussed in more detail below. Most govern-

¹ This is the non-excludability (anyone can benefit) characteristic, which allows ‘free riding’. The other characteristic of non-rivalry means that use by one member of the public does not detract from use by others.

ments claim to devote some attention to them all, but the relative importance given to each one is likely to vary from country to country.

Economic efficiency. This implies making the most productive use of national resources. A crude, but useful, measure is provided by the level of national income (Gross Domestic Product) per capita. Annual growth in average per capita income is used as an indicator of an increase in economic efficiency and successful development policies. Given this objective, all livestock development strategies and programmes, as items of public expenditure, should be carefully managed and controlled. Budgetary over-spend should be avoided and, ideally, strategies and programmes should be aimed at yielding a competitive economic rate of return.

Food security. Within the developing world rapid growth in demand for livestock products, widely described as the 'livestock revolution' has been met by substantial increases in livestock production. Concerns arise as to whether these high rates of growth in livestock production are sustainable. With regard to food security however, there are two important considerations. One is that although on average globally, livestock products contribute 15 percent of total food energy and 25 percent of dietary protein supply as well as essential micronutrients, they are not considered as part of the basic staple diet of the poor or of emergency food aid. Secondly, food security does not require that a country is self sufficient in a particular product. In fact, the least developed countries are generally net importers of food, including livestock products. None the less, governments of these countries are likely to be concerned that the shortfall in domestic livestock production does not widen and create the need for increased imports and a weakening of the balance of payments.

Poverty relief. The key goal of improving the livelihoods of the poor can be achieved as a result of national income growth. Increases in livestock production may lead to income and welfare improvements for both rich and poor producers. However, some technological and institutional changes, designed to improve livestock production in general, may disadvantage small-scale producers and generate inequalities. Hence livestock sector policies that are aimed primarily at poverty relief may differ from policies aimed more specifically at economic growth.

Natural resource and environmental protection. Livestock production has significant impacts on the environment. Feed crop production is often associated with land degradation and water pollution. Atmospheric pollution is also important, while inbreeding for yield improvement lessens the extent of biodiversity. Given the global concerns over protection of the environment and amelioration of global warming, these issues should be borne in mind when planning livestock development policy. However, in low-income developing countries this objective is unlikely to be considered as important as economic growth and poverty relief.

Protection of human health and food safety. Another key objective of livestock development strategies and programmes is that livestock products should be safe to eat. In recent years, new animal diseases have emerged, such as highly pathogenic avian influenza (HPAI) and bovine spongiform encephalopathy (BSE), from which the fears of human infection have caused major disruption to livestock production and trade. All governments must be aware of the dangers of a global pandemic from a livestock borne disease, but in

low-income developing countries the need for investment in disease prevention and control is likely to have lower priority than the desire for income growth and poverty relief.

RECONCILING CONFLICTING OBJECTIVES

Governments and societies must find a balance between different objectives, but the chosen balance of objectives will differ from country to country, depending on the level of development and the role of livestock in the economy. For some low income countries, economic growth may be the first priority, for others poverty relief and livelihoods will take precedence. Food security may also have a high weighting. In wealthier middle and high income countries, human health concerns and the environment will be paramount.

There are challenges in balancing multiple objectives. A practical approach may be based on judgements of the national relative weightings, or rankings of the set of objectives. The primary strategic objective for livestock policy is then to strive for the highest ranked of the set, while avoiding restraints on other objectives. For instance if the primary objective is economic growth, the sector strategy should also be designed to avoid any adverse impacts on the livelihoods of the poor, food security, the natural environment, and human health risks. Practically all the alternative objectives listed in the previous section are associated with risk and uncertainty. Economic growth is subject to global market and price uncertainties and undesirable fluctuations. Food security and poverty relief may require periodical emergency support. Disease incidence is hard to predict. Production from livestock is affected by natural resource disasters. Hence a further development objective may be added to the above list, namely '**resilience**' meaning the ability to adapt and adjust to external environmental social and economic shocks and thereby limit damaging fluctuations.

SCOPE, SCALE, TIMING AND COSTS OF REVIEWS

The scope, scale and cost of a livestock sector review must be influenced by the size of the country or region under review. For example a comprehensive livestock sector review study for India (World Bank 1999) is necessarily a larger scale exercise than one for the Lao PDR (Stür *et al.*, 2002). However, for any given country or region reviews may range in scope from a broad general review of the whole livestock sector to one concerned only with one particular livestock species or even a specific livestock production system.

Mention has already been made of Livestock Sector Reviews required as contributions to thematic surveys of wider development-policy issues. Examples might include environmental studies such as the sources of greenhouse gas emissions or carbon recycling, international trade policy, disaster risk management or gender roles, rights and responsibilities. The livestock component of such studies is likely to be narrower and more tightly defined than for reviews specifically focussed on the livestock sector.

Indications of the potential size, duration and costs of three main types of sector review study have been derived from a detailed summary analysis of 49 Agricultural Sector Studies (referred to as Public Expenditure Reviews) funded by UKaid (Draft Practitioners' Toolkit for Agriculture Public Expenditure Analysis: World Bank and DfID 2010). Although these data apply to agricultural sector reviews rather than to the livestock sub-sector, so some down-

ward adjustment might be justified, they are based on recent field experience in conducting sector reviews and are therefore worth quoting.

- **Comprehensive review of the whole sector:** Such a study is undertaken as a detailed, self-standing sector-wide review. The main objective may be economic growth or poverty relief. **Suggested length:** 80-100 pages, **duration of study:** 2 years, **cost:** US\$ 250,000 to US\$ 350,000
- **Rapid reviews:** These are intended to deepen policy dialogue, frame strategic action plans, guide project preparation and contribute to broader multi-sectoral reviews: **Suggested length:** 15 pages, **duration of study:** several months, and **cost:** US\$ 50,000 to US\$ 100,000
- **Thematic reviews:** These are concerned with a specific livestock sub-sector programme, particular livestock species/ enterprise or project. They may involve a comprehensive or a rapid review of a particular theme. **Suggested length:** 80 pages, **duration of study:** 2 years

A further category may be added in the context of livestock policies, namely:

- **Very rapid reviews:** These may be required for immediate response to emergencies. They are likely to be focussed on a very narrow area but need to be set in the context of the broader sector background and development objectives. This is to ensure that the emergency response does not destabilize livestock sector development plans. **Suggested length:** 10-15 pages, **duration of study:** 3 months **cost:** US\$ 50,000

All types of livestock sector review are best conducted by livestock economists and livestock production specialists. In some cases a veterinary epidemiologist or a GIS data manager should be included in the team. However, it may also be possible to hire the services of other disciplinary specialists, preferably from within the country, in the course of the review study. The team should include government staff, to contribute local knowledge and ensure continuity and compatibility with other policies, a knowledgeable, representative stakeholder from the private sector and international staff that can provide information and experience from external sources.

It should also be added that the suggested lengths, durations and costs listed above probably represent the maximum feasible resource inputs. The practical reality is that the client often requests the review, to make an investment decision, support an emergency action or check policy decisions already made, at very short notice. This may explain why detailed reviews are few and why, in practice, review teams focus so much on secondary data and why some complex elements like feed budgets are often omitted.

In effect there is a trade off between the higher levels of detail and accuracy obtained from a lengthy and expensive comprehensive livestock sector review and the swifter response, greater immediacy and relative resource economies derived from a more rapid review. The pros and cons are set out in a little more detail below Table 1. Actual choices must depend on circumstances.

Comprehensive reviews and rapid reviews are not mutually exclusive. Where comprehensive reviews are only completed at long intervals, they may be supplemented by rapid appraisals for specific purposes. Alternatively a rapid review may be used to pave the way for a subsequent comprehensive review.

TABLE 1
Relative advantages and disadvantages of comprehensive and rapid reviews

	Comprehensive reviews	Rapid reviews
Advantages	Comprehensiveness Good coverage Accuracy and reliability Scope for collecting primary data Scope for cross-checking triangulation Scope for assembling a database	Faster delivery of results Lower resource costs Can provide “scoping” for later more extensive review
Disadvantages	Long wait for results High cost	Greater reliance on secondary data Validation difficult Inconsistencies between different sources Some data not available

PREPARATORY ACTIVITIES

Before the programme of investigation for the livestock sector review can begin, a number of key preparations are needed. These include clarification of the aims of the review, gathering background information, planning the operational programme and securing the necessary resources and are essential precursors of an effective study. A brief checklist follows, each item requiring serious attention.

Responsibility for the initial stages of launching a livestock sector review study lies first with the clients, the government representatives and the support agencies requiring the review. These stages include **collaboration between government officials** from relevant Ministries, who may also engage with international support agencies and other development partners, to **identify objectives and scope** of the review. Preparation of the research proposal requires preliminary discussion of data sources and analysis, and may be presented in a concept note. **Terms of Reference** must then be developed to provide the contractual basis for the team activity, possibly with specific tasks allocated to individual members. **Budgetary allocations** must be made and the **review team selected** and appointed.

The remaining preparatory tasks are largely the responsibility of the review team. Close collaboration with stakeholder clients may enhance the effectiveness of the review. However, this will add to the cost and time required to complete the review. The team must assess the trade-offs between relative benefits and costs. In any case, the host Government may be required to provide authority for access to data sources, to approve movements of review staff members and to provide the necessary resources. These preliminary tasks are to:

- **digest and accommodate the objectives and terms of reference** for the review
- **initiate collection of background information**, by secondary data search and social networking

- **plan the study itinerary**, allocating time of individual team members to individual desk work, visits to key functional units at central and sub-national levels, workshops and focus groups. Movements of individual team members must be co-ordinated and harmonised, and may need approval by the host government clients.
- **organize access to the necessary resources**, including finance, transport, and translation services. Since these are likely to be provided by the clients, arrangements must be negotiated and agreed.

Chapter 2

Core content of the review

The items described in this section would normally be included to some extent in any livestock sector review. The level of detail that is appropriate will be defined by the scope of the review (comprehensive or rapid, broad or related to a specific problem), as discussed in Section 1.

BACKGROUND INFORMATION

It is normal good practice to start a livestock sector review with a basic description of the national ecological, economic, social and political environment. Information on most of the relevant items is, in most cases, readily available from published international or national sources. Items that should be reported include the following.

- **Land areas**, total, arable, irrigated and permanent pasture
- **Human populations, total and economically active**, agricultural, rural and urban
- **National Income (GDP), total and per capita**
- **Agricultural value added as proportion of GDP** and livestock's contribution to GDP (if available)
- **Incidence of poverty**, and under-nutrition
- **Outline of political system**
- Outline **description of main agro-ecological zones**

For many of these variables it is useful and instructive to **demonstrate trends over time**. This applies to population and labour force numbers, national income per capita, the contributions of agriculture and livestock to total national income and the incidence of poverty. It is also useful to calculate agricultural **population density** in relation to agricultural land and **numbers of those defined as poor** in relation to total population. All these measures for the country under review may be put into context by **comparison** with results for other neighbouring or otherwise similar countries. Within a large country comparisons may be made between provinces or regions.

STRUCTURE OF THE LIVESTOCK SECTOR

Information on the numbers of livestock, production systems, productivity and contributions to rural livelihoods, is an essential part of the review. Some items of data, at least national aggregates or mean values, should be readily available from secondary sources. Other items are less commonly available from secondary sources and are difficult to quantify. For the latter, a choice is needed between a) extra efforts to acquire information, b) use of crude subjective estimates or c) omission from the study. In the following list, items are labelled as readily available (RA) or difficult to quantify (D).

- **Livestock populations, by species (RA).** They may be aggregated as livestock units which are basically an 'exchange ratio' among livestock species obtained by converting the body weight into the metabolic weight, namely body weight^{0.75} (Livestock, Environment and Development Initiative 2005)². Annex Table 1 provides a list of livestock-unit coefficients that may be used. Densities of grazing livestock units per hectare of agricultural land and of total livestock units per person engaged in agriculture may then be calculated. These figures, together with trends over a period of years, provide a clear view of stocking rates and changes over time.
- **Production systems (D).** A full description requires classification of the main types of production system for each livestock species and estimates of the numbers of each type of producer. Information on the spatial distribution of the main types of production system may be derived from GIS mapping systems, or from electronic atlases such as GLiPHA. This allows relationships to be explored between livestock populations and production with animal disease incidence, human population densities, land-use and topography.
- **Herd/flock structures (D).** Average proportions of breeding males, breeding females, replacements and growing stock are seldom accurately recorded, for the national herd/flock or for particular production systems. Nor are data readily available on production traits, such as reproduction rates, growth rates and mortalities, from which to calculate herd structures and growth rates. However, estimated production parameters for ruminant livestock in sub-Saharan Africa are given by Otte and Chilonda (2002). In other regions, estimates of herd/flock structures, needed for the determination of feed requirements, technical and financial budgets, must often be based on local judgement.
- **Livestock production I (RA).** Estimates of average annual production per head of each of the main animal species may be obtained from national or international published statistics (secondary sources). Annual production of food from livestock is measured by the quantities of meat produced by each of the main livestock species, together with the milk equivalent quantity of dairy products and the quantity of eggs, all measured by weight. National totals are generally recorded in domestic statistical records, but are also available from FAOSTAT. These data may be used in conjunction with estimates of national levels of consumption and trade to construct national food balance sheets. However, for further comparative analysis and planning, it is necessary to estimate the annual production per head of the corresponding livestock populations. Thus the average annual production of meat per pig, for instance, equals the quantity of pig-meat produced, divided by the pig population. Where there are joint products, meat and milk from ruminant species, and meat and eggs from poultry, in the absence of further information on herd or flock structures, the whole population must be treated as a dual purpose herd or flock, each individual contributing some of both products. It is useful to estimate time trends in all these measures.
- **Livestock production II (D).** If detailed information is available on numbers of animals, in each main age and sex cohort, and the production parameters on yields,

² Other methods of estimating Livestock Unit values have been devised, e.g. see estimates used in LDPS².

growth rates and mortalities are known for each production system, then system-specific estimates of average production per animal (or per bird) can be obtained. If the corresponding product price data are available, production can be measured in value terms to give the 'gross output' per animal or bird. Note that in order to estimate production of meat, a suitable herd /flock-growth model is needed to predict numbers and live-weights of the animal (or bird) off-take (see Section 5.4). Research conducted by agricultural research centre staff or postgraduate university students may provide useful estimates of production and costs for particular livestock production systems.

- **Livestock productivity (RA).** Productivity is measured by the quantity of useful production per unit of a critical resource input and is an indicator of technical efficiency. Thus the values of production per head of livestock or yields, discussed above, may themselves be seen as productivity measures. Estimates are readily obtained from published statistics of livestock production and populations. Comparability between species may be improved by using Livestock Units, or even kg of biomass, rather than animal numbers as the denominator. A useful measure of productivity for intensively grown livestock is the kg of live-weight gain per kg of concentrate feed. The benefits of a change in farming system or methods of production should be indicated by an increase in productivity (for further discussion see Annex 4).
- **Values of draught power and manure (D).** These intermediate products are important in some crop-livestock systems. Indeed draught power may be the only valued product for species such as horses or donkeys. Quantities of draught power output, in terms of animal hours worked, and manure production, in tons per animal per year, are rarely quantified. Furthermore valuation is difficult unless there are functioning markets for draught power hire and for the sale of manure. Judgemental assessments may be needed. Other non-food products, such as wool and hides and skins, are also important in some livestock production systems and where appropriate yields per animal should be recorded.
- **Risks and vulnerability (D).** Rural people are at risk from climatic effects such as droughts and floods, illness and high mortality rates, and frequently from local wars, cattle raiding and civil disturbance. Give details of serious endemic disease problems, and trans-boundary disease risks. Information on previous incidence and coping strategies should be recorded.

LIVESTOCK IN THE ECONOMY

This section of the guidelines is devoted to assessment of markets, international trade and human livelihoods and nutrition derived from livestock products. Once again some items of information are readily available (RA), while others are difficult to quantify (D), and are labeled accordingly.

- **Livestock in the household economy (D).** There are a number of issues deserving investigation such as the numbers of households owning livestock, herd/flock sizes, economic and non-economic contributions to livelihoods, associated social/cultural uses of livestock, and employment opportunities in livestock processing and retail markets. For some countries, relevant information on household livelihoods is available, or might be extracted, from the Rural Income Generating Activities database

(access can be gained through the following link: <http://www.fao.org/economic/riga/riga-database/en/>). Otherwise information can only be derived from local key informant interviews and focus groups. Such information may be used to estimate contributions of different livestock production systems to livelihoods of the poor. Where possible, differences between households of different types (by wealth categories, rural and peri-urban areas, male-headed/ female-headed) should be reported as well as differences within households.

- **Quantities and values of imports and exports of livestock products (RA/D).** Numbers and values of live animals and day old chicks traded should be included in the analysis. Official livestock trade statistics are generally available from domestic sources and from the FAOSTAT database (RA). However, in many developing countries there is a considerable amount of unofficial, informal cross-border trade. Records are rarely available but attempts should be made to assess quantities and values (D) Since most countries are both importers and exporters of most commodities, it is useful to calculate the difference, in quantities or values, as the net exports, or net imports if negative. For net exporters, the relative importance of trade may be assessed by the ratio of net exports to total domestic production. For net importers a more appropriate ratio is that of net imports to total domestic consumption. At the time of writing, the Least Developed Countries, as a group, are net importers of all livestock products, except sheep and goat meat. This suggests that, in many poor countries, there is scope for livestock product market expansion by substitution for imported milk, meat and eggs. A further point of interest is that the same group, of Least Developed Countries, is a net exporter of live ruminants. This suggests that improvements in domestic meat processing and marketing could allow the products to be retained for domestic consumption, thereby contributing to more value added to national income.
- **Market chains (D).** Analysis is needed, for each major livestock commodity, of the market chain from producer to consumer. Input markets are often included as upstream components of the chain, but these are discussed in Section 3.5 of this paper. Essentially market chain analysis involves, (i) identifying the main actors or organizations, (ii) identifying the linkages between them through different market routes and (iii) assessment of how well the market chain is working, evaluating **competitiveness, profitability, food security, technical and operational efficiency, equity and consumer satisfaction.** (see Silva and de Souza Filho 2007). An additional important issue is that of 'governance' meaning the manner in which the market chain is governed and transactions are conducted, e.g spot markets, different forms of contracting, vertical integration and the degree of state regulation. Analysis of market chains is facilitated by diagrammatic mapping of the main participants and the transaction linkages between them. Further useful information should be obtained on the number of actors at each transaction point, numbers of producers using each market route, volume of product and values of produce passing through each transaction point. Gathering of the necessary detailed information mainly by key informant interviews is sufficiently demanding to be described as difficult to quantify.

- **Average national consumption of livestock commodities (RA).** Information should be gathered on total and average *per capita* quantities consumed. These can also be used to estimate average daily (or annual) consumption of calories, protein and some essential micro-nutrients unlikely to be available from crop products. Where possible, this information should be reported by income quintile. Data may be adequate to determine consumption trends and to estimate future changes in demand.
- **Livestock's contribution to agricultural and total GDP (D).** An official estimate of the contribution of livestock to agricultural value added may already have been recorded under Section 2.1. However, with addition information on livestock markets and the value of non-marketed produce, a more precise estimate may be obtained.

NATURAL AND HUMAN CAPITAL RESOURCES

- **Livestock breeds and breeding (D).** Breeds of livestock used in each of the main production systems, with production traits if available. In particular fitness traits, such as inherent immunity to endemic disease, should be considered. Description of any ongoing breed improvement programmes, breeding and supply of exotic breeds for crossing, farmer access to sires or AI. Performance of schemes for the distribution of improved breeding stock or semen and problems faced. For poultry, maintenance of parent and grandparent flocks. Possible threats to genetic diversity. Descriptions of all of the above can usually be provided by local experts, but quantitative information is often hard to find.
- **Endemic disease problems, and trans-boundary disease risks (D).** Qualitative assessments of endemic disease problems may be available, but quantitative estimates are generally poor or non-existent except for major, recent disease emergencies. Records may be available of the incidence of trans-boundary disease outbreaks in the past, nationally and in the OIE, WAHID database. Details should be obtained of any major disease prevention programmes undertaken in recent years. Impacts and costs should be quantified so that any proposed improvement plans can be integrated with ongoing disease control strategies.
- **Permanent pasture (RA/D).** Efforts should be made to record accessible areas of grassland potentially suitable for ruminant grazing. Where there are seasonal, transhumant movements of livestock, attempts should be made to assess seasonal changes in areas available and periods of use. Information may be available from local sources, but estimates of national areas of 'permanent meadows and pastures' are also available from FAOSTAT. Measures of areas accessible may then be used to estimate stocking rate, of grassland based systems, in ruminant Livestock Units per hectare, and possibly to make judgements of the potential maximum stocking rate or 'carrying capacity'. Alternatively if the productivity of the pasture can be estimated, in terms of megajoules of metabolisable energy (MJME) this may be used to predict carrying capacity for comparison and to determine scope for increasing grazing livestock numbers or the risks of overgrazing and land degradation. Communal rangelands are often occupied under participatory land use rights, which may not ensure effective management. These institutions should be investigated.

- **Water supplies (D).** Adequacy of supplies for livestock drinking in grassland based and intensive systems, and for hygiene under intensive systems, should be assessed. Projections suggest that water scarcity will intensify in the coming decades, possibly leading to increasing conflicts between alternative uses and users. Problems may be particularly intense where crops are grown under irrigation, which places heavy demands on water supplies. The increased costs of crop production under irrigation may render forage crop production uneconomic, although irrigated fodder production may be justified for intensive dairying.
- **Human Resources (D).** Assessment is needed of the adequacy, in terms of both quantity and quality of human resources. Some development theories have been based on the assumption of surplus, low priced agricultural labour available for other employment. In practice it is generally the case that average productivity per person employed in agriculture is much lower than that for other parts of the national economy and that over time agricultural production has increased despite continuous migration from rural to urban areas. However, labour requirements for crop production are highly seasonal, with work peaks for planting at the start of the rains and at harvest-time. Animal production offers the advantages of a more even spread of human labour inputs over the year and, in some cases, labour saving through the provision of draught power and mechanization. The quality of human resources is highly dependent on levels of education and human health provision, and may be improved by extension and training programmes. Yet indigenous knowledge and skills gained from local experience may be valuable qualifications for dairy farming, small ruminant production or the use of draught animals. It is therefore important to review the adequacy of numbers, skills, knowledge and health status of the labour force for existing and proposed livestock production programmes. Information on labour use in the livestock sector is not easily available from national or international databases (the ILO database, for example, aggregates all of agriculture and forestry) and it will almost certainly be necessary to calibrate aggregate figures against reports from smaller, detailed surveys of household and industry labour use. It is particularly challenging to estimate the allocation of labour within mixed farming systems, or to find figures that differentiate between male and female labour.

INPUT DELIVERY SYSTEMS

In this section the previous convention of designating components as readily available (RA) and difficult to obtain (D) is not used because in each case, the designation is highly case-specific, depending on the level of detail reported in this component and the existence of reports from recent formal surveys or evaluations. Comprehensive databases of the necessary information are generally rare to non-existent.

- **Feed resources.** Grassland based ruminant systems are largely dependent on pasture grazing (see discussion of Permanent pasture above) and some livestock subsist on scavenging and household scraps but for more intensive systems feed is generally the most important item of cost. Supplies of feed ingredients may originate from domestic crop production, or as imports from other countries. Information on national aggregate quantities of crop use for feed are generally readily available from

Supply Utilization Accounts and food balances, in which production, consumption by humans, imports, exports and waste are recorded as well as quantities used for feed. With estimates of the feed requirements of the total numbers of livestock produced annually, crude feed balance calculations could be made comparing requirements with supplies. Databases of feed production and use are susceptible to gaps (e.g. non-inclusion of locally-compounded feeds) or double-counting (e.g. aquaculture and livestock using the same feed ingredients) and it is important to be aware of these.

- **Feed supply chains.** For more detailed information on feed supplies to individual livestock production systems, time-consuming local investigation of the feed supply chains is needed. Sources, quantities and energy values of each feed item would be needed, with details of seasonal differences. Further analysis of feed costs requires information on prices. As part of the analysis, details of the feed mill industry, its capacity and raw-material input supplies would be useful. With adequate information on the herd/flock structure or production traits for each livestock system, estimates of feed requirements may be compared with feed supplies, incorporating imports of compound feeds and their ingredients, in feed balance studies (see Chapter 5 Feed balance models and Annex 2).
- **Animal health services.** Information should be provided on typical producer access to clinical veterinary services and the extent of public and private provision, together with the roles of qualified veterinarians, para-vets, veterinary auxiliaries and community based animal health workers. Estimates of prices charged and typical transport costs would be useful. A fuller analysis of the standard of veterinary services would involve assessments of quarantine, movement and border control measures, disease surveillance, diagnosis and control procedures, vaccination and vector control programmes, and food hygiene and inspection services. However a comprehensive review would probably require a formal Performance of Veterinary Services (PVS)³ evaluation. In addition to the broad information generated by a PVS, it is also important to report, if possible, on the extent to which access to services depends on location (it is often easier for farmers living close to main towns), the species kept (owners of larger animals may be more inclined to call on the veterinary service), and the income level and gender of the animal's owner.
- **Availability of drugs.** Although in some cases veterinary clinics are the main source of veterinary medicines, they may also be obtained from pharmacies or other sources. Details are needed of the regulatory framework for drug manufacture, and controls on unregistered and untrained suppliers. Ease of access and assurance of quality is important particularly for dispersed rural livestock producers.
- **Extension advice on animal husbandry.** National public and private veterinary services rarely provide advice on animal husbandry other than in relation to animal health and disease control. Agricultural extension workers may provide some advice on livestock production, although it is often subsidiary to the emphasis on crop agronomy. In addition, however, there may be public, NGO or private provision of

³ Introduced by the World Organisation for Animal Health (OIE) and originally named as the Performance, Vision and Strategy (PVS) tool.

advice and training in animal husbandry, for instance in farmer field schools. Information on inputs, such as feeds, drugs and genetic material, is often provided by private suppliers. Relevant information on all formal sources of information should be reported. This may include records of emergency response facilities for disease control, climatic disasters (droughts or floods), or civil unrest.

- **Credit.** Loans may be needed for productive investment in livestock or other assets, and for consumption smoothing for instance to provide for restocking after a serious drought. Ease of access to formal, bank and co-operative credit, and average interest rates, should be recorded. Similar information should be recorded for microfinance institutions, which are often run by NGOs in South and South-East Asia. Further information on rules of operation and typical repayment rates are also of interest. The operation of group credit schemes joint liability and of credit in kind, as in 'heifer in trust' programmes may be recorded.
- **Livestock insurance.** In India, and other Asian countries, livestock insurance schemes have been introduced, initially with public funding but with subsequent involvement of private insurers. Under the Indian scheme, the cattle owning client is only compensated for direct losses if the animal dies. A low level of uptake is reported for the scheme, due to lack of awareness and inability or unwillingness to pay premiums, while transaction costs and risks of moral hazard are high (Sharma 2009). In Mongolia, an index-based livestock insurance project, with terms and conditions based on a local index of livestock mortality, has been launched in some districts. It is built on a partnership between private insurance companies and the Government and is supported by international funding (Goodland 2010). When compulsory culling of livestock is adopted, as part of a stamping-out strategy for a transboundary disease, compensation may be paid as an incentive for the provision of the public good of reporting an outbreak. Since the scheme also provides indemnity against the direct loss of birds or animals, it represents a form of insurance, although the compensation is often publicly funded and provided at zero cost to the producer (ARD 2006). Lack of information and financial resources of livestock producers, difficulties of risk assessment, shortage of public finance and problems of establishing equitable institutions limit the development of effective insurance schemes. Clearly if any livestock insurance or compensation schemes are in operation, details should be recorded of the system and its economic and social impacts.

INSTITUTIONS AND ORGANIZATIONS

- **Role of Government** should be recorded in regulating/ co-ordinating a) livestock product and input markets, b) land and water property rights, c) animal health services, d) foreign trade in livestock and livestock products and inputs of feeds, drugs etc. e) meat inspection and sanitary health standards, and f) provision of information and advice.
- **Ongoing public sector livestock development programmes**⁴. Government and donor assisted programmes, already in operation, for the provision of technical ser-

⁴ A programme is a planned series of actions aimed at delivering a service and is subject to time and resource constraints. A project is generally aimed more specifically at a particular locality or stakeholder focus group.

vices for animal health, breeding, and nutrition, should be described and assessed. This should include information on applied and adaptive research on livestock production and animal health conducted by Universities and research institutes. For such programmes, it is useful to summarise the general levels of administration, management and achievement of objectives.

- **Review of public expenditure on the livestock sector.** This concerns spending on the livestock sub-sector in relation to total agricultural and national development expenditure. Contributions from donor funding should also be assessed. The results may be compared with the relative total value added by the livestock sector and with findings from other countries. Review budgetary allocations between livestock programmes and projects.
- **Private sector participation.** In addition to the livestock producers, private agents are involved in the market chain, both as input suppliers and in product processing and marketing. Apart from market transactions, private agents may provide services such as information and advice. In many countries, there is increasing reliance on private veterinary service provision. This may lead to sharing of 'corporate social responsibility' as exemplified by the Australian system. Animal Health Australia is an innovative partnership involving the Australian Government, state and territory governments, major livestock industries and other stakeholders. The aim is to strengthen Australia's national animal health system and maximize confidence in the safety and quality of livestock products in domestic and overseas markets. Any such private, or mixed, initiatives in the livestock sector should be described and assessed.
- **Non-government livestock activities.** Details should be provided of the organization of community associations and co-operatives, for marketing, input supply, and credit. Non-government organization (NGO) activity is commonly focused at the community level. An example is the provision of support for community-based animal health workers in East Africa, as an alternative to the more highly trained, and more costly, veterinarians. Any such non-government activities, relevant to the livestock sector should be reviewed.
- **Stakeholder analysis** Perceptions of livestock producer and market participant representatives of: ranking of problems faced, possible solutions, allocation of responsibilities for solving them. Local social and cultural constraints should also be described.
- **Sources of information for planning.** Give details of main secondary sources (see Chapter 5). Describe where they are held and by whom, how they were originally collected and if and when they were updated.

Chapter 3

Analysis of specific issues

Frequently a livestock sector review is required as a contribution to a thematic review of a wider development-policy issue. In this context, the livestock component will be focused more specifically on the relevant aspects of the livestock sector. Some specific types of development issue, likely to be affected by livestock production, are discussed in this section, which also suggests indicators that might be used in an analysis.

ENVIRONMENTAL ISSUES

- **Environmental problems and their mitigation.** This requires discussion of impacts of livestock on land degradation, atmosphere (greenhouse gas emissions) and climate, water pollution and biodiversity. Thought should be given to appropriate regulations and resource and service pricing to mitigate adverse environmental impacts (see Steinfeld *et al.*, 2006). Possible indicators: Evidence of expansion into natural ecosystems, rangeland degradation, nutrient loading in livestock concentration areas and intensive feed crop agriculture
- **Intensification.** An increase in the intensity of land use implies that use of other resource inputs and levels of product output per hectare have increased. For livestock keepers the process is reflected in increased stocking rates, a switch to more intensive types of livestock (for instance pigs and poultry rather than ruminants) and/or increased variable input use per animal. Intensification is occurring in many countries, particularly in the vicinity of urban conurbations. Trends should be assessed and the likely impacts on land degradation, atmospheric and other pollution, nutrient recycling, water supplies and biodiversity. Possible indicators: Increase in livestock numbers, increase in production per head, increase in carcase weights, switch from ruminants to intensive pig and poultry production.

MARKETS AND TRADE

- **Meeting urban demand.** Market chain analysis (discussed previously in Chapter 2, Market chains) should indicate the relative proportions of all main domestic livestock products supplied to urban areas. Comparison of product prices in rural and urban markets, with those received by producers, reflects the costs of processing, transport and other marketing functions⁵. These costs are likely to be influenced by the social and economic environment, particularly whether refrigerated transport facilities are available, and where animal slaughter and milk processing facilities are located in

⁵ Estimation of marketing margins for meat animals is complicated since the producer sells the whole animal, while the retailer sells separate joints of meat. Clearly price comparisons should relate to equivalent units of the product, possibly the whole animal. Furthermore, for all livestock products price differences may reflect differences in quality.

relation to production zones and urban markets. Current levels of achievement, in meeting urban demand, are indicated by assessment of the supply-demand balance, reflected in current product price trends. Adequacy of supply of livestock products also depends upon maintenance of required standards of health inspection and food safety. Future growth of urban demand depends upon the rates of urban population and income growth and the urban income elasticity of demand. Growth in domestic supply depends upon increased livestock production supported by institutional and technical improvements in the efficiency of marketing systems. Possible indicators: trends in production and consumption per head, trends in urban market prices

- **Self sufficiency.** Where, as is often the case, the country under review is a net importer of livestock products, the price and quality of the imported product provides a standard for comparison with those of the domestic equivalent. The goal of self-sufficiency depends upon import substitution. Import restrictions, such as tariffs or quotas may be used to protect domestic producers from foreign competition, but have the adverse effects of raising prices and causing welfare losses for society. Direct subsidies to domestic producers may have similar adverse effects. Strategies should therefore be aimed at promoting improved efficiency of production and marketing and raising domestic 'competitive advantage'. Possible indicators: Comparison of enterprise gross margins with those obtained by potential international competitors.

SOCIAL ISSUES

- **Poverty alleviation.** Economic growth is necessary for poverty alleviation, but the benefits to the poor are greater where income is distributed equitably and all income groups are enabled to participate. Thus attention must be given to removing sources of inequality, while targeting development efforts on rural people engaged in agriculture, where the majority of the poor are found. The benefits of agricultural development stem from the relative importance of the sector and the strong consumption and production linkages with other sectors of the economy and the scope for balanced growth. Livestock form an integral part of smallholder mixed-crop-livestock farming systems and contribute to the income and welfare gains resulting from improvements in such systems. Indicators of sources of inequality include relative levels of access, by the poor, to livestock (numbers and types), land and water, new production technologies, information, input and product markets and finance.
- **Disaster risk management.** Livestock producers are at risk from climatic effects such as droughts and floods, human illness and high mortality rates, and frequently from social disputes, cattle raiding and civil disturbance as well as serious endemic disease problems, and transboundary diseases. Information should be gathered on precautionary measures that may be adopted for risk management. Possible indicators: These include livestock insurance (see Chapter 2, Livestock insurance), early warning systems, contingency plans, emergency feeding programmes, establishment of grazing reserves, de-stocking during the crisis or re-stocking after the emergency has ended.
- **Gender.** In most countries, both men and women are involved in livestock production. The allocation of rights, responsibilities and rewards of livestock keeping,

between men and women, is generally governed by traditional, culturally determined customs or rules. Female-headed households, resulting from widowhood, separation or temporary absence of the partner, represent an important group for study. Possible indicators: Comparisons with male-headed households in terms of land-use rights, livestock ownership, by species and numbers and contribution to livelihoods, provide some indications of gender balance. More generally, within families, ownership of livestock by species, responsibilities for husbandry, processing and marketing, participation in decision-making on livestock management and access to produce and income generated, all justify analysis of gender differences.

- **Social impacts.** Livestock are capital assets that may serve social and cultural functions. They have a special role in religious and other ceremonies, participating in displays or processions for instance. Increased demand for livestock for special festivals, such as for poultry at Christmas or for sheep or goats at Id-el-Fitr, have significant impacts on local seasonal markets in many countries. Livestock producers organize the timing of production to correspond with the associated spikes in demand and prices. Ceremonies for child births and weddings may involve the gift of livestock, or the payment of a dowry in the latter case. Livestock ownership, by an individual or family, is an indicator of social status and wealth. This carries with it benefits in market power, for instance in obtaining credit. Livestock may also be provided as loans-in-kind, in which repayment is made by return of the offspring. 'Heifer-in-trust' schemes are of this nature, but loans of small-stock, with shorter generation intervals, are likely to be easier to operate efficiently. Possible indicators: Details of all such social institutions, associated with livestock keeping, should be recorded, where they apply.

ANIMAL HEALTH AND WELFARE

- **Disease prevention and control measures.** Assessment generally involves a project appraisal of the incremental costs and benefits likely to result from a proposed new set of control measures. This involves comparison of the predicted levels of production, and the costs of the new control measures, with those prevailing before the new measures are implemented. Estimates of the impacts of the disease control measures on livestock production require a substantial input of epidemiological modelling. However, the livestock economist's contribution has much in common with that normally provided within a livestock sector review, including the following assessments:
 - i. livestock population affected
 - ii. classification and populations of livestock production systems
 - iii. production parameters of each system (with and without the disease)
 - iv. proportion of animals, in each system, affected by the disease each year.
 - v. costs of current disease control methods in each system
 - vi. a herd/flock growth model to simulate annual livestock production, as affected by the relevant control measures, over a chosen time horizon (e.g. 20 years).

Additional analysis involves:

- vii. Estimation of costs of changing the control measures and disease status
- viii. Estimation of the impacts of the changed disease status on quantity of produce and market prices for the product

- ix. Estimation of the annual incremental costs and benefits (cash flows) over the chosen time horizon.
- x. Assessment may then be based on discounted cash flow analysis of the results, with sensitivity analysis to assess risk.

(List adapted from Rushton 2009)

Note that a closely similar procedure may be used to assess other improvements in production technology.

- **Animal welfare.** A set of five principles, known as the Five Freedoms, form the basis of guidelines, and in some countries legislation, that contribute to animal welfare. Good animal welfare should provide freedom from, (i) hunger and thirst, (ii) discomfort, (iii) pain, injury and disease, and (iv) fear and distress together with (v) freedom to express normal behaviour. High priority problem areas include:
 - a. transportation**, for instance use of public transport, unsuitable vehicles or long distance trekking;
 - b. slaughter**, including pre-slaughter management, for example where animals are dispatched with no prior stunning, for religious reasons or because the necessary equipment is not available;
 - c. access to food and water**, particularly difficult where these resources are scarce;
 - d. handling/herding methods**, culling or disposal of sick or low-value animals and keeping of animals in environments to which they are genetically unsuited. These problems may arise with poultry kept in battery cages, or at very high stocking densities. In Indian Hindu society cows are revered and are not slaughtered for meat. However, in the fast changing urban areas, many cows are abandoned to fend for themselves with corresponding welfare losses. Indicators: Assessments of local stakeholder attitudes, animal welfare standards achieved, relevant institutions and policies should be included in the livestock sector review.

Chapter 4

Conclusions: Future investment and policy options and action plans

The conclusions of livestock sector reviews intended as contributions to thematic reviews of wider development policy issues discussed in Section 3, are likely to be incorporated in the wider policy reviews. Therefore they are not discussed further in this context. However, any livestock sector review focused mainly on the livestock sector should conclude with recommendations regarding the future of the sector, necessary adjustments to policy and legislation, and identification of areas for potential public investment. Further assessment of these policy and investment options is justified in completing the review, although further detailed planning and appraisal should await the launch of the project or programme development and appraisal exercise.

EXPLORATION OF POLICY AND INVESTMENT OPTIONS

- **Translate the review analyses and findings into livestock development options.** The recommendations should be supported by the findings of the review as potential pathways to achievement of the key goals of economic growth, poverty relief and food security. They may include all the main livestock species and production systems, or just one or two that show the most promise. Most livestock interventions fall into five broad areas, (Heffernan *et al.*, 2005).
 - Direct livestock aid.
 - Service delivery.
 - Technical responses to specific production or disease problems.
 - Institutional and capacity building projects.
 - Product value-added or storage/processing and marketing.
- **Use of SWOT analysis.** It may be desirable to present more than one scenario and analyse the trade-offs between them. The analysis may be better focused by using SWOT analysis to analyse the 'strengths, weaknesses, opportunities and threats' of the proposed development options. Potential characteristics for a particular investment option are as follows.
 - *Strengths*: current importance, number of producers, production (quantity and value), consumption and markets, gross margins, experienced labour.
 - *Weaknesses*: Resource constraints, finance, land, possibly labour, low animal productivity.
 - *Opportunities*: Market potential (local, urban or international), new technology, new effective institutions.

- *Threats*: Competing imports, endemic or transboundary disease risks, climatic disasters.
- **Identify the necessary system of interventions.** A series of technical, institutional and financial interventions that are needed to implement the proposed strategies should be identified. Agencies that may be responsible for funding, implementation or research, include the government, private individuals or organizations, donors, non-government organizations, community-based organizations, agricultural research institutes or universities.
- **Discuss potential sources of risk.** Possible threats to the strategy, such as climatic fluctuations, diseases, product or input market collapse, or other institutional failures should be recognized. This involves prediction of the likely consequences, financial, economic, demand for human resources, and environmental, using sensitivity analysis. Suggestions for possible relief measures would also be valuable.
- **Funding and provision for monitoring and evaluation.** Potential sources of funding and arrangements for future monitoring and evaluation should be considered.

PRESENTATION OF FINDINGS

Many of the benefits of conducting a livestock sector review are often lost through poor communication of the findings and recommendations to all stakeholders in the wider community. It is highly desirable that finances and staff time should be provided for the process of dissemination of the review findings and promotion of its main recommendations. The results should be made available, not only to the main clients but also to all potential stakeholders in the livestock industry. However, a proper process of consultation and editing should be followed, with the following stages observed.

- **Interim verbal presentation**, before completion of the study, may be outline or partial results. Useful to get feedback and likely to be essential for a comprehensive review.
- **Draft report**, published electronically – circulation restricted to clients and team members.
- **In country peer reviews**, government (Ministries of Agriculture and/or Livestock Development and of Finance and Planning) and stakeholder in-country workshops and discussions of draft
- **Peer reviews** by members of other relevant organizations
- **Revised, edited report delivered to clients**, who may be FAO, a member country and international financial institutions, possibly with an associated review database; delivered electronically or in hard-copy.
- If clearance is approved, by the host country Government, the **report should be made generally available** (on the web and/or in hard-copy).
- **Dissemination of findings and promotion of action plans.** The publication of the review does not ensure that it reaches, and is discussed and debated by, all the private and public sector stakeholders in the livestock sector. Ideally, if resources are available, focus group discussions, followed by participatory workshops with staff of central and local government, the private sector, academia, donor agencies and key civil society groups, would be beneficial. It may also be advisable to establish a system for monitoring and evaluating progress in implementing the review recommendations.

Chapter 5

Data, information and analytical tools

The material covered in this section spans the subject matter of a number of specialised books. This summary is not intended to provide a guide to carrying out analysis, but simply to present the range of data and analytical techniques that may be involved, and therefore the range of data sources that may be involved and the expertise needed within the review team.

DATA AND INFORMATION REQUIREMENTS

- **Data definitions.** Data, from which information is derived, may be qualitative or quantitative, the former being subjective, verbal and descriptive, the latter being objective, and numerical. Data collection may be subject to formal rules of sampling and statistical analysis, with corresponding substantial resource cost, (see Poate and Daplyn 1993) while informal surveys are normally small, but need to be conducted by skilled and motivated investigators (see Moris and Copestake 1993).
- **Remote sensing and mapping.** A formal method for collecting data on spatial distributions of variables.
- **Primary or secondary sources.** Data gathered by direct measurement, observation or interview are described as 'primary data,' while records from other studies conducted in the past provide 'secondary data'. This report does not cover methods for the formal collection of quantitative primary data, on the assumption that there is rarely time to gather it within the scope of a sector review. However such data may be available from secondary sources. (See Use of secondary sources, below).
- **Different levels of data collection.** Livestock review data are needed at many levels of aggregation, ranging from the micro level, individual animal or bird performance to the macro-level of national quantitative aggregates and policies.
- **Special features of livestock data.** Additional complexity of livestock records is due to: animal mobility (movement traceability may be important), time dependence of production (over seasons and years), reproduction, growth, mortality and morbidity, multiplicity of products and disease threats that may disrupt international trade.
- **Key data attributes.** In relation to the whole data set, these include comprehensiveness (extent to which all livestock species and production systems, all elements of the market chain, all aspects of trade in livestock and their products, public and private institutions relating to the livestock sector, are included), and coverage (extent of geographical areas covered). Other characteristics relate to individual data items or sub-groups. These include accuracy and reliability (depending on methods of collection and analysis), consistency (between and within data sets), cost and time minimization and ease of access.

USE OF SECONDARY SOURCES

- **Sample census and surveys.** These are large scale, and possibly expensive formal studies, unlikely to be included as primary data sources in a livestock sector review. However, results of previous studies, of this type should be accessible as secondary data sources. Strengths lie in their ready availability, scope, and cheapness and, if they are repeated annually, they provide a basis for time-series or trend analysis. Weaknesses arise from the difficulty of validation, inconsistencies between and within samples, and lack of relevant data on some aspects of the livestock sector.
- **Other secondary sources.** A wide variety of other secondary sources include research trials, early warning systems, and biophysical monitoring systems. Remote sensing has become a valuable tool for geographical information system (GIS) mapping of livestock production systems.
- **National sources.** Relevant secondary data should be available from the national statistical office and its official publications. However, these are often out of date and more recent and unpublished data may require search of the 'grey' unpublished documentation in public and private sector offices.
- **International sources.** All these are accessible on the world-wide web although some are derived directly from national sources so are not independently verified.
 - National economic background: World Bank/IMF or United Nations Common Database UNCDB
 - Trade projections: OECD
 - Livestock populations, crop areas, use as feed, production, consumption, international trade: FAOSTAT
 - Maps give spatial distributions: GLIPHA: FAO
 - Disease incidence, World Animal Health Information Database: OIE
 - Labour and employment: ILO
 - Human development indicators: UNDP
 - Public health information: WHO

RAPID ASSESSMENT USING LOCAL INFORMANTS

- **Semi-structured, key informant interviews.** Used to generate in-depth information, normally based on a checklist of key questions, but otherwise subject to free-form discussion. May provide technical, economic and social data.
- **Focus groups.** Group discussions that may be focused on a specific topic, on which key stakeholders serve as 'facilitators' to provide group judgemental assessments. Ideally groups should be small, fewer than 10 participants, but to avoid biases all types of stakeholder should be represented. Careful explanation of the purpose of the meeting is needed together with careful documentation of the narrative process and agreed outcomes.
- **Participatory exercises.** An array of informal visual methods may be used for intensive interaction with local informants. They include production and management calendars, ranking, livelihood changes diagrams, historical trend analysis, community and household resource and rangeland maps, and healthcare provider maps (see Heffernan *et al.*, 2005).

- **Quality control.** A systematic and rigorous approach is needed for all rapid assessment exercises, with purposive sampling used to focus on study of key data strata. A balanced choice of respondents avoids bias. Daily checks must be made by the review team leader to ensure comparability between results and inconsistencies dealt with, possibly by triangulation (using a third estimate to find the median of three).
- **Skills and training.** Professional judgement of the review team is needed in identifying respondents, guiding but not suppressing discussion, encouraging participant contributions, dealing with data inconsistencies, and recording findings. Development of the skills and expertise of the review team, in interviewing and participatory techniques, is desirable and may require training in advance of the review.

ANALYTICAL TOOLS: A SUMMARY

- **Coding and processing data.** Relevant data should be organized, 'cleaned', documented and stored in computer spreadsheets or databases, most commonly Microsoft EXCEL™ and ACCESS™. Quantitative data are set out in a convenient layout for further summary and analysis. Textual qualitative data are more conveniently recorded as coded form, categorized, and may be allocated numerical values – or may be stored as full transcripts using specialized software. Either of these can be time consuming. Visual material, sketch maps and diagrams can be stored as photographs but are less easily stored in a form susceptible to analysis.
- **Sorting and summarizing data.** Numerical data can readily be sorted into categories, summarized to give totals or mean values (note possible use of mode or median) and presented as bar charts or pie charts. Data variation, or spread, are likely to be of interest, measured by variance or, if too few categories, by range.
- **Relationships between variables.** For categorical, discrete variables, cross-tabulations (pivot analysis) may identify relationships, to which non-parametric tests may be applied⁶. For continuous numerical data, relationships between pairs of variables are best explored using scatter plots, for which a regression line of best fit may be added. A measure of the goodness of fit is given by the 'coefficient of determination, R^2 ', which is the proportion of the variation in the dependent variable explained by the regression relationship. For straight line relationships, correlation analysis provides the same information⁷.
- **Time trends.** Time series data are available for many key variables such as human and animal populations, production, national income *per capita*, and volumes of traded commodities. Advanced time-series analysis has become a sophisticated area of econometric research and is not recommended within the confines of a livestock sector review. However, a line graph of annual data is useful in indicating the trend over time. The annual growth rate, g measured over n years, with an initial value of a and an n th year value of b may be calculated as:

$$g = (b/a)^{1/(n-1)} - 1$$

⁶ The test is whether the probability of the null hypothesis (of no relationship) being false is so small as to be unlikely to arise by chance. Some statisticians object to describing this as a test of significance.

⁷ More sophisticated multivariate statistical analysis would require larger samples than are likely to be available, and research time of statisticians.

- **Herd/flock growth models.** A herd-growth model is a mathematical description of the herd structure, in terms of the numbers in each age and sex cohort, together with annual rates of change in numbers due to births, transfers from one cohort to another, and removals due to mortalities and off-take. The resultant equations yield an estimate of the herd structure at the end of the year and thus the annual growth rate (Hallam 1983 or Upton 1989). Such models are readily constructed using a spreadsheet package or purpose-built computer programmes (for instance see LDPS²)⁸ provided that the necessary information on herd structure, reproduction and age-specific mortality rates is available. Estimates have been published for cattle and small ruminants in Sub-Saharan Africa (Otte and Chilonda 2002), but generally local primary sources must be consulted. In order to measure productivity, feed requirements and output, the special case of a steady-state (or zero growth) herd, achieved by adjustment of the off-take rate, should be used.
- **Feed balance models.** A feed balance analysis involves comparison of the annual feed requirements of the livestock population with the estimated availability from domestic production, processing and imports. Feed requirements are estimated from details of the herd and flock structures, outlined above, and the annual nutritional needs per head, quantified in megajoules of metabolisable energy (MJME) or tonnes of dry matter, or alternatively by converting animal or bird numbers into livestock units. Quantities of feeds available, from domestic production and imports are assessed in the same units for comparison (again see LDPS²)⁸ For premixed concentrate feeds, a two-stage process may be needed whereby quantities of concentrates are translated into equivalent quantities of raw materials, cereals and oilseeds (See Annex 2).
- **Livestock enterprise gross margins.** An enterprise gross margin is measured as the enterprise gross output (value of production) minus the associated variable costs, and indicates the net contribution to farm household income (see Annex 3 below). The results are normally presented as the annual average per breeding female for breeding herds/flocks or per head of fattening stock. Measurement of gross output includes not only production of milk or eggs, and young stock plus other non-food products, but also the increase in weight and value (appreciation) of young-stock and the annual loss in value (depreciation) of breeding stock. Alternatively, estimates may be obtained from steady-state herd/flock growth models together with price estimates. The main items of variable cost are feed and veterinary expenses. Feed costs may be estimated from feed balance models, together with price data. Once they have been calculated, gross margin estimates are useful for partial budgeting, for instance in comparing the economics of alternative production systems⁹.
- **Value chain analysis.** These are analyses of the whole marketing system from input suppliers, upstream of the livestock producer, to downstream participants, agents dealers, processors and retailers. The initial procedure followed involves i) identifica-

⁸ This programme may be accessed at www.fao.org/agriculture/lead/tools/livestock0/en/

⁹ A further step might be to complete a **Policy Analysis Matrix**, by including an estimate of the unit fixed costs (or domestic resource costs) and estimating how the values of outputs and costs would differ at world price equivalents. This might give useful indications of the competitive advantage of domestic producers.

tion of the main participant individuals and organizations, ii) determining the main routes, linking different participants and iii) illustrating the resultant chain graphically. The chain diagram may be labelled to show a) numbers, or proportions, of producers using each route, b) volumes of the product moving through each route and c) money values or value added to the produce at each stage of the chain. Value chain analysis is useful in revealing strengths and weaknesses in market performance, competitiveness, market margins, economic returns at each stage, food security (see Silva and Souza Filho 2007). Further analysis of the 'transactions costs' of doing business, namely i) gaining information prior to making deals ii) negotiating contracts and iii) monitoring and enforcing implementation of the exchange, throws more light on market shares, equity, technical and operational efficiency and consumer satisfaction.

- **Value chain governance.** The term 'governance' is used to denote the ways in which transactions, at different points in the chain, are conducted. The choice of type of contract influences the transactions costs, market efficiency and equity. Alternatives range from simple face to face exchanges, through an array of different types of informal or formal contract, to vertical integration and amalgamation of activities into a single organization (Humphrey and Napier 2005). In most countries, direct public sector involvement in the provision of marketing services has ended, but the government still has a role in providing the institutional, legal and regulatory framework for efficient market operation. This includes dissemination of information to the public, legal enforcement of contracts, and promotion of food safety and quality standards. However, policies and regulations, that are badly designed or administered, act as barriers to efficient market operation and require amendment. Choice of an appropriate form of contract depends upon i) the degree of uncertainty surrounding the transaction, ii) the frequency of the transaction and iii) the asset specificity, meaning the extent to which the contracting agents have invested in specialised assets. An increase in any of these characteristics is likely to motivate use of tighter controls through relational and long-term formal contracts. Thus the owner of a poultry abattoir and processing plant is likely to seek long-term, formal supply contracts with poultry growers, and vice versa. It is suggested that 'analysis of "non-standard" governance structures, therefore, should:
 - Define the attributes of the transactions in question in terms of asset specificity, uncertainty and frequency.
 - Describe the incentive and adaptive attributes of alternative governance structures.
 - Decide whether the observed structures are functioning to reduce transaction costs and, therefore, to promote trade or are primarily exploitative or otherwise inefficient. (Dorward, Kydd and Poulton 1998).
- **Risk analysis.** Risk is the chance of encountering some form of harm, loss or damage, and has two components, namely the probability of the harmful occurrence and the consequences if it occurs. Animal disease is one of the main causes of risk for stakeholders in the livestock sector, for the analysis of which epidemiologists use both qualitative and quantitative methods (OIE 2004a and b). While quantitative analysis, involving estimates of probabilities, costs and benefits, is unlikely to be justified in a livestock sector analysis, qualitative methods of hazard identification,

scenario tree mapping and risk assessment may well be useful. The Hazard Analysis Critical Control Points, where infection may occur, are likely to correspond with transactions in the market value chain. Although designed for disease control planning, the broad approach could be applicable to risks of market, institutional or personal disturbances. More information should be gathered on stakeholder vulnerability and coping strategies and public sector support policies.

- **Saving quantitative data and models.** Many of the data and analyses used in a Livestock Sector Review are not fully reported in the final review document. However, if they are saved in a suitable computerised database or workbook, they may be of value for future studies and as secondary sources of information. Effective usage depends upon their accessibility, clear user-friendly presentation and details of data sources and modelling procedures. Depending on the complexity of these procedures, a users' manual may be required. Preparation of a database and user instructions for new software, with example case-studies, requires additional time and expert resource inputs, with associated costs, beyond those needed for data recording and simple programming. The successful use of new computer models will also depend on their complexity and the experience of national staff.

Bibliography

- ARD.** 2006. *Enhancing Control of Highly Pathogenic Avian Influenza in Developing Countries through Compensation: Issues and Good Practice*. Agriculture and Rural Development, Washington D.C.: The World Bank, Rome: FAO, Nairobi: IFPRI, Paris, OIE.
- Dorward, A., Kydd, J. & Poulton, C. (Eds.)** 1998. *Smallholder Cash Crop Production under Market Liberalisation*. Wallingford CAB International
- FAO.** 2009. *The State of Food and Agriculture Part I, Livestock in the Balance*. Rome: FAO
- Goodland, A.** 2010. *Mongolia Livestock Sector: challenges and options. Findings from World Bank projects and analytical work Andrew Goodland*. Power point presentation. http://Siteresources.worldbank.org/INTMONGOLIA/Resources/Mongolia_Livestock_Sector.eng.pdf
- Hallam, D.** 1983. *Livestock development planning: a quantitative framework*. Centre for Agricultural Strategy, University of Reading. CAS paper 12.
- Heffernan, C, Nielsen, L., Sidahmed, A. & Miah, T.** 2005. 'Labour development and poverty' in E. Owen, A. Kitalyi, N. Jayasuriya and T. Smith (Eds.) *Livestock and Wealth Creation: (Improving the husbandry of animals kept by resource-poor people in developing countries*. Nottingham University press
- Humphrey, J. & Napier, L.** 2005. *The value chain approach as a tool for assessing distributional impact of standards on livestock markets: guidelines for planning a programme and designing case studies*. FAO AGAVESC initiative on market exclusion. Rome: FAO and Brighton: IDS
- Livestock, Environment and Development Initiative.** 2005. *Tropical Livestock Units*. <http://www.virtualcentre.org/en/dec/toolbox/Mixed1/TLU.htm#What>
- Moris, J. and Copestake, J.** 1993. *Qualitative Enquiry for Rural Development: A Review*. Intermediate Technology Publications, London.
- Nell, A.J.** 2006. *Quick Scan of the Livestock and meat Sector of Ethiopia: Issues and Opportunities*. Wageningen International.
- OIE.** 2004a. *Handbook on Import Risk Analysis for Animals and Animal products*. Vol. 1: Introduction and qualitative risk analysis. Paris: World Organisation for animal health
- OIE.** 2004b. *Handbook on Import Risk Analysis for Animals and Animal products*. Vol. 2: Quantitative risk analysis. Paris: World Organisation for animal health
- Otte, M.J. & Chilonda, P.** 2002. *Cattle and small ruminant production systems in sub-Saharan Africa: a systematic review*. Livestock Information Sector Analysis and Policy Branch, AGAL, FAO, Rome 98 p TC/D/Y4176e/1/10.02/1000
- Poate, C.D. & Daplyn, P.F.** 1993. *Data for Agrarian Development*. Wye Studies in Agricultural and Rural Development. Cambridge University Press.
- Porter, M.E.** 1998. *The Competitive Advantage of Nations: With a New Introduction* (2nd Edn.). Basingstoke and New York: Palgrave
- PPLPI.** 2006. Economic growth, poverty reduction and the livestock sector: Development of a methodological guide to the appropriate inclusion of the livestock sector in PRSPs. Draft 3, December 7, Alive, PPLPI

- Rhissa, Z.** 2007. III Livestock Sub-Sector, in *National Programme for Food Security (NPFS) for Liberia*. CAAS-Lib Sub Sector Reports, Vol 2.1. Rome: FAO
- Rich, K.M., Baker, D., Negassa, A. & Ross, R.B.** 2009. *Concepts, applications, and extensions of value chain analysis to livestock systems in developing countries*. Contributed Paper prepared for presentation at the International Association of Agricultural Economists Conference, Beijing, China, August 16-22, 2009
- Rushton, J., Viscarra, R., Guerne-Bleich, E. & McLeod, A.** 2005. Impact of avian influenza outbreaks in the poultry sectors of five South East Asian countries (Cambodia, Indonesia, Lao PDR, Thailand, Vietnam): outbreaks, costs, responses and potential long-term control. *World Poultry Science Journal* 61 (13) 491-514
- Rushton, J.** 2009. *The Economics of Animal Health and Production*. CABI, Wallingford
- Sharma, A.** 2009. *Livestock Insurance in India: A Sector review*. Power point presentation. Center for Insurance and Risk Management, India. Adobe acrobat document. Session2_Livestock_Insurance
- Silva, C.A. & Souza Filho, H.M.** 2007. *Guidelines for rapid appraisals of agrifood chain performance in developing countries*. Agricultural Management, Marketing and Finance Occasional Paper 20, Rome: FAO <http://www.fao.org/docrep/010/a1475e/a1475e00.htm>
- Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. & de Haan, C.** 2006. *Livestock's long shadow: environmental issues and options*. Livestock, Environment and Development (LEAD) Initiative. Rome: FAO <http://www.fao.org/docrep/010/a0701e/a0701e00.HTM>
- Steinfeld, H. & Opio, C.** 2009. *Measuring productivity growth in the livestock sector*. SOFA 2009 background paper. Unpublished. Rome.
- Stür, W., Gray, D. & Bastin, G.** 2002. *Review of the Livestock Sector in Lao People's Democratic Republic*. ILRI, Manila, Philippines for Asian development Bank
- Touré, M.M., Alassane, M., Khibé, T., Diall, M., Touré, O.B., & Diakite, L.** 2009a. *Développement de l'élevage et réduction de la Pauvreté au Mali: Diagnostic de la situation de l'élevage*. Partenariat pour le développement de l'élevage, la réduction de la pauvreté et la croissance économique en Afrique. Alive (African livestock development Initiative). Ministère de l'Elevage et de la Pêche: République du Mali
- Touré, M.M., Diakite, L., Touré, O.B., Diall, M., Khibé, T. & Alassane, M.** 2009b. *Développement de l'élevage et réduction de la Pauvreté au Mali: Plan d' Action*. Partenariat pour le développement de l'élevage, la réduction de la pauvreté et la croissance économique en Afrique. Alive (African livestock development Initiative). Ministère de l'Elevage et de la Pêche: République du Mali
- Upton, M.** 1989. Livestock Productivity Assessment and Herd Growth Models. *Agricultural Systems* 29, 149-164
- Upton, M.** 1993. Livestock Productivity Assessment and Modelling. *Agricultural Systems* 43, 459-472
- World Bank.** 1998. *India Livestock Sector Review: enhancing growth and development*. Washington D.C.: World Bank, Mumbai, India: Allied Publishers
- World Bank.** 2006. *Kyrgyz Republic Livestock Sector Review: Embracing New Challenges*. Washington D.C.: The World Bank

World Bank. 2009. *Minding the Stock: Bringing Public Policy to bear on Livestock Sector development*. Report No 44010-GLB Agriculture and Rural Development Department. Washington D.C.: The World Bank

World Bank & DfID. 2010. *Practitioners' Toolkit for Agriculture Public Expenditure Analysis*. Washington D.C.: World Bank and London: DfID
<http://Draft-Agriculture PER Toolkit-06-16-10.pdf>

Additional sources not cited

- Blench, R., Chapman, R. & Slaymaker, T.** 2003. *A study of the Role of Livestock in Poverty Reduction Strategy Papers*. PPLPI Working Paper No. 1, Rome: FAO
- Chilonda, P. & Otte, J.** 2006. Indicators to monitor trends in livestock production at national, regional and international level. *Livestock Research for Rural Development* 18(8) <http://lrrd.org/lrrd18/8/chil18117.htm>
- FAO.** 2005. *Uganda: Livestock Sector Brief*. Livestock Information, Sector Analysis and Policy Branch (AGAL) FAO: Rome
- FAO.** 2008. *Poultry in the 21st Century: avian influenza and beyond*. Proceedings of the International Poultry Conference, held 5-7 November 2007, Bangkok, Thailand. Edited by O. Thieme and D. Pilling. FAO Animal Production and Health Proceedings, No. 9. Rome <http://www.fao.org/AG/againfo/home/events/bangkok2007/en/background.html>
- IEPC.** 2002. *Republique Islamique de Mauritanie. Initiative 'Elevage, Pauvrete et Croissance' (IEPC). Document National 2002*. World Bank and FAO
- Kamuanga, M.J.B., Somda, J., Sanon, Y., & Kagoné, H.** 2008. *Livestock and regional market in the Sahel and West Africa: Potentials and Challenges*. SWAC-OECD: Paris-Cedex, France
- Knips, V.** 2004a. *Review of the Livestock Sector in the Mekong Countries*. Livestock Sector Report Cambodia, Lao PDR, Thailand, Vietnam., AGAL, Rome: FAO
- Knips, V.** 2004b. *Review of the Livestock Sector in the Horn of Africa. (IGAD) countries*. Livestock Sector Report, AGAL, Rome: FAO
- Landes, M., Persaud, S. & Dyck, J.** 2004. *India's Poultry Sector: Development and prospects*. Market and Trade Economics Division, Economics Research Service, US Department of Agriculture, USDA: Washington D.C.
- McLeod, A. & Chilonda, P.** 2004. *Mission report of an assessment of the livestock sub-sector in Zambia, with special reference to policies*. Livestock Sector Report, AGAL, Rome: FAO
- MLD.** 2006. *National Livestock Policy* The United Republic of Tanzania, Ministry of Livestock Development. Dar Es Salaam: Tanzania
- NATHAN: EME.** 2009. *Zambia, Jobs, Prosperity & Competitiveness: What would it take for the Cattle Industry to achieve its potential?* Nathan Associates Inc. and Emerging Market Economics for World Bank, DfID & AfDB. [Cattle_Report_FINAL.pdf](#)
- PAN Livestock Services.** 1991. *The Livestock Production Efficiency Calculator. User Guide*. PAN Livestock Services, School of Agriculture, Policy and Development, PO Box 236, Reading RG6 6AT, UK
- Peeler, E.** 1996. *Manual of Livestock Production Systems in Kenya*. KARI/ODA Livestock Socio-Economics and Epidemiology Project, KARI, Nairobi, Kenya
- Pica-Ciamarra, U., Otte, J. & Martini, C.** 2010. *Livestock Sector Policies and Programmes in Developing Countries: A Menu for Practitioners*. PPLPI, Rome: FAO

- Prise.** 2008. *A General Review and a Description of Poultry Production in Vietnam*. Research Consortium on risks associated with Livestock Intensification (PRISE), CIRAD: Montpellier
www.prise-pcp.org
- Ramnath, N.** 2003. *Outlook for the Indian poultry Sector*. Rabobank International
- Silva, J.F.** 2005. *Brazil Poultry and Products: Annual Poultry Report 2005* GAIN Report No. 5620, Global Agricultural Information Network, USDA foreign Agricultural Service

Annex 1

Livestock unit coefficients that can be used for international comparisons

Region	Cattle	Buffalo	Sheep	Goats	Pigs	Asses	Horses	Mules	Camels	Chickens
Near East North Africa	0.70	0.70	0.10	0.10	0.20	0.50	0.40	0.60	0.75	0.01
North America	1.00		0.15	0.10	0.25	0.50	0.80	0.60		
Africa South of Sahara	0.50		0.10	0.10	0.20	0.30	0.50	0.60	0.70	0.01
Central America	0.70		0.10	0.10	0.25	0.50	0.50	0.60		0.01
South America	0.70		0.10	0.10	0.25	0.50	0.65	0.60		0.01
South Africa	0.70		0.10	0.10	0.20	0.50	0.65	0.60		0.01
OECD	0.90	0.70	0.10	0.10	0.25	0.50	0.65	0.60	0.90	0.01
East and South East Asia	0.65	0.70	0.10	0.10	0.25	0.50	0.65	0.60	0.80	0.01
South Asia	0.50	0.50	0.10	0.10	0.20	0.50	0.65	0.60		0.01
Transition Markets	0.60	0.70	0.10	0.10	0.25	0.50	0.65	0.60		0.01
Caribbean	0.60	0.60	0.10	0.10	0.20	0.50	0.65	0.60		0.01
Near East	0.55	0.60	0.10	0.10	0.25	0.50	0.56	0.60	0.70	0.01
Other	0.60	0.60	0.10	0.10	0.20	0.50	0.65	0.60		0.01

Annex 2

The development of feed balances for livestock

INTRODUCTION

It is predicted that the world's population will increase by 2.3 billion over the next 20 years, and that this will be accompanied by an increase in the demand for animal products, namely milk, meat and eggs. A structured approach to planning for this increase in demand will be necessary if demand is to be met cost-effectively, with minimal social disruption and with minimal environmental impact. Part of this process requires an assessment of the available feedstocks and the requirements of the current livestock population, and this can be achieved by developing a livestock feed balance. Having done this, it is then possible to identify limitations to current levels of production and estimate the feed requirements for increasing production. A livestock feed balance can be undertaken at a local, regional or national level depending on policy requirements and the degree of accuracy required.

At its simplest level, a feed balance is a comparison between the requirements of livestock at any given time (demand) and the amount of utilisable feed (supply), and therefore provides a 'snapshot' of the current situation. However, a feed balance can also identify potential shortages in feed to meet increasing demand for food, and help identify types of feed materials that might be required where shortfalls are identified. Alternatively, where a feed balance identifies a surplus of feed, it can be used to estimate the additional livestock production that the surplus might support.

This approach may also be undertaken to develop balances for specific nutrients. For example, phosphorus (P) is an essential nutrient that is often deficient in livestock diets, leading to reduced productivity and fertility. A phosphorus balance for a particular area or country can help identify where or when deficiencies might occur, and identify where and how much additional P may be needed to meet livestock needs and productivity targets.

Feed balances are usually calculated on an annual basis and since many feed crops, such as cereal grains, have an annual production cycle with one harvest this may be appropriate. However, there is no reason why a feed balance may not be done over a shorter period, and indeed there may be advantages in doing so in certain circumstances. For example, if there are periods of the year when the amount of natural grassland available for grazing animals is low, it may be appropriate to prepare a feed balance for those periods in order to establish the maximum potential livestock carrying capacity of a particular region when feeds are in limited supply. However, since the production cycles of many livestock systems do not equate to one calendar year, it is necessary to make adjustments to the feed balance to take account of the length of a particular cycle. For example, the cycle for growing and fattening pigs from weaning to slaughter may be only about 20-24 weeks on intensive pro-

duction systems, but this may be followed by a period when the fattening house is empty to allow for cleaning and general maintenance before the next feeding period begins. If a feed balance is being prepared on an annual basis, it will be necessary to include both the length of the production cycle and the non-productive periods in calculating annual feed requirements and livestock production.

In order to produce a feed balance, two sets of data and a number of processes need to be completed, and these are described below.

STEP 1: ESTIMATING FEED SUPPLY

Estimates of feed supply should be based on local, regional or national inventories. There has been considerable progress in developing techniques to estimate feeds available, and in particular forages. The merits or limitations of these are not discussed here, but depending on the specifications of the inventory and the way in which the available forages are quantified, it may be necessary to make adjustments for the following:

- Seasonality of supply
- Feed losses

Seasonality of supply: For many livestock, the availability of feeds may be reasonably consistent throughout the year. This will particularly apply to feeds such as cereal grains and conserved forages, where feeds can be stored without deteriorating in quality. However, in many regions a significant proportion of livestock, particularly ruminants, are kept under extensive farming systems, where the main or only feed may be native pasture. Seasonal changes in climate and growth stages of plants culminate in an annual cycle of forage production that peaks during the wet period and is severely limited during the dry period. As a result there may be periods of the year when grazing livestock are often unable to satisfy their nutritional requirements, resulting in lower growth rates and reproduction. It is important that where *annual* feed inventories are used, they are adjusted to take account of the peaks and troughs in supply relative to livestock numbers and their feed intake. Unless surplus feeds are conserved, e.g. forages conserved as silage or hay, then failure to do so may result in an over-prediction of available feed.

Feed losses: Despite the best husbandry and feed management practices, losses do occur; these are usually associated with harvesting and storage and in some circumstances these may be considerable. Some losses are inevitable, for example those associated with conserving forages (as silage or hay), where 30% or more of the dry matter may be lost as a result of field, storage and feeding out losses. Poor storage conditions for cereal grains, nuts and other crops can result in losses due to pest infestations and fungal contamination. Not only do they result in direct dry matter loss, but many are associated with the transfer of disease or production of toxins. Again, failure to adjust a feed inventory for these losses may lead to an overestimate of feed available.

In addition to forages, livestock are fed a wide variety of feeds. These may include cereal grains and co-products of cereal processing, oilseeds and oilseed meals derived from them, co-products of brewing and distilling, legume seeds, feeds derived from the manufacture of human food and animal products such as fish meal and processed animal proteins; collectively these are often termed "concentrates". In addition tubers or root crops such as cassava, and co-products derived from processing such as sugar beet pulp, are frequently

important feeds. Information on the quantities of these used in animal feeds may be obtained from a number of sources including import statistics, production records from compound feed manufacturers and feed merchants.

As with forages, some losses are inevitable as a result of transport, manufacture and storage, and it is important to include an estimate of these in any feed balance calculations.

STEP 2: QUANTIFICATION OF HERD /FLOCK NUMBERS AND PRODUCTION TRAITS

In order to estimate the demand for feed, an estimate of the number of livestock in a region or country is needed. Where regional or national statistics are available, these should be used. However, in some situations reliable data may not be available, in which case best estimates should be obtained based on local knowledge of livestock production systems.

Many feed and nutrient balances are based on census data, which provide an indication of livestock numbers at a given time. However, livestock numbers within a region might fluctuate considerably during the course of the year, and as a result the use of data derived at one particular point in time may be misleading when applied to a full year. Where this is the case, adjustments in estimates of livestock numbers will need to be made, again based on local knowledge¹⁰.

In addition to data on livestock numbers, some estimate of productivity is required so that the amount of feed required to provide energy demands for maintenance, pregnancy and production can be calculated. For growing and fattening cattle, sheep, goats, pigs and meat poultry (e.g. broilers, ducks) this will require estimates of daily liveweight gain. In addition, data on the output of livestock products (eggs, milk and fibre, or wool) are necessary, while for reproductive (breeding) animals data on numbers of offspring are also required. In summary, production data are required to show:

- Productive life of mature animals;
- Numbers of animals at the beginning and end of the feed balance period (usually the beginning and end of the year);
- Herd or flock production as measured as;
 - Calving/lambing/kidding/farrowing frequency
 - Lactation length
 - Milk production
 - Liveweight gain
 - Output of animal products (milk, meat, eggs, wool)
- Adjustments necessary to account for climatic extremes or physical activity.

For most feed balances, it is sufficient to provide estimates of liveweight gain and product production in terms of their weight. Where data are available to show that milk composition varies significantly from the breed average, then information on the composition of milk, and in particular the fat and protein contents, should be used, since energy requirements vary for milk of different composition. If detailed nutrient balances are being undertaken, for example to establish a nitrogen balance, then data on the composition of animal products and liveweight gain will be necessary. In most cases, standard values for the composition of gain and livestock products will suffice.

¹⁰ In particular, for species such as pigs and poultry where several batches of young are produced annually per breeding sow or hen, numbers produced differ substantially from the census populations

STEP 3: ESTIMATING FEED REQUIREMENTS

Feed materials vary significantly in their concentration of nutrients, and the contribution they make to meet the requirements of livestock. Energy is usually the first limiting component in livestock diets, and for this reason feed balances are normally calculated in terms of the energy required by livestock and the energy supplied by feeds. Therefore the next step is to estimate the energy needed by the livestock identified in Step 2.

For each class of livestock, it is necessary to calculate the energy requirements for

- Maintenance;
- Pregnancy;
- Production (e.g. milk yield, liveweight gain, number of eggs produced); and
- In some situations, it may also be necessary to make adjustments for exercise and for extremes of climate (heat or cold), and for exercise where this is significant.

There is no one internationally accepted unit of energy, and different energy systems have been developed for different livestock groups. For ruminants, metabolisable energy (ME) is widely used as the measure of feed energy, while net energy (NE) values (expressed as either MJ or Mcal) are used in Germany, Switzerland, Netherlands, Denmark, France, Ireland and North and South America. In principle, there is no difference between the ME and NE systems; both accept that the overall energy requirement is the sum of their energy needed for maintenance, production (milk and liveweight gain) and foetal growth. However, they differ in where the energetic efficiencies are embodied within the calculation. In the ME system the energetic efficiencies are used for ration formulation and the prediction of animal performance, while in the NE system the efficiencies are included as part of the energy evaluation of feeds.

For pigs and poultry, digestible energy (DE), metabolisable energy (ME) and net energy (NE) systems have all been proposed and are used in different countries. There have been long lasting debates as to the merits of each system, but in practice differences between systems in estimating total energy requirements for livestock are relatively small.

It is not the purpose of this paper to review these various systems or to pass judgement on their relative merits. What is important is that the system chosen is one which includes both estimates of requirements for the livestock production in the region/country concerned, and provides tables of feed composition that are appropriate for the feeds that are available in the region or country in question. It is also important that the system chosen is one that the user is most familiar with and feels competent in working with.

Systems providing both the nutrient requirements of livestock and the composition of feeds have been published by a number of national authorities, some of which are given at the end of this chapter. In addition, a number of breed companies provide nutrient requirements for livestock for particular strains or breeds.

Using the data on livestock numbers, together with information on reproduction rates and productivity, e.g. eggs produced, numbers of pigs sold or the amount of milk produced, the energy requirements can be calculated. This can be done on a daily basis and scaled up to provide an annual estimate. Alternatively, where production data, are available for a region or country, it is possible to calculate energy requirements on an annual basis. It can be done for an individual flock or herd, or on a regional or national basis depending on the scale of the feed balance, the need for precision and the data are available.

Reference has been made to the publications that provide energy requirements of livestock. While it is recommended that these be used, where possible, for producing detailed feed balances, the following can be taken as indicative values for planning purposes.

Pigs

Energy required for growth at different live weights ¹ :	25 kg	22 MJ ME/day
	60 kg	34 MJ ME/day
	90 kg	40 MJ ME/day
Energy required for pregnancy:		3,280 MJ ME per sow (total)
Energy required for lactation:		2,565 total ² per litter (total)

Poultry

Laying hens: 52 weeks of lay, 340 eggs:	430 MJ ME/bird
0-17 weeks (pre-laying)	72 MJ ME/bird
Meat chickens (broilers) to 6 weeks (LW ♀2.3 kg, ♂2.7kg):	54 MJ ME/bird

Ruminants

	Sheep	Goats	Cattle
	MJ ME/kg LW/year		
Energy required for maintenance	Liveweight, LW (kg)		
	30	66	77
	40	65	71
	50	58	68
	60	55	65
	70		63
	100		63
	200		51
	300		45
	400		41
			39
	MJ ME/kg LW gain/day		
	< 3 months		
	> 3 months		
Energy required for gain	< 6 months		26 - 34
	> 6 months		41 - 49
	< 1 year		19 - 26
	> 1 year		32 - 42
	Energy required for pregnancy	1,480 MJ ME per ewe (total) ³	2,150 MJ ME per dam (total) ⁴
Energy required for lactation	2,160 MJ ME total ⁶	5.1 MJ ME/litre	5.3 MJ ME/litre ⁷

¹ Derived from NRC (1989) Nutrient Requirements of Swine.

² Assumes a weaning age of 40 days

³ Assumes a 60 kg ewe carrying twins

⁴ Assumes dam carrying twins (total birth weight 7.9 kg)

⁵ ME requirements for maintenance and pregnancy of a 600 kg housed, pregnant, non-lactating cow gaining 0.5 kg/day liveweight in addition to the foetus for a 40 kg calf.

⁶ Assume a lactation of 3 months; milk requires 4.7 MJ/litre

⁷ For standard milk containing 4% fat and 3% protein.

It must be stressed that the values above are indicative only, and that anybody compiling a feed balance database is strongly encouraged to refer to tables of nutrient requirements in the publications listed at the end of this chapter.

STEP 4: ESTIMATING ENERGY SUPPLIED FROM AVAILABLE FEEDS

The previous steps have allowed us to estimate the energy requirements of the herd or flock on a farm or on a regional or national basis. Since most feed inventories describe the amount of feed available in terms of dry matter (DM¹¹), it is necessary to convert this to the same energetic terms, i.e. MJ ME or NE in the case of ruminants, or ME or DE for pigs or poultry. Again, these should be expressed on a DM basis. Tables of feed composition and nutritive value are widely available, and these should be used to calculate the amount of energy provided by the feeds available.

However, the intake of feeds is not unlimited, and in order to get an accurate estimate of the contribution that feeds make in meeting the nutritional needs of livestock it is necessary to include an adjustment to allow for variations in intake.

Despite the considerable research that has been undertaken to identify the factors that determine how much feed an animal will consume, experts are not in agreement about the mechanisms that control intake. It is clear, however that a wide range of animal, feed and management characteristics influence intake. These include

- The breed or strain or the animal/bird;
- Age/weight;
- The nutrient balance of the diet;
- Accessibility to feed;
- Health and welfare status;
- Ambient temperature; and
- Production level

In all livestock systems, the optimum feed intake will depend on the commercial goals of the enterprise within the constraints of the maximum potential intake of the animal or bird.

Where there is good access to feed, and health and welfare are optimum, then pigs and poultry would be expected to consume about 4-4.5% DM of their body weight per day as young stock, reducing to 3% of body weight in mature animals.

For ruminants, maximum DM intake is also likely to be 4% of body weight in young animals, declining to 2-2.5% in mature animals. However, where forages are the main or only feed, *voluntary* intake will be significantly influenced by the digestibility of the feed. Low digestibility feeds take longer to progress through the digestive tract, and as a result low digestibility is reflected in lower intakes.

In order to complete a feed balance, it is necessary to have an estimate of feed consumed, and the energy provided by it. However, predicting the intake of forages by ruminants has proved to be particularly challenging. A number of theories and equations have been developed to predict intake, many of them based on the digestibility of the forage, the amount of any supplementary feed, e.g. concentrate feeds, and the level of production. While they may be appropriate to use in many situations, an alternative approach for

¹¹ This is the weight of feed after all moisture has been extracted.

a feed balance is to use a form of reverse-balance calculation. Using this approach, the energy required for a given level of production – growth rate, milk yield, calves born etc. – is calculated. This is then divided by the energy concentration of the forage, after any energy provided by supplementary feeds has been discounted. This is illustrated below, for a lactating dairy cow.

- i. Energy required for maintenance and production = 190 MJ ME/day
- ii. ME provided by compound feed 1.8 kg DM at 12.5 MJ/kg DM = 22.5 MJ ME/day
- iii. Energy from forages = $190 - 22.5 = 167.5$ MJ/day
- iv. ME content of forage = 10.5 MJ ME/kg DM
- v. Forage DM intake = $167.5/10.5 = 15.9$ kg DM/day

In this example, dry matter intake is predicted as 15.9 kg/day but as discussed above it is necessary to allow for losses, and the estimate of the amount of feed required to sustain this level of production would need to be increased to adjust for these.

This approach can be used to calculate intakes on a daily basis for an individual animal, as illustrated above, but it can also be done for a herd of animals and on a monthly or annual basis. The choice will depend on the quality of the data available and the degree of precision required, although it should be noted that an annual estimate could lead to misleading conclusions where there is large seasonal variation in the amount of forage available. This approach can equally be used to make estimates of forage consumed on a regional or national basis, where data on the total output of milk or meat are available and the numbers of offspring produced are known. This approach is particularly appropriate for uniform categories of livestock such as lactating dairy cows or milking goats.

RECONCILIATION

Having established quantities of feed materials available and feed required by livestock, a surplus or deficit can be calculated. A surplus may suggest the potential for further livestock production, although it is important to establish when and where the surplus occurs. A surplus of forages during a brief period of the year or in an area not suitable to livestock production may not be fully utilisable unless livestock can be temporarily moved to the area. Alternatively, it may be possible to conserve the forage as silage or hay and used it to supplement grassland when growth is low. In the case of a deficit, this can be rectified by increasing crop production or improving the efficiency of conservation of surplus forages, by the purchase of feeds or a reduction in numbers of animals.

Although this analysis can be completed at a national level, greater accuracy will be achieved if it is done at local or regional levels and the results consolidated. Because of the different feeds for ruminant and non-ruminant livestock, it is recommended that reconciliations are done separately for each species before producing a national feed balance.

The following is a list of a number of national publications providing data on nutrient requirements and feed composition for livestock.

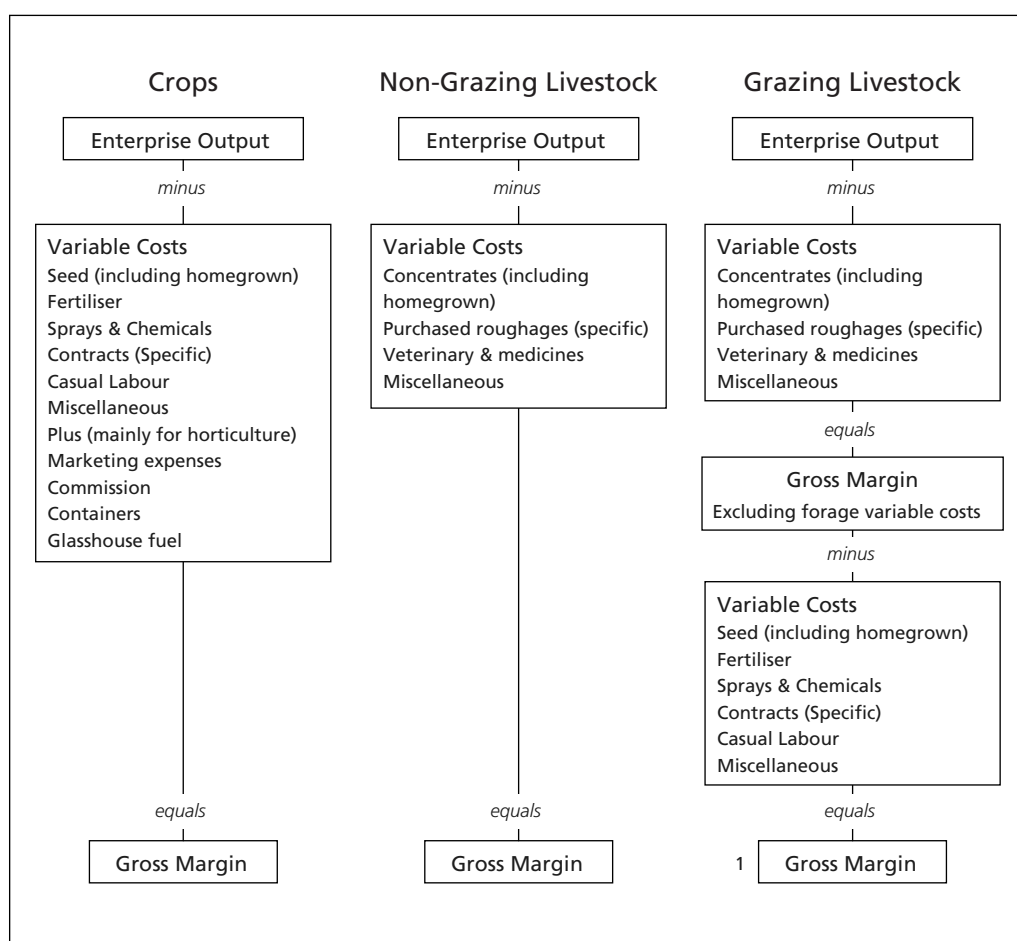
- AFRC** (1993). *Energy and Protein Requirements of Ruminants*. An advisory manual prepared by the AFRC Technical Committee on Responses to Nutrients. CAB International, Wallingford, UK
- ARC** (1980). *The Nutrient Requirements of Ruminant Livestock*. Commonwealth Agricultural Bureaux, Farnham Royal.
- CSIRO** (2007). *Nutrient Requirements of Domesticated Ruminants*. CSIRO Publishing, Collingwood, Australia.
- INRA** (1978). *Alimentation des Ruminants* (Ed. R Jarrige). INRA Publications, Versailles.
- NRC** (1985). *Nutrient Requirements of Sheep* (6th edition). National Research Council. National Academy Press, Washington, DC.
- NRC** (1998). *Nutrient Requirements of Swine* (10th Revised edition). National Research Council. National Academy Press: Washington, DC.
- NRC** (2001). *Nutrient Requirements of Dairy Cattle* (7th Revised edition). National Research Council. National Academy Press: Washington, DC.
- NRC** (2006). *Nutrient Requirements of Small Ruminants*. National Research Council National Academy Press, Washington, DC.

In addition, livestock breeding companies frequently publish tables on nutrient requirements for specific breeds and strains of livestock.

Annex 3

Determination of gross margins for crops, non-grazing livestock and grazing livestock

(from MAFF, 1980, p.7)



Annex 4

Productivity measurement

Productivity, normally defined as the ratio of output per unit of input, is a measure of technical efficiency. However, it is only useful as a guide for choosing between alternative uses of resource inputs if the output scale reflects a desired objective (for instance kg of meat or of animal protein or net revenue) and the selected input represents a limiting resource constraint (animals, grazing land or feed) (Upton 1989). Although the productivity concept is widely used for assessment of national or even regional industry- or economy-wide performance, within the livestock sector estimates of outputs, inputs and productivity are generally based on the annual averages for a flock or herd.

A simple and obvious measure of meat output, of pigs for instance, is provided by data on the annual quantity of pig meat production, in metric tonnes. This can be further subdivided into the number of pigs slaughtered, the 'off-take', and the average carcass weight per pig. The corresponding productivity measures, after dividing by the pig population, are annual production per pig and annual off-take *per* pig. Similar productivity measures may be estimated for other livestock species, the necessary national-level data being available on databases such as FAOSTAT.

Comparability between different animal species may be improved by using Livestock Units, rather than animal numbers, as the denominator, but problems arise in measuring total output when there are joint products, such as milk and meat or eggs and meat. These problems may be met by adopting the biomass–food productivity (BFP) indicator (Steinfeld and Opio 2009). BFP for a herd or flock is given by the annual output in protein divided by total biomass in the herd or flock, all expressed in kilograms. This assumes that mass of animal protein is the most desired livestock product, while livestock biomass is used rather than Livestock Units as the common denominator for different livestock species.

A limitation of this and other measures discussed so far, is that only food outputs from a herd are considered, while non-food outputs, such as draught power and manure, hides and skins and wool, are disregarded. It may thus underestimate productivity in some traditional production systems where such outputs are important. In order to record food and non-food joint product output, monetary values must be used throughout, although difficulties may arise in estimating values of items such as manure and draught power that may not be marketed.

Production and productivity measures often are restricted to animal food products, but in all cases measurement errors arise because livestock numbers and flock and herd structures change over time. Thus if cattle herd growth is occurring, the annual increases in animal numbers and herd valuations are additional to the recorded annual product output of meat and milk, and should also be included. Farm business accountants adjust for this by comparing the estimated value of the herd, at the beginning of the accounting year, the 'opening valuation', and at the end of the year, 'closing valuation'. An increase,

or if negative a decrease, in valuation, 'closing valuation minus opening valuation,' is then added to measured sales revenue for the year. Accurate estimates of the values of animals at different ages are rarely available in practice, even on commercial holdings, so personal judgement is involved and for simplicity, all animals in the herd may be assumed to be equal in value. This is more likely to be the case for less commercial and more traditional herds.

If output is measured in physical, rather than monetary units, similar problems arise in estimating changes in average live-weight or mass of edible animal protein between opening and closing valuation dates.

The above discussion has been concerned largely with the output per animal or its livestock unit, or biomass equivalent. Productivity measures for other inputs, particularly feed resources, may be useful guides to productive efficiency. Thus production of meat, milk or animal protein per ha of grazing land, or for intensive livestock, kg of live-weight gain per kg of concentrate feed may be useful indicators.

Alternatively the increased level of off-take, that would be needed to maintain a constant herd size and structure, a 'steady state', together with milk production, would give a clearer measure of output.

In herd growth models the structure of the herd is defined in terms of animal numbers in different age and sex cohorts, with breeding females as one such class. Estimates of annual production traits, of reproduction, sex/age specific mortalities and milk yields together with planned off-take rates are used to predict changes in the herd size and structure over a year. Alternatively the model may be used to predict the off-take rate necessary to establish a steady state herd size and structure.

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4. A value chain approach to animal diseases risk management – Technical foundations and practical framework for field application, 2011 (E)
5. Guidelines for the preparation of livestock sector reviews, 2011 (E)
6. Developing the institutional framework for the management of animal genetic resources (E**)
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The 'livestock revolution' has generated steadily increasing levels of livestock production, making this sub-sector one of the fastest-growing in agriculture. Furthermore evidence shows that livestock provide a vital contribution to livelihoods, income and nutrition of the rural poor. Yet expansion of the livestock sector is linked with challenging problems, such as the risks of infectious animal diseases especially those that may infect humans, and potential environmental impacts. Hence despite the important contributions of private sector producers, traders and distributors, there is a continuing need for public sector policies, institutions and controls. The preparation of a Livestock Sector Review is a valuable tool in the design of policies for animal production, health and disease control, marketing and trade.

Based on experience of such studies, in many developing countries, these guidelines provide indications of tried and tested approaches, analytical tools, contents, and delivery methods for the presentation of livestock sector reviews. Five main sections provide recommendations on:

- i) the purpose of livestock sector reviews – reconciling different social objectives, review requirements and resource constraints;
- ii) core content of the review – key components and recommendations;
- iii) analysis of specific issues – covering specialist topics not included in all reviews;
- iv) conclusions - future investment and policy options and action plans and
- v) data, information and analytical tools – covering data recovery and methods of analysis.

The guidelines provide an essential reference for recruiting officers, responsible for drafting Terms of Reference for reviews, FAO consultants who would appreciate a checklist, young professionals and other livestock or social science specialists who have not previously conducted a sector review.

ISBN 978-92-5-106910-3 ISSN 1810-0708



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