ILRI Research brief

ILRI
International Livestock Research Institute

Research Theme on Improving Market Opportunities

Markets Theme Research Brief 1

Dairy Farming in Uganda

Production Efficiency and Soil Nutrients under Different Farming Systems

Key points

- Current policies and some development projects have promoted dairy intensification systems, such as zero-grazing, in a variety of settings. However, the results show that less intensive production systems can be equally appropriate in most areas.
- Smallholder dairy production is shown to be profitable and competitive in a variety of settings, where level of intensification suits different local circumstances.
- There is need for targeted interventions of dairy intensification to meet area-specific conditions and the farmers' specific circumstances, particularly those that place additional demands on the farmers' labour.
- Nutrient balances of nitrogen, phosphorus and potassium are positive (though small) at the farm level, but strongly negative at the land level.
- Organic fertilizer (manure) from the livestock enterprise is rarely used on crops.
- Farmers could improve soil productivity by using available manure, although labour constraints may be an impediment.
- Development efforts should consider the technical and economic feasibility, environmental sustainability and social benefits of the project.

NARO
National Agricultural Research Organisation

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Introduction

A series of policy changes, coupled with the promotion of intensive production systems, have resulted in significant changes in the dairy sector in Uganda over the last two decades. Prior to the 1980s smallholders made little contribution to the nation's marketed milk production; now both overall production and the proportion of milk produced and marketed by smallholders have significantly increased.

Notable policy and institutional changes in the Ugandan dairy sector

1980s:	Promotion of zero-grazing by NGOs such as Heifer Project International.
1986:	Introduction of the National Rehabilitation and Development Program led, *inter alia,* to the introduction of the zero-grazing system.
1992:	The Government launched a Milk Master Plan to improve dairy production and processing.
1993:	Liberalization of the dairy subsector and emergence of private milk processors.
1998:	The Dairy Industry Act established the Dairy Development Authority to realize objectives of Milk Master Plan.

Despite these changes, there were major knowledge gaps concerning the dairy sector in Uganda. Important unanswered questions included:

- What factors and incentives influenced adoption of dairy intensification measures by smallholder farmers?
- Is intensification always the best option?
- What are the trends in nutrient balances of soils on smallholder dairy farms?

Study rationale and objectives

To answer these questions, an in-depth study was carried out between 2001 and 2005 by a team of researchers from the Ugandan National Agricultural Research Institute (NARO), Makerere University, the International Livestock Research Institute (ILRI) and the Danish Institute of Agricultural Sciences (DIAS) with funds provided by the Danish International Development Agency (DANIDA).

Improved understanding of dairy production systems in Uganda was expected to enable better targeting of evidence-based extension messages and development of policies that would improve the contribution of dairying to sustainable livelihoods of resource-poor farmers.

The study had three components:

- Characterization of dairy farming systems in Uganda
- An economic component that examined the factors and incentives influencing farmers' adoption of dairy intensification and crop–livestock interactions, such as feeding crop residues and using manure to improve soil fertility; determined the degree of risk aversion; and assessed the enterprise choices consistent with farmers' resources and objectives.
- A nutrient cycling component which evaluated key nutrients essential for successful crop production (nitrogen, phosphorus and potassium).

Data sources and methods

Dairy systems at various levels of intensification were studied in Jinja, Masaka and Mbarara districts of Uganda (study sites shown in Figure 1). These ranged from intensive systems in which exotic dairy cattle were maintained in zero-grazing units through to extensive systems in which predominantly local breeds were grazed on natural pastures.

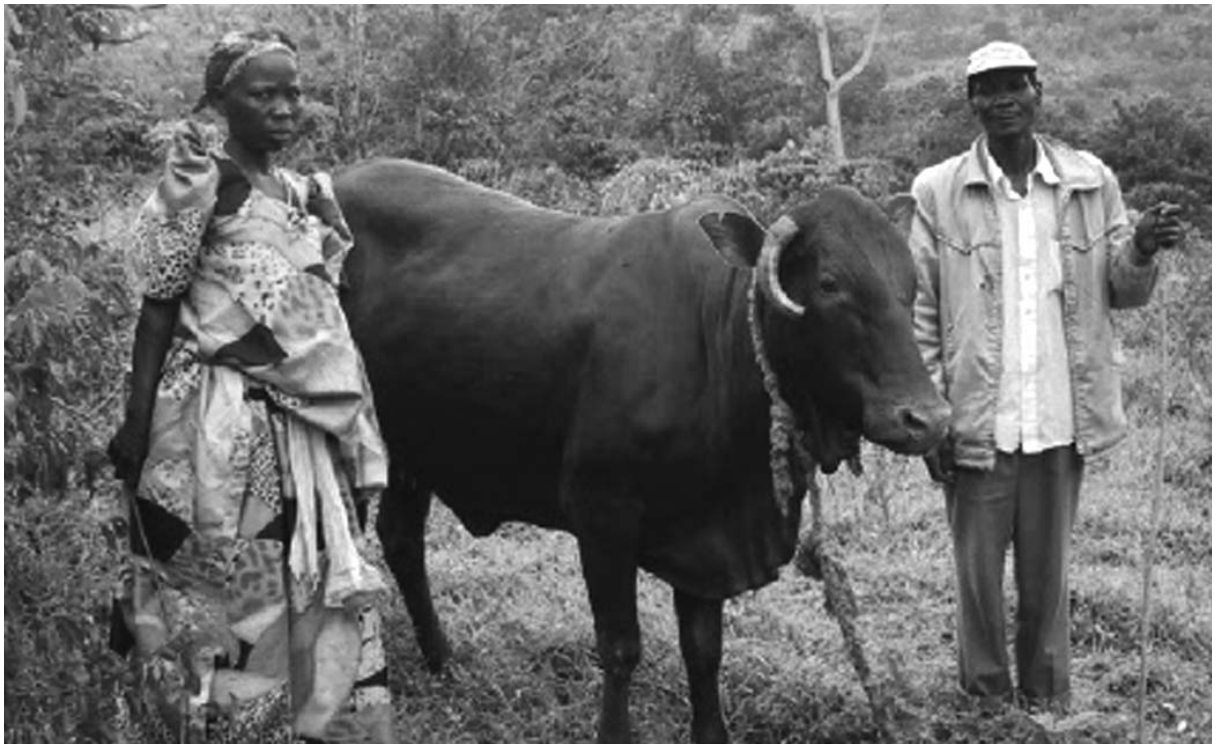
Two surveys were conducted: a cross-sectional survey (one visit per household) in 2001 covering 303 farmers and an in-depth longitudinal survey comprising repeat visits to 24 farmers over a one-year period between August 2003 and August 2004.

Data analysis focused on two main aspects: economic efficiency and nutrient management.

Economic efficiency and factors driving intensification were assessed by 'net farm benefit and regression analyses'. Net farm benefits were evaluated as revenues from all farm activities, including consumption of farm outputs (crops and milk) by the household and relatives, minus all expenses relative to farm activities. Dairy benefits were evaluated as revenues from sale of milk and dairy animals, plus the value of milk consumed by the household, minus all expenses relative to dairy.

A linear programming model was developed to evaluate the farmers' choices of crop and dairy activities. The model provided the combination of farm activities that maximizes benefits and can therefore be used to assess individual farmers' efficiency by looking at the difference between current (or observed) farm plans and profit maximization plan.

Nutrient management was assessed by calculating detailed nutrient balances of nitrogen (N), phosphorus (P) and potassium (K) at whole farm and cultivated land levels. Farm nutrient balance was calculated as the quantity of nutrients entering the farm minus the quantity of nutrients leaving the farm. Land nutrient balance was calculated as the quantity of nutrients applied to the land minus the quantity removed from the land. Simulation analyses were carried out to assess what the nutrient balances would be if the farmers were to apply the manure available on their farms to the soil.



Key findings

Farm characterization

The study identified five different dairy production systems, listed below in descending order of intensification:

- zero-grazing
- semi-intensive
- fenced
- tethered
- herded

Zero-grazing is the most intensive of the five production systems. In this system improved dairy cattle are permanently kept in stalls with no free-grazing and there is a high level of external inputs, including bought-in feeds, and significant expenditure on livestock and veterinary services.

Semi-intensive is similar to zero-grazing except cattle spend some time confined to stalls and some time grazing in paddocks.

In fenced systems, cattle – a large proportion of which are improved dairy breeds – graze in paddocks.

In the tethered system, predominantly local breeds of cattle are grazed mostly off-farm, freeing up land for cultivation. Density of cattle tends to be high.

Herding is the least intensive of the five production systems and consists of mostly local breeds of cattle being grazed on and off-farm.

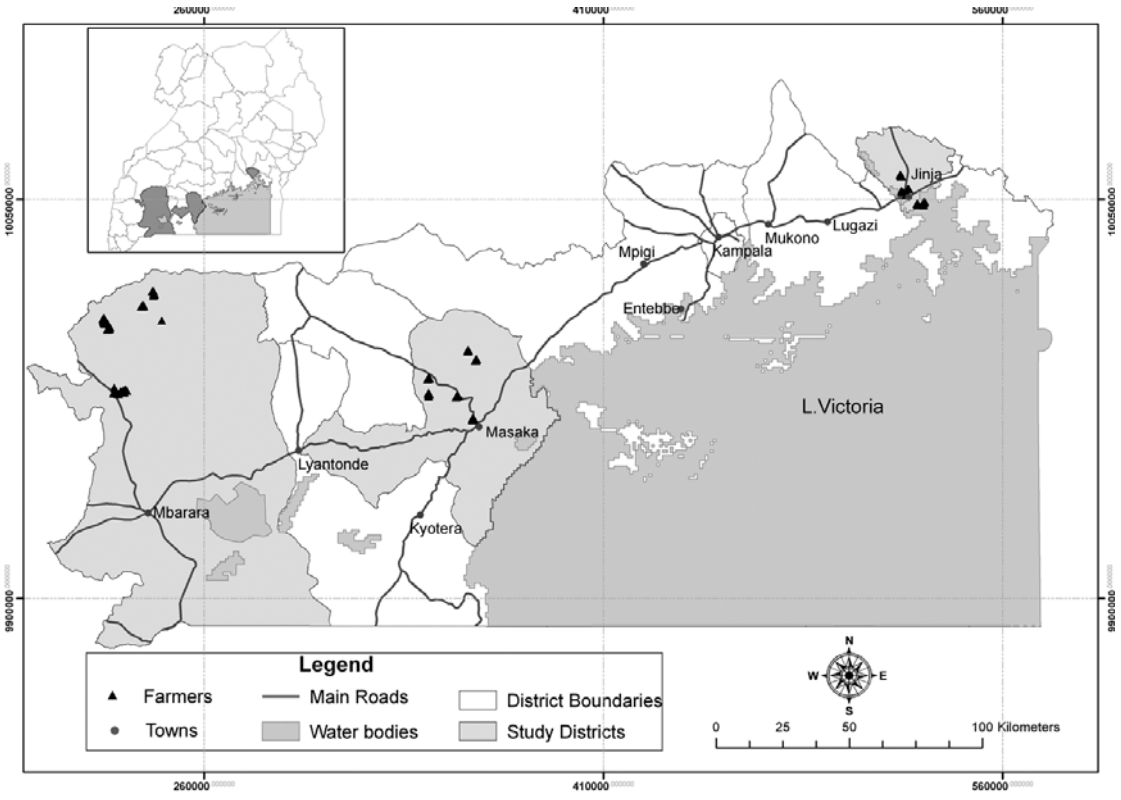


Figure 1: Study sites

Economics of milk production

The cost of milk production was compared for each of the five dairy production systems. Cost of production was highest in the tethered and lowest in the herded system. Estimates of fixed costs (like stalls and dairy equipment) were not included and therefore a true profit margin could not be calculated. However, the contribution margin – which is the difference between sales price and the variable costs of dairy production – was highest for zero-grazing and lowest for the tethered system. Breakdowns of the cost components under the different systems are shown in Figure 2.

While dairy farming is profitable under all five farming systems, profitability in terms of contribution margin was highest under the two most intensive systems, zero-grazing and semi-intensive. However, intensification was not necessarily the best option in all situations; profitability was higher under the herded system, considered to be the least intensive, than under the fenced or tethered systems.

Extension messages and policies regarding intensification in the smallholder dairy sector need to be carefully targeted to ensure they are relevant and appropriate.

The study also highlights the value of seeing benefits for oneself, such as by working on neighbour's farms, and of farmer-to-farmer training approaches.

Economic efficiency of dairy production

Economic efficiency was evaluated from two points of view: opportunity cost of labour and the profit maximization plan.

Analysis of milk productivity of the different farming systems revealed that increasing the level of intensification resulted in an increase in the milk productivity and the percentage of milk sold (Figure 3). However, despite the variability in milk productivity and the market orientation between farming systems, the net farm and dairy benefits per hour remained above the cost of labour (Figure 4) and there was no apparent relationship between degree of intensification and the dairy benefits per hour. This indicates that in the current situation, all systems are remunerating the farmers' labour above what they could get if they were to offer their services outside their farms.

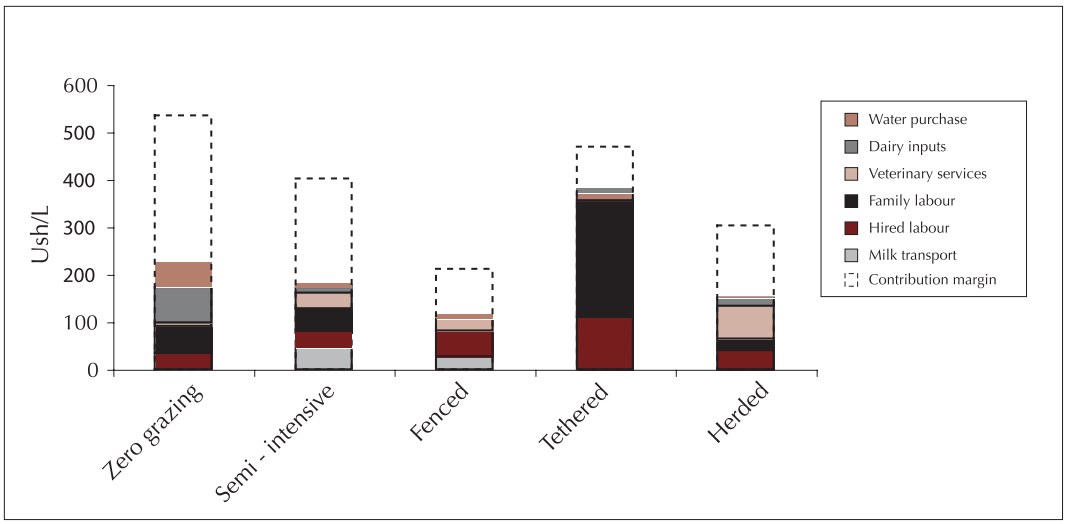


Figure 2: Cost (Ush per litre) of milk production and its components by dairy production system.

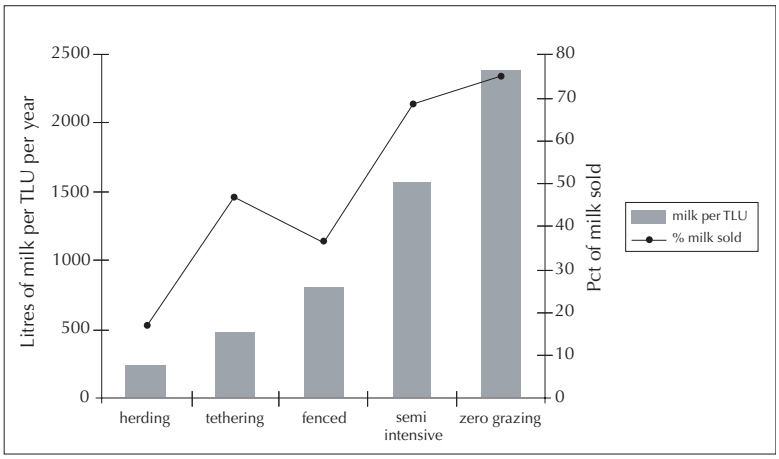


Figure 3: Relationship between milk productivity, market orientation and cattle farming system.

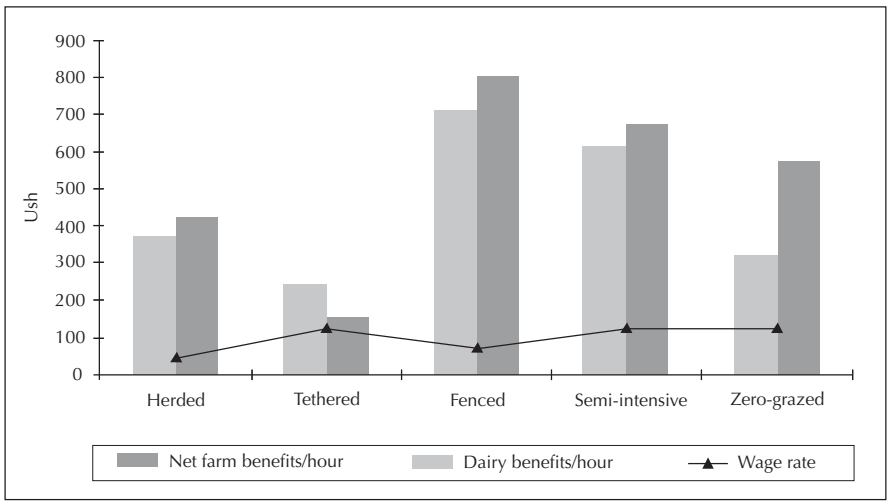


Figure 4: Comparison of the net farm and dairy benefits per hour and the local wage rate for different cattle farming systems.

To measure economic efficiency in relation to the profit maximization plan, the net benefits achieved using actual farm production practices were compared with net benefits achievable if farmers used profit-driven optimal production practices as predicted by the linear programming model. Results showed that farmers are operating near the profit maximization levels for dairy but could improve their overall farm benefits by discontinuing fallow and switching to more profitable crops (Figure 5).

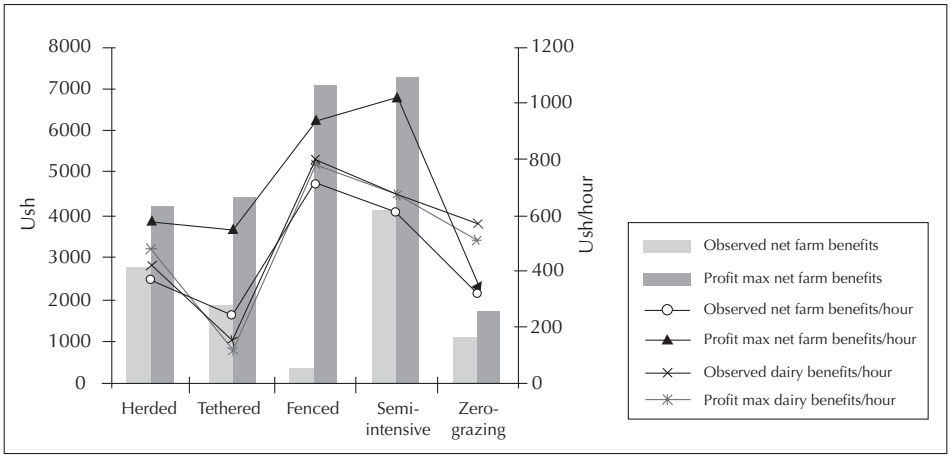


Figure 5: Comparison of observed and profit maximization net farm and dairy benefits.

Drivers of intensification

Four drivers of intensification were identified. These included two human capital drivers, years of formal education of the household head and proportion of adults working off-farm, and two demand drivers, human population density and access to local markets.

Soil nutrient levels and balances

A worrying situation is revealed with regards to nutrient management on mixed dairy-crop farms in Uganda. Irrespective of degree of intensification, levels of some key plant nutrients in the soil, especially nitrogen, are already below the level considered critical for successful crop production (Figure 6). Nutrients removed in crops and milk are not being replaced at a commensurate rate. This has serious implications for the long-term sustainability of these farming systems. In most systems adequate amounts of manure are available on the farm to reverse this situation but currently most of this potentially valuable manure is not utilized.

Shortage of labour may be one reason that manure is underused; in cases where manure is applied, this tends to be done during the school holidays when family labour is most plentiful. Also, in some cases the cultivated plots may be distant from the zero-grazing units, exacerbating transport problems. But in feedback provided by the farmers at the end of the study, other factors were also mentioned such as lack of awareness of the benefits of using manure, lack of basic equipment for transporting manure and fear of introducing pests and diseases to their plots.

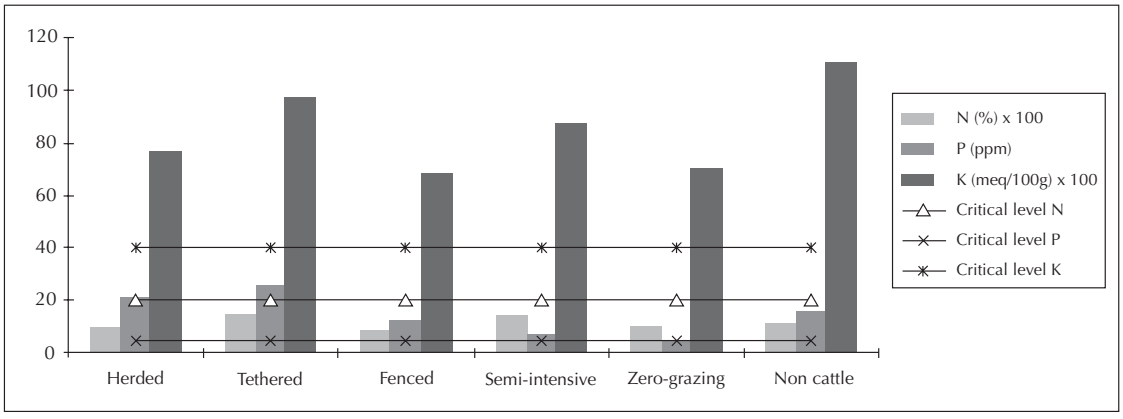


Figure 6: Comparison of soil nitrogen (N), phosphorus (P) and potassium (K) levels with critical minimum levels under different cattle farming systems (land-level based on soil samples).

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Conclusions and policy recommendations

- Dairy farming in Uganda is a profitable activity under all five farming systems.
- Profitability (as measured by the contribution margin) was highest under the two most intensive systems, zero-grazing and semi-intensive.
- Intensification was not necessarily the best option in all situations; profitability was higher under the herded system, considered to be the least intensive, than under the fenced or tethered systems.
- Factors associated with a tendency to intensification are: years of formal education of the household head and proportion of adults working off-farm as well as factors associated with increased demand for milk.
- Irrespective of degree of intensification, levels of key plant nutrients in the soil, especially nitrogen, are already below the level considered critical for successful crop production. Nutrients removed in crops and milk are not being replaced at commensurate rate.
- In all systems except fenced and semi-intensive, adequate amounts of manure are available on the farm to reverse this situation but currently most of this potentially valuable manure is not utilized.
- The five farming systems present unique opportunities and constraints. Therefore, research and development agenda should take cognizance of their uniqueness.

More work needs to be done to investigate the economics and practicalities of manure application and how best to integrate this activity with others that compete for available labour.

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