Chapter 1

The forage and livestock system: overview and concepts

An integrated or systems approach to forage-based livestock production can best identify the management practices and research priorities for achieving biological and economic sustainability of our livestock industries.

Livestock industry issues

This viewpoint is reinforced when the complexity and uncertainty of primary production is recognised. Primary industry sectors have to not only cope with technology and business management, but also with:

- narrowing margins between costs and prices
- the uncertainty of weather and price
- more exact product specifications and competitive export markets
- community concerns about environmental impacts and resource conservation.

An integrated approach

A systems approach integrates knowledge and experience on components that make up the whole and shows how these components interrelate or influence one another.

Awareness of each component and its favourable, neutral or unfavourable effects on other components assists in decisions to achieve optimal solutions.

The aim of this manual is to:

- provide a simple framework for forage-based livestock production systems and their components
- assemble and link the key quantitative relationships, benchmark data and supporting qualitative information for northern Australian tropical livestock production systems
- present the information in a systematic and quick-reference format.

What is a system?

One dictionary definition of a 'system' is ... '**a set of connected things or parts that form a whole or that work together**'.

In natural systems, physical (e.g. climate, soil) and biological (e.g. micro-organisms, plants and animals) components represent **variables** in the system. **These interact continuously in time to influence growth and reproductive processes of individual organisms or communities of organisms** (e.g. vegetation and wildlife communities).

The notion of variables and their interactions applies equally within agricultural systems. Pasture, crop and domestic livestock communities and their processes, along with the climate, soil and management variables that modify them (bio-physical factors), are primary factors determining farm productivity and sustainability.

Business and life-style considerations introduce equally important socio-economic factors. These include the viability, profitability and sustainability of the financial aspects of production, and the socio-economic effects of production on the '*natural environment*' on and off-farm.

In systems terminology, the state or value of a system component at points in time are termed *state variables*, with the transition between states being influenced by the rates of relevant driving processes or *rate variables*.

Examples of state variables are forage yield, animal liveweight, milk yield or product prices. Examples of rate variables are pasture growth, feed intake, and wool growth rates.

Changes in a number of state variables often influence the same rate variable, or a number of rate variables; thus interactive and feedback relationships among state and rate variables are common.

Figure. 1. 1. Some relationships between state and rate variables in a grassland system (after Pearson and Ison, 1987).

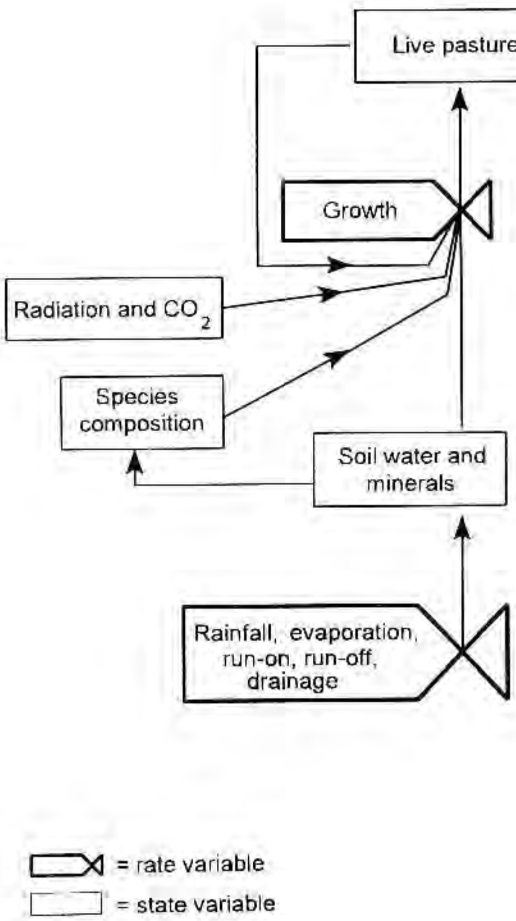
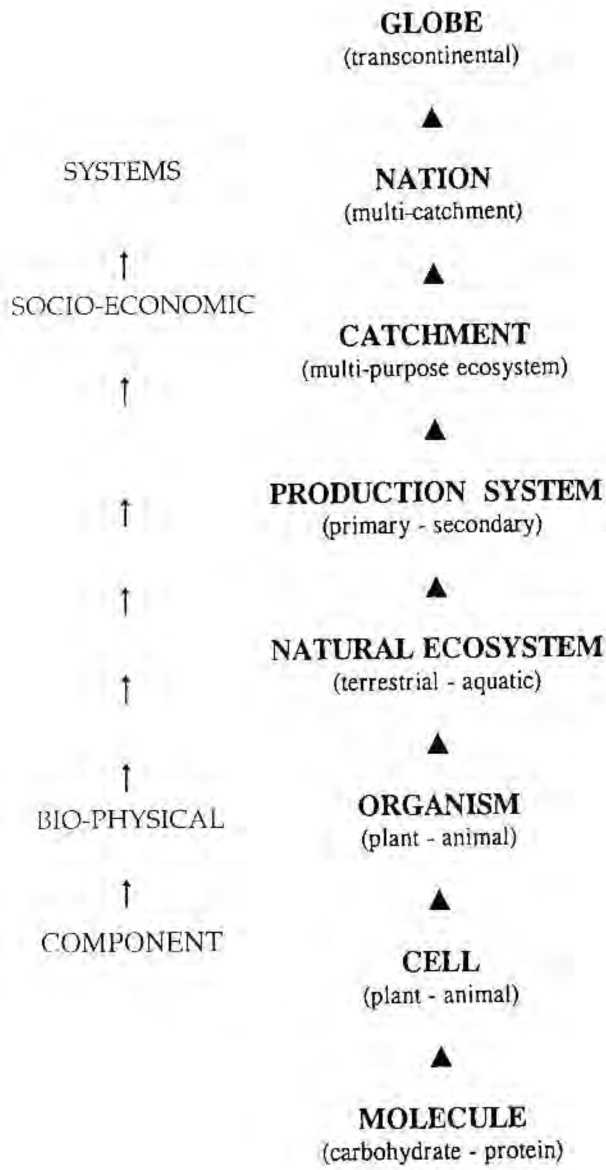


Figure. 1. 2. A natural systems hierarchy incorporating agricultural and other sub-system levels and their interdependency (adapted from Bawden et al., 1985).



System hierarchies

There is a hierarchy of levels of organisation within natural systems which progressively links variables from the basic molecule and cell levels, through natural and agricultural ecosystems, to complex national and global systems (Figure 1. 2).

This hierarchy demonstrates an increasing complexity of integration which makes decision-making increasingly difficult as one moves from the basic component level to the global level. The upward sequence moves from a mainly bio-physical and quantitative (hard knowledge) realm of relatively simple relationships (e.g. plant response to a nutrient), to one where socio-economic and environmental issues increase in importance (e.g. farm enterprise and integrated catchment management). At these levels, problem-solving often becomes more qualitative and dependent on experience (soft knowledge).

The hierarchies within systems emphasise the existence of interrelated issues and their potentially far-reaching influence, for example:

- truly sustainable forage-based livestock systems demand management practices that consider both productivity of the livestock and the sustainability of the forage resources
- a property system is a part of a larger river catchment system that will be affected by on-farm decisions about livestock and pasture management practices
- the role of grazing land and livestock systems in increasing greenhouse gas emissions is now a global issue, with tree clearing, fire and livestock production efficiency receiving particular attention.

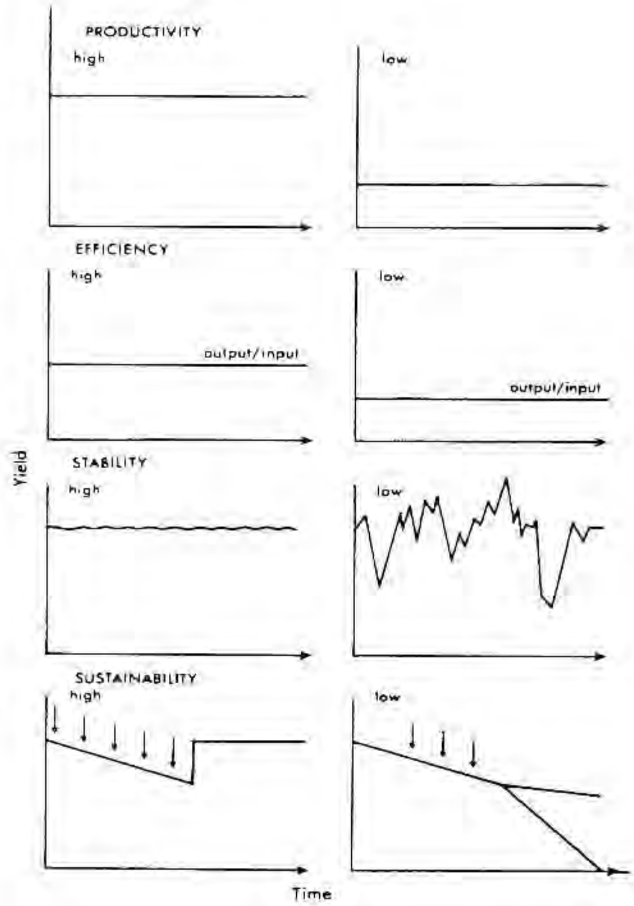
Measures of system status

The status of a system may be measured in terms of its productivity, efficiency, stability or sustainability. These measures apply equally to bio-physical and socio-economic aspects (Figure 1. 3).

Productivity is a rate variable which measures the speed at which the system operates; it is best expressed as **output over time**. Examples are daily pasture growth, annual liveweight gain of beef cattle per head or per hectare, milk yield per lactation, animals weaned per dams mated per mating season, and dollars earned per annum.

Efficiency measures **output relative to inputs**, and provides an index of the degree of success achieved by varying inputs or management practices. Examples are kg beef per kg nitrogen fertiliser applied to a pasture or per kg of grain supplement (feed conversion efficiency), dollar benefit per dollar expended (benefit:cost ratio), and annual return on investment.

Figure. 1. 3. High and low levels of some attributes which measure the status of a system (Pearson and Ison 1987, adapted from Conway 1985).



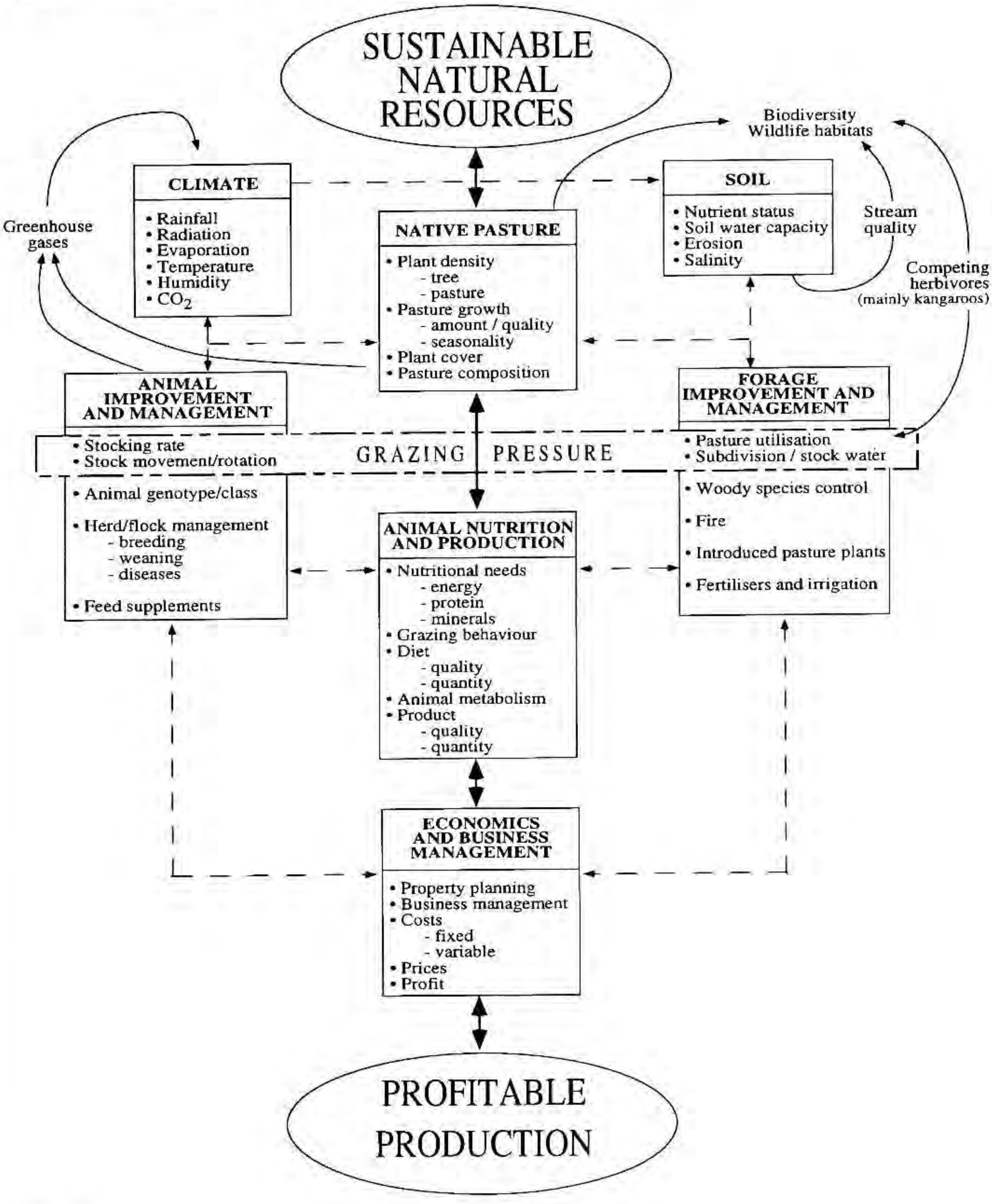
Stability characterises **the extent of variation over time** in production, markets and resource condition created by temporary but recoverable disturbances. Uncertainty is intrinsic in most agricultural systems, with **risk management strategies** essential to overcome, for example, large fluctuations in seasonal rainfall and commodity prices.

Sustainability may be expressed as either **the capacity of the system to maintain its present state and avoid irreversible change to another level** (usually perceived as a less productive one) or **the extent of management difficulty required to avoid or achieve the change.** Two contrasting examples are the adoption of conservative grazing pressure to avoid an irreversible reduction in pasture productivity, and projections about the reliability of feed supply and infrastructure required to establish and maintain a highly intensive dairy feedlot.

The forage-based livestock system

A schematic and generalised representation of a forage-based livestock system gives an overview of the whole system, its major sub-systems and the key elements within each sub-system.

Figure. 1. 4. A forage-based livestock system.



System objectives

The basic objectives of a sustainable system are to:

- harness and manage the soil and the forages of native grasslands and woodlands as a base source of animal nutrients
- improve and manage livestock and forages for increased levels and efficiencies of nutrition and production
- produce animal products that are marketable and that lead to a profitable enterprise
- ensure the above are achieved with the best possible impact on the environment.

Sub-systems

Climate and soil sub-systems dominate the forage and animal production potential of the system through their primary effects on the native and improved forage resources
(Chapter 2).

An animal nutrition sub-system directly drives the level and efficiency of animal production (Chapter 3).

A forage improvement and management sub-system seeks to increase the level and quality of nutrition of the base forage resource through better forage management practices and the efficient use of improved forage plants (Chapter 4).

An animal improvement and management sub-system seeks to increase the level and efficiency of animal nutrition through animal genetic improvement and better husbandry practices (Chapter 5).

Finally, a business and financial management sub-system seeks to translate animal products into acceptable monetary rewards through effective property planning, financial management and market intelligence (Chapter 6).

The more global impacts of livestock production systems, such as on the sub-systems relating to greenhouse gases and possible climate change, stream quality of catchments, wildlife habitats and biodiversity, are appended to the system schema in Figure 1.4.

Key sub-system interrelationships

Climate, soil, and forage and animal management practices all interrelate, with strong influences and feedbacks occurring between each sub-system. These are especially important for the physical and biological sustainability of production and the resource base.

Grazing pressure is a rate variable operating between the animal and forage sub-systems. After climate, it ranks as one of the most vital determinants of the production and sustainabilty of both animals and pastures.

All management interventions have a monetary cost and therefore impinge on enterprise economic efficiency and sustainability.

Integrated management

An integrated approach to management will come from a working knowledge of the relationships among the variables within the production system, preferably in a quantitative form.

However, as the knowledge of complex systems is incomplete, and may always be so, to some degree, qualitative knowledge and practical experience are vital for making sound decisions.

The key principles, issues and known quantitative and qualitative relationships between variables of tropical forage-based livestock systems presented in Chapters 2 to 6 should provide a quick reference resource for a wide audience of readers. Hopefully, industry practitioners may be able to combine this knowledge with their practical experiences to achieve more integrated and worthwhile approaches to livestock production.

The final three chapters on the constraints and opportunities for the northern Australian beef, dairy and wool industries should help link the component information described in the earlier chapters.

References

Bawden, R.J. *et al.*, (1985). In 'Agricultural Systems Research for Developing Countries'. (Ed. J.V. Remenyi) pp. 31-42. Canberra: ACIAR.

Conway, G. R. (1985). *Agric. Admin.* 20, 31-55.

Pearson, C.J. and Ison, R.L. (1987). 'Agronomy of Grassland Systems'. Cambridge University Press: Cambridge. p. 2 and 4.