



Integrated crop-livestock farming systems

Population growth, urbanization and income growth in developing countries are fuelling a substantial global increase in the demand for food of animal origin, while also aggravating the competition between crops and livestock (increasing cropping areas and reducing rangelands).

The livestock revolution¹ is stretching the capacity of existing production, but it is also exacerbating environmental problems. Therefore, while it is necessary to satisfy consumer demand, improve nutrition and direct income growth opportunities to those who need them most, it is also necessary to alleviate environmental stress.

Conventional agriculture is known to cause soil and pasture degradation because it involves intensive tillage, in particular if practised in areas of marginal productivity. Technologies and management schemes that can enhance productivity need to be developed. At the same time, ways need to be found to preserve the natural resource base. Within this framework, an integrated crop-livestock farming system represents a key solution for enhancing livestock production and safeguarding the environment through prudent and efficient resource use.

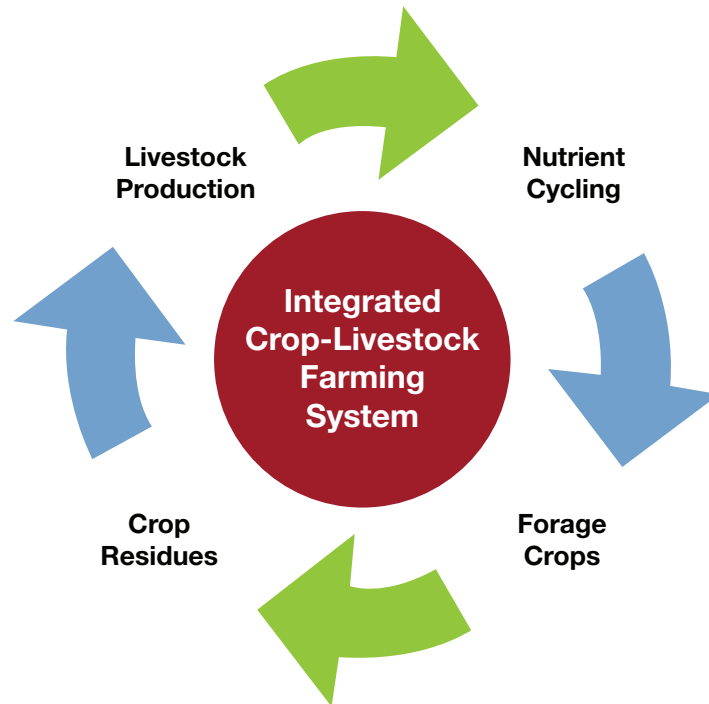
The increasing pressure on land and the growing demand for livestock products makes it more and more important to ensure the effective use of feed resources, including crop residues.

An integrated farming system consists of a range of resource-saving practices that aim to achieve acceptable profits and high and sustained production levels, while minimizing the negative effects of intensive farming and preserving the environment. Based on the

¹ This term summarizes a complex series of interrelated processes and outcomes in livestock consumption, production and economic growth. The revolution could provide income growth opportunities for many poor rural people involved in the livestock sector (Delgado et al., 1999).

Figure 1

Integrated crop-livestock farming system – Key aspects



principle of enhancing natural biological processes above and below the ground, the integrated system represents a winning combination that (a) reduces erosion; (b) increases crop yields, soil biological activity and nutrient recycling; (c) intensifies land use, improving profits; and (d) can therefore help reduce poverty and malnutrition and strengthen environmental sustainability.

Advantages and main constraints

Advantages

In an integrated system, livestock and crops are produced within a coordinated framework.² The waste products of one component serve as a resource for the other. For example, manure is used to enhance crop production; crop residues and by-products feed the animals, supplementing often inadequate feed supplies, thus contributing to improved animal nutrition and productivity.

The result of this cyclical combination is the mixed farming system, which exists in many forms and represents the largest category of livestock systems in the world in terms of animal numbers, productivity and the number of people it services.³

Animals play key and multiple roles in the functioning of the farm, and not only because they provide livestock products (meat, milk, eggs, wool, hides) or can be converted into prompt cash in times of need. Animals transform plant energy into useful work: animal power is used for ploughing, transport and in activities such as milling, logging, road construction, marketing, and water lifting for irrigation.

Animals also provide manure and other types of animal waste. Excreta has two crucial roles in the overall sustainability of the system:

- (a) *Improving nutrient cycling*: Excreta contains several nutrients (including nitrogen, phosphorus and potassium)

² Van Keulen and Schiere, 2004.

³ Mixed farming systems utilize about half of all the land used for livestock production systems, or roughly 2.5 billion hectares worldwide, of which 1.1 billion hectares are arable rainfed cropland, 0.2 billion hectares irrigated cropland and 1.2 billion hectares grassland. Mixed farming systems make the largest contribution to world livestock products with just over 50 per cent of the meat and 90 per cent of the milk currently consumed being produced in such systems (Council for Agricultural Science and Technology, 1999, quoted in Van Keulen and Schiere, 2004).

Box 1:

Diversified versus integrated systems

Diversified systems consist of components such as crops and livestock that coexist independently from each other.⁴ In this case, integrating crops and livestock serves primarily to minimize risk and not to recycle resources. In an integrated system, crops and livestock interact to create a synergy, with recycling allowing the maximum use of available resources.

Crop residues can be used for animal feed, while livestock and livestock by-product production and processing can enhance agricultural productivity by intensifying nutrients that improve soil fertility, reducing the use of chemical fertilizers.

A high integration of crops and livestock is often considered as a step forward, but small farmers need to have sufficient access to knowledge, assets and inputs to manage this system in a way that is economically and environmentally sustainable over the long term.

4 Food and Agriculture Organization of the United Nations, 2001.

and organic matter, which are important for maintaining soil structure and fertility. Through its use, production is increased while the risk of soil degradation is reduced.

- (b) *Providing energy:* Excreta is the basis for the production of biogas and energy for household use (e.g. cooking, lighting) or for rural industries (e.g. powering mills and water pumps). Fuel in the form of biogas or dung cakes can replace charcoal and wood.

Crop residues represent the other pillar on which the equilibrium of this system rests. They are fibrous by-products that result from the cultivation of cereals, pulses, oil plants, roots and tubers. They are a valuable, low-cost feed resource for animal production, and are consequently the major source of nutrients for livestock in developing countries.

The overall benefits of crop-livestock integration can be summarized as follows:

- Agronomic, through the retrieval and maintenance of the soil productive capacity;
- Economic, through product diversification and higher yields and quality at less cost;
- Ecological, through the reduction of crop pests (less pesticide use and better soil erosion control); and
- Social, through the reduction of rural-urban migration and the creation of new job opportunities in rural areas.

This system has other specific advantages:

- It helps improve and conserve the productive capacities of soils, with physical, chemical and biological soil recuperation. Animals play an important role in harvesting and relocating nutrients, significantly improving soil fertility and crop yields.
- It is quick, efficient and economically viable because grain crops can be produced in four to six months, and pasture formation after cropping is rapid and inexpensive.
- It helps increase profits by reducing production costs. Poor farmers can use fertilizer from livestock operations, especially when rising petroleum prices make chemical fertilizers unaffordable.
- It results in greater soil water storage capacity, mainly because of biological aeration and the increase in the level of organic matter.
- It provides diversified income sources, guaranteeing a buffer against trade, price and climate fluctuations.

Constraints

- Nutritional values of crop residues are generally low in digestibility and protein content. Improving intake and digestibility of crop residues by physical and chemical treatments is technically possible but not feasible for poor small farmers because they require machinery

and chemicals that are expensive or not readily available.⁵

- Crop residues are primarily soil regenerators, but too often they are either disregarded or misapplied.
- Intensive recycling can cause nutrient losses.
- If manure nutrient use efficiencies are not improved or properly applied, the import of nutrients in feeds and fertilizers will remain high, as will the costs and energy needs for production and transportation, and the surpluses lost in the environment.
- Farmers prefer to use chemical fertilizer instead of manure because it acts faster and is easier to use.
- Resource investments are required to improve intake and digestibility of crop residues.

Mixed farms are prone to using more manure than crop farms do. Manure transportation is an important factor affecting manure use.

Challenges

- Develop strategies and promote crop-livestock synergies and interactions that aim to (a) integrate crops and livestock effectively with careful land use; (b) raise the productivity of specific mixed crop-livestock systems; (c) facilitate expansion of food production; and (d) simultaneously safeguard the environment with prudent and efficient use of natural resources.
- Devise measures (for instance, facilitating large-scale dissemination of biodigesters) to implement a more efficient use of biomass, reducing pressures on natural resources; and develop a sustainable livestock manure management system to control environmental losses and contaminant spreading.

Key principles

- *Cyclic*. The farming system is essentially cyclic (organic resources – livestock – land – crops). Therefore, management decisions related to one component may affect the others.

- *Rational*. Using crop residues more rationally is an important route out of poverty. For resource-poor farmers, the correct management of crop residues, together with an optimal allocation of scarce resources, leads to sustainable production.
- *Ecologically sustainable*. Combining ecological sustainability and economic viability, the integrated livestock-farming system maintains and improves agricultural productivity while also reducing negative environmental impacts.

Some lessons learned and recommendations

- The maintenance of an integrated crop-livestock system is dependent on the availability of adequate nutrients to sustain animals and plants and to maintain soil fertility. Animal manure alone cannot meet crop requirements, even if it does contain the kind of nutrients needed. This is because of its relatively low nutrient density and the limited quantity available to small-scale farmers. Alternative sources for the nutrients need to be found.
- Growing fodder legumes and using them as a supplement to crop residue is the most practical and cost-effective method for improving the nutritional value of crop residues. This combination is also effective in reducing weight loss in animals, particularly during dry periods;
- Given their traditional knowledge and experience, local farmers are perfectly able to apply an integrated system. In practice, however, relatively few adopt this system, mainly because they have limited access to credit, technology and knowledge. The crop-pasture rotation system is complex and requires a substantial capital outlay for machinery and implements. Associations of grain and livestock producers are useful for filling these gaps and can promote the adoption of a crop-livestock system;
- Veterinary services are generally unable to reach poor small farmers in remote areas. Therefore, for livestock production to be

⁵ Keftasa and International Livestock Centre for Africa, 1988.



improved, more attention needs to be paid to making veterinary care accessible, particularly in terms of prevention;

- Better livestock management is needed to safeguard water. Livestock water demand includes water for drinking and for feed production and processing. Livestock also have an impact on water, contaminating it with manure and urine. All of these aspects need to be given due consideration.
- Intensification of agriculture through appropriate incorporation of small livestock has the potential to decrease the land needed for agricultural production and relieve the pressure on forests.

Key issues and questions for project design

The increase in demand for livestock products presents opportunities for small farmers who can increase livestock production and benefit from related income.⁶ However, in terms of environmental impact, the growing number of livestock and the increase in livestock processing can have a negative impact on natural resources unless actions are taken to identify farming practices that are economically and ecologically sustainable. Thanks to the dynamic interaction of its various components, the highly improved integrated crop-livestock system can guarantee more sustainable production and therefore constitutes a valid new approach.

Experience in the use of this system has shown that (a) adopting sustainable management practices can improve production while preserving the environment; (b) residues, wastes and by-products of each component serve as resources for the others; and (c) poor farmers have the traditional knowledge needed to integrate livestock and crop production, but because of their limited access to knowledge, assets and inputs, relatively few adopt an integrated system.

The challenge for development practitioners is to ensure that poor small farmers can increase the productivity of traditional farming systems, adopting an

effective integrated system that produces usable biomass while conserving natural resources, and can therefore be sustainable in the long term.

Within this framework some key questions for project design are

- How can livestock production increase to meet the growing demand for livestock products, using methods that the resource base can sustain?
- Do the strategies devised for raising productivity in integrated crop-livestock systems take into account the stage of development of the target population with respect to the nature of crop-livestock interactions?
- Do the farmers concerned have the right skills, knowledge, capital and technology to set up this system?
- Are the roles and responsibilities of men and women given sufficient consideration?
- How can additional needed nutrients be obtained? And, can the productivity of the system be increased without stressing the environment?
- Is enough good-quality feed available to sustain animals, especially during the dry season?
- Are nutrients that are relocated from grazing areas to croplands efficiently recovered?
- Are the different components of the farming system (crop, livestock and, eventually, fish) efficiently integrated?

⁶ Delgado et al., 1999.

References

- Council for Agricultural Science and Technology. 1999. Animal Agriculture and Global Food Supply. In *Task Force Report*, no. 135. Ames, Iowa: CAST.
- Delgado, C., M. Rosegrant, H. Steinfeld, S. Ehui and C. Courbois. 1999. *Livestock to 2020: The Next Food Revolution*. Food, Agriculture and the Environment Discussion Paper 28, Washington, D.C.: International Food Policy Research Institute.
- Food and Agriculture Organization of the United Nations. 2000. *Small Ponds Make a Big Difference: Integrating Fish with Crop and Livestock Farming*. Rome: FAO.
- Food and Agriculture Organization of the United Nations. 2001. *Mixed Crop-Livestock Farming: A Review of Traditional Technologies based on Literature and Field Experience*. Animal Production and Health Papers 152. Rome: FAO.
- Food and Agriculture Organization of the United Nations. 2003. *Integrated livestock-fish farming systems*. Rome: FAO.
- Food and Agriculture Organization of the United Nations. 2007. *Tropical Crop-Livestock Systems in Conservation Agriculture. The Brazilian Experience*. Rome: FAO.
- Food and Agriculture Organization of the United Nations and World Bank Group. 2001. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. Rome: FAO.
- International Fund for Agricultural Development. 2008. *Improving Crop-Livestock Productivity through Efficient Nutrient Management in Mixed Farming Systems of Semi-arid West Africa*. <http://www.ifad.org/lrkm/tags/384.htm> (accessed 8 May 2008).
- International Fund for Agricultural Development. 2005. *Integrated Crop-Livestock Farming System, Burkina Faso*. Rome: IFAD.
- International Fund for Agricultural Development. Undated. *Community Approach to the Development of Integrated Crop/Livestock Production in the Low Rainfall Area*. <http://www.ifad.org/lrkm/tans/3.htm> (accessed February 2008).
- International Livestock Centre for Africa (1998). *Crop-Livestock Interactions. A Review of Opportunities for Developing Integrated Models*. Llangefni, United Kingdom: Stirling Thorne Associates.
- International Livestock Research Institute. 1996. *Nutrient Cycling in Integrated Rangeland/Cropland Systems of the Sahel*. Niamey: ILRI, Sahelian Center.
- Keftasa, D. and International Livestock Centre for Africa. 1988. *Role of Crop Residues as Livestock Feed in Ethiopian Highlands*. In *Proceedings of the Third Workshop at the International Conference Centre*. Arusha, United Republic of Tanzania, 27-30 April 1987. Addis Ababa: ILCA.
- Preston, T.R. and E. Murgueitio. 1992. *Sustainable Intensive Livestock Systems for the Humid Tropics*. *World Animal Review* 72:2-8.
- Van Keulen, H. and H. Schiere. 2004. *Crop-Livestock Systems: Old Wine in New Bottles?* In *New Directions for a Diverse Planet. Proceedings of the 4th International Crop Science Congress*, Brisbane, Australia, 26 September-October 2004. http://www.cropsscience.org.au/icsc2004/symposia/2/1/211_vankeulenh.htm



Contact

Antonio Rota
Senior Technical Adviser on
Livestock and Farming Systems
Technical Advisory Division
Tel: +39 06 5459 2680
a.rota@ifad.org

Authors

Antonio Rota
Senior Technical Advisor for
Livestock and Farming Systems
Technical Advisory Division
a.rota@ifad.org

Silvia Sperandini
Consultant, Technical Advisory
Division
s.sperandini@ifad.org



International Fund for
Agricultural Development
Via Paolo di Dono, 44
00142 Rome, Italy
Telephone: +39 06 54591
Facsimile: +39 06 5043463
E-mail: ifad@ifad.org
www.ifad.org
www.ruralpovertyportal.org

These materials can be found on IFAD's
website at www.ifad.org/lrkm/index.htm