Improvement of dairy production to satisfy the growing consumer demand in SubSaharan Africa

A conceptual framework for research

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International Livestock Centre for Africa (ILCA)

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Preface

This document is based on the deliberations and outputs of two ILCA in-house workshops held in 1992, and of numerous individual contributions by ILCA scientists (Azage Tegegne; C. O'Connor; S. Ehui; H. Fitzhugh; H. Khalili; A. Lahlou-Kassi; M. Lippner; D. Little; V. Umunna and E. Zerbini)

Background

Can African livestock production systems maintain, or better yet improve, their share of provision of dairy products to African consumers, particularly those in urban areas?

Meeting the food needs of urban populations is of growing concern in developing countries. The case of dairy products in sub-saharan Africa is illustrative. Demand for milk and dairy products exceeds supply in most parts of sub-Saharan Africa (SSA) (Brokken and Seyoum, 1992). Over the last decades, the population growth in SSA, combined with rising per capita income has caused rapid growth in food consumption, in particular of dairy products. The World Bank (1992) has estimated that demand for milk and dairy products in SSA will increase by 5.5 million tonnes by the year 2025, an annual growth rate of 4%, questioning the supply side.

Much of this increased demand will be concentrated in urban areas. The population in SSA is expected to increase by 2.75% a year between 1990 and 2025, resulting in an additional 800 million people to feed. Of these, over 500 million will be in cities and large towns. Meeting the food needs of these people will present an enormous challenge to African farmers and their governments for whom welfare of urban consumers is becoming a political concern.

The rapid growth in consumption has been principally covered by imports of basic staples (7% growth per year). Commercial dairy imports in SSA have increased steadily since 1960, and absorbed in 1980 about five percent of the region's total revenue from agricultural, forestry and fishery exports (von Massow, 1989). Many countries cannot sustain this situation. Implementation of the structural adjustment policies would furthermore discourage imports through devaluation.

Although inadequate to meet the increase in demand, marketed dairy production is already increasing in most African countries, as a direct response to consumer demand, to changes in the infrastructure in rural areas (better road system, input markets ...), or as a result of development efforts to promote smallholder dairy production (justified by the above). For smallholders, dairying allows year-round employment of the family labour force, provides a means of intensifying land use when it is a limiting resource, and milk often plays the role of a "cash crop", hence insuring regular income.

Acknowledging the fact that dairy producers may find a primary market among their rural neighbours, under exploited market opportunities exist in nearby urban markets, where the challenge in meeting consumers, demand lies. Producing household targetting urban consumers will have access to larger markets and better prices, and hence achieve higher returns than it they were to target only local, rural consumers. It is also more likely that increased supply might result from an increase in the current herd productivity, and from more efficient marketing channels, than from an increase in the size of the producing herd.

The development of dairy production aimed at "distant" markets is a recent trend in SSA. As can be expected with recent trends, it is at various stages around different consumer centres, which are expressed by some variations in its components (Walshe et al, 1992):

- Types of farmers involved: from specialised smallholders (like in the Kenyan highlands) to recently sedentarised pastoralists (like in West Africa); within sites, farmers are also implementing different strategies to organise dairy production

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as a response to differences in farm structure (land, labour, cash availability) and organization of input and output markets

- consumption patterns of dairy products are also varying across the continent according to income level and cultural tastes and preferences (semi-processed dairy, processed dairy, fresh milk)

- marketing channels vary from place to place: direct selling, and involvement of commercial farms and enterprises.

The diversity in the components of dairy systems and in their combination has not been documented in SSA. Knowledge and understanding of this diversity, however, is needed to foresee research needs and development prospects.

Although in a process of dynamic change, market-oriented dairy production is facing several constraints in its sustainable development; these address the different components: feed-resource base, upgraded genotype, management of reproduction, diseases of intensification, efficiency of collection, processing and marketing mechanisms and policy environment. These constraints affect the different dairy systems in varied ways depending the characteristics of the systems and the level of market integration.

Thus, the current milk deficit, combined with large projected increase in demand as a result of both population and income growth, represents a major market opportunity for domestic dairy producers. As a consequence of the magnitude of the challenge and the good prospects for market-oriented dairy production, in many African countries, dairy systems have become a priority area for research and development agencies; still,

- development agencies are looking for adapted means to overcome a number of constraints and difficulties which are identified.

- National Agricultural Research Systems have repeatedly stated the need for methodologies to design relevant interventions on dairy systems.

This framework presents and organises a set of potential research activities which can be carried out in sub-Saharan Africa by National Agricultural Research Systems (NARS) and/or ILCA to answer the question of a better provision of dairy products to consumer centres, with due consideration for the variety of situations and problems dairy systems are facing.

ILCA has research teams currently carrying on activities on dairy production and marketing around several consumer centres. They constitute locations within this framework, but do not preclude research at other locations representative of the different ecozones and production systems in sub-Saharan Africa.

The dairy-system concept

A "dairy system" in this document incorporates all areas and production systems producing, and the marketing channels delivering dairy products to consumers in urban centers, including the policy environment. It is therefore often refered to as a periurban dairy system although it is not defined in terms of rigid geographical boundaries (like a circle) around a city.

A study site is to be defined by a consumer center, with its dairy shed and the processing and marketing actors and processors linked to them.

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A dairy system is thus constituted by four subsystems: production, processing, marketing and consumption (figure 1). Each subsystem has components. For instance, the production sub-system has genetic, feeding and health components, among others.

Figure 1. *Schematic representation of a peri-urban dairy system.*
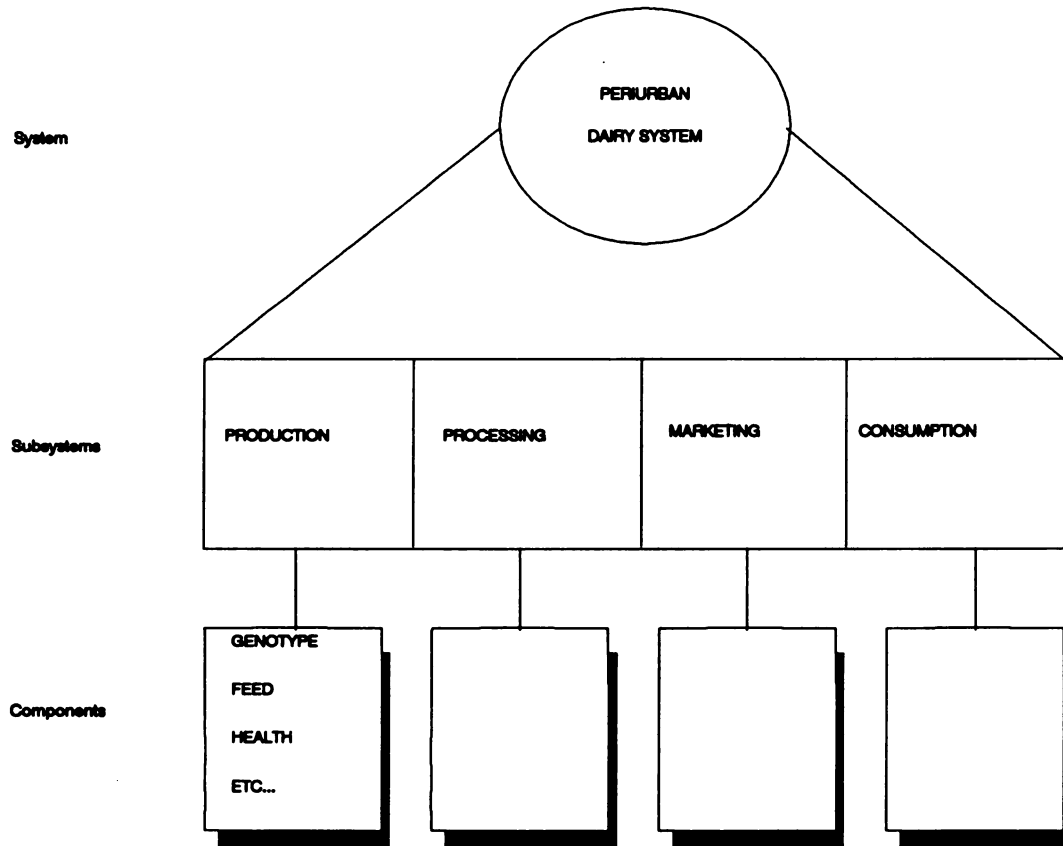
Objectives

The broad objective of research conducted within this framework is to identify and act upon relevant researchable issues and improvement options to promote the development of the dairy sector in sub-Saharan Africa.

The specific objectives are to:

1) understand the evolution and development trends of dairy systems

2) characterise existing dairy systems

3) identify constraints and opportunities, and prioritise the researchable issues for improvement of dairy systems

4) develop and test cost-efficient technologies/components for improvment of dairy systems

5) develop policy strategies to support efficient dairy systems

6) make impact on NARS dairy systems research programmes through the development of methodologies and tools, including models, that could be used by them.

Hypotheses

The following hypotheses guide this framework. Based on ILCA field experience, they focus on the factors that influence the development of market-oriented smallholder dairying in the continent, and on the factors that affect farm productivity in dairying. The latter correspond to the major expected areas of intervention.

Factors influencing development of market-oriented smallholder dairying in SSA

(1) As access to markets at the farm gate increases, farmers' practices change towards specialisation and intensification of dairy production.

(2) Increased demand for milk and dairy products is being met by the intensification of production, not by an increase in herd size.

(3) As food crop productivity increases, more land is allocated to livestock enterprise (production).

(4) The intensity of croplivestock production interactions is driven by population pressure on land.

(5) Intensity of croplivestock production interaction is positively related to access to dairy market.

(6) On mixed food crop/dairy farms, food crop production is accorded higher importance/priority when labour allocation decisions are made.

(7) Dairying offers lower returns to investment in comparison to other farm activities.

(8) Specialisation in dairy production is regarded by smallholders as undesirable because it is perceived as being too risky.

(9) Household welfare and security are enhanced by the incorporation of a dairy enterprise into smallholder crop-farming systems.

(10) Smallholder dairy farmers cannot achieve the same levels of cost efficiency as those achieved on large commercial farms.

(11) Labour associated with intensification of smallholder dairying is mostly shouldered by the women of the household.

(12) Supplemental income associated with intensified smallholder dairying is disproportionately retained by the men of the household.

(13) Regulations constitute the major constraints to increased commercialisation by small-scale entrepreneurs (processors - marketers).

(14) Policies related to dairy products are consumer-biased in sub-Saharan Africa (imports, fixed consumer prices, subsidies, non-price barriers like licensing etc).

(15) Growth of smallholder dairying has been greater where government has intervened with support services (e.g. veterinary) rather than by direct interventions (e.g. producing and marketing dairy products).

(16) The greater the degree of liberalisation of the dairy sector the fewer the number of smallholder dairy producers (i.e. smallholder are "squeezed out" of the market because of no economies of scale).

(17) Government intervention in dairy markets corresponds with increased participation in and growth of informal dairy markets.

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(18) Market accessibility influences the ratio of marketed surplus (commercial sales to production).

(19) Community-level processing and handling enhance farmers' production and supply of dairy products.

(20) Consumption levels of marketed domestic dairy products is positively correlated to population concentration.

(21) Tastes and preferences are more important determinants to consumption patterns than household income level.

(22) Among urban households the demand for dairy products is greater than for meat.

(23) Relative expenditures for dairy products increase with household income levels in urban areas.

Factors affecting farm productivity in dairying

(24) Technologies adopted by smallholder dairy farmers are scale-neutral.

(25) Farmers' ranking of constraints to increased dairy production vary when intensification takes place.

(26) Most milk producers do not grow their own feeds.

(27) The production of improved forages is related to increased milk production.

(28) Land allocation to forage production is positively related to security of land tenure, and negatively to the access to communal or other land, and to the ability to acquire additional land.

(29) Lack of access to agro-industrial by-products is a factor limiting dairy intensification.

(30) For a given level of dairy production, use of agro-industrial by-products substitutes for forage production to intensify production.

(31) Extent of use of crop residues is negatively correlated to dairy intensification.

(32) Crop residues can provide the feed basis for profitable milk production during the dry season.

(33) Social and policy factors are more important determinant explaining the choice of genotype than higher milk production *per se*.

(34) Exotic germplasm is introduced into the herds of smallholder dairy farmers before improved management systems.

(35) Disease risk, germplasm availability and feed resources are key factors limiting the increased use of exotic germplasm.

(36) Exotic germplasm predominates among smallholder market-oriented dairy farmers.

(37) Significant productivity gains (litres/cow) can be obtained with pure indigenous breeds.

(38) Cost efficiency (including cost of risk) of milk production by crossbred cows is lower than that of indigenous cows.

(39) Availability and utilisation of veterinary services for curative interventions increase with intensification.

(40) Patterns of disease incidence change as dairy production intensifies.

(41) Acuity of reproductive wastages increases with the degree of utilisation of exotic germplasm.

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(42) Reducing reproductive wastage will have the single most significant impact on milk production.

(43) For dairying vs other livestock enterprises, disease-risk control is cost-effective.

(44) Availability and cost of credit are a major obstacle to dairy intensification.

(45) Most milk is processed/transformed in some way before being sold by the smallholder producer.

(46) Processing/handling milk on-farm is perceived by farmers as a major constraint to increased milk production and processing.

List of phases

The various objectives and research activities have been catagorised in phases, corresponding to their scope (system, subsystem, components) and balanced by the depth of study required (Figure 2). Four phases have been identified as part of this conceptual framework, and are described hereunder. "Phase" does not imply an absolute sequence in time, although all phases are presented in a logical order.

Figure 2. *Research phases for the study of dairy system.*
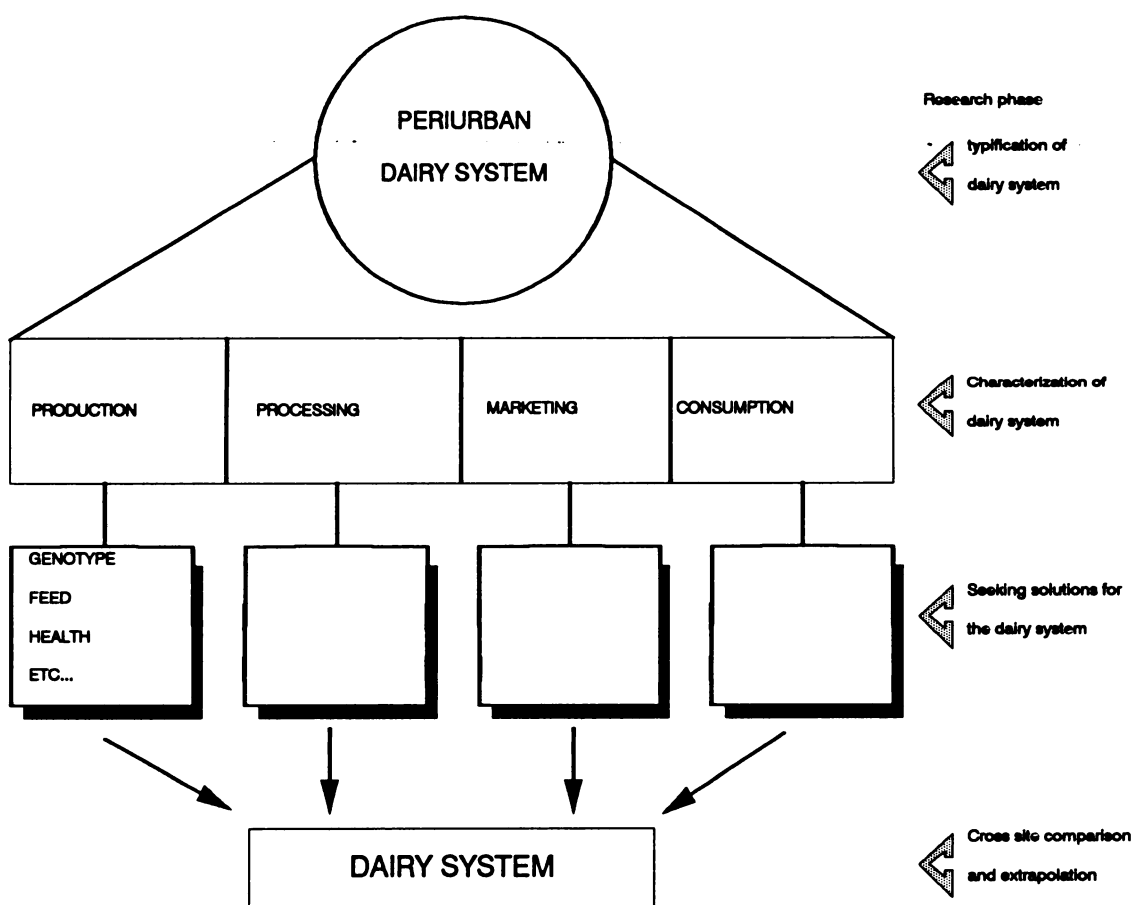
Phase 1. Typification of dairy systems

General identification of types of dairy systems to reflect and understand the main characteristics of production, processing, marketing and consumption subsystems

Objectives

- To understand the extent of variation (similarity/dissemblance) of dairy systems over a large geographical region

- To discern the relative importance and geographical coverage of the respective dairy system or subsystems in SSA

- To identify trends of dairy systems development in SSA

- To determine representativeness of sites where, or dairy system upon which, research is, has been or will be carried out.

Methods

For typification, information will be gathered at the dairy system level (a location). Information will be mostly qualitative, and might involve the level of magnitude of some quantitative data. Key informants in each location will be surveyed to collect those data.

Phase 2. Characterization of a specific dairy system.

Detailed characterisation of a dairy system which includes quantification of its subsystems, components and subcomponents at the household level for production and consumption, and at the levels of individual processing and marketing units.

Objectives

- To provide baseline data on the dairy system performance

- To understand factors influencing dairy production: constraints and opportunities, farmers' rationale and objectives

- To understand linkages between different subsystems and their influence on the development of the dairy system

- To identify and prioritise researchable issues which make an impact on the development of dairy system (at the component level)

Methods

A sampling technique and a set of instruments will be determined for the characterisation of each subsystem (at the household level for production and consumption, and at the level of individual processing and marketing units). Efforts will be made to define a minimum data set on dairy systems to permit system assessment and prioritisation for research. A multidisciplinary baseline analysis of each dairy system will be documented. Methods of *ex-ante* analysis will be developed to determine the relative advantage of working on a given issue in a given system.

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Phase 3. Seeking ways to enhance the development of specific dairy systems

Seeking solutions to lift constraints or take advantage of opportunities relevant to specific dairy systems.

Objectives

- To quantify the impact of constraints on production

- To design and test alternatives to enhance dairy production

- To design and test methodologies.

Method

Most research will be carried out at the component level. Important areas of research where methodologies will be tested include:

* Feed - production interaction

* Animal health - dairy production interaction

* Genetic resources - dairy production interaction

* Animal management- dairy production interaction

* Marketing system - dairy production interaction

* Policies - dairy production interaction.

Phase 4: Cross-site synthesis

To synthesise the information collected in phases 2 and 3 in various sites, in order to extrapolate to SSA, and feed back on research needs.

Objectives

- To develop a comprehensive view of dairy systems and of their prospects in sub-Saharan Africa

- To carry out cross-site comparisons of research results for the different types of dairy systems

- To assess the evolution of dairy systems in SSA and project emerging constraints

- To simulate interventions on dairy systems.

Methods

Computer modelling is complementary to field analysis for heuristic purposes; it has also a prospective purpose in assessing the evolution of the system and foreseeing emerging constraints, without intervention and with intervention on the basis of experimental results. Several models might be involved:

* Regional models (policy analysis), at the dairy-system scale

* Farm models (production economics), or other subsystems models

* Component models (biological interactions).

Integration/articulation of phases

Table 1 indicates the research framework phases where each hypothesis can be primarily tested.

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Table 1. *Research framework phases where each hypothesis will be primarily tested.*

Areas	Hypothesis	Phase 1	Phase 2	Phase 3
Demand/ consumption	(20) Consumption levels of marketed domestic dairy products is positively correlated to population concentration	*	*	
	(21) Tastes and preferences are more important determinants to consumption patterns than household income level		*	
	(22) Among urban households the demand for dairy products is greater than for meat			*
	(23) Relative expenditures for dairy products increase with household income levels in urban areas		*	
Supply/ processing/ markets	(18) Market accessibility influences the ratio of marketed surplus (commercial sales to production)		*	
	(19) Community-level processing and handling enhance farmers, production and supply of dairy products			*
	(45) Most milk is processed/transformed in some way before being sold by the smallholder producer		*	
	(46) processing/handling milk on-farm is perceived by farmers as a major constraint to increased milk production and processing.		*	
Economics of production/ intensification	(1) As access to markets at the farm gate increases, farmers' practices change towards specialisation and intensification of dairy production		*	*
	(2) Increased demand for milk and dairy products is being met by the intensification of production, not by an increase in herd size		*	
	(3) As food crop productivity increases, more land is allocated to livestock enterprise (forage production)		*	
	(24) Technologies adopted by smallholder dairy farmers are scale/neutral		*	
	(25) Farmers, ranking of constraints to increased dairy production vary when intensification takes place		*	
	(6) On mixed food crop/dairy farms,,food crop production is accorded higher importance/ priority when labour allocation decisions are made		*	*
	(4) The intensity of croplivestock production interactions is driven by population pressure on land		*	

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			*	
	(44) Availability and cost of credit are a major obstacle to dairy intensification		*	
	(5) Intensity of croplivestock production interaction is positively related to access to dairy market		*	
	(7) Dairying offers lower returns to investment in comparison to other farm activities*			*
	(8) Specialisation in dairy production is regarded by smallholders as undesirable because it is perceived as being too risky			*
	(9) Household welfare and security are enhanced by the incorporation of a dairy enterprise into smallholder cropfarming systems			*
	(10) Smallholder dairy farmers cannot achieve the same levels of cost efficiency as those achieved on large commercial farms.			*
Sociology	(11) Labour associated with intensification of smallholder dairying is mostly shouldered by the women of the household.		*	
	(12) Supplemental income associated with intensified smallholder dairying is disproportionately retained by the men of the household.			*
Policy	(13) Regulations constitute the major constraints to increased commercialisation by small-scale entrepreneurs (processors - marketers)		*	
	(14) Policies related to dairy products are consumer-biased in sub-Saharan Africa (imports, fixed consumer prices,,subsidies,,non-price barriers like licensing etc)		*	*
	(15) Growth of smallholder dairying has been greater where government has intervened with support services (e.g. veterinary) rather than by direct interventions (e.g. producing and marketing of dairy products).	*	*	
	(16) The greater the degree of ilberalisation of the dairy sector the fewer the number of smallholder dairy producers		*	*
	(17) Government intervention in dairy markets corresponds with increased participation in and growth of informal dairy markets.			*
Feeding resources and utilisation strategies	(26) Most milk producers do not grow their own feeds		*	

	(27) The production of improved forages is (not) related to increased milk production		*	*
	(28) Land allocation to forage production is positively related to security of land tenure, and negatively to the access to communal or other land, and to the ability to acquire additional land.		*	
	(29) Lack of access to agro-industrial by-products is a factor limiting dairy intensification.		*	
	(30) For a given level of dairy production, use of agro-industrial by-products substitutes for forage production to intensify production		*	
	(31) Extent of use of crop residues is negatively correlated to dairy intensification		*	
	(32) Crop residues can provide the feed basis for profitable milk production during the dry season			*
Breeds and breeding strategies	(33) Social and policy factors are more important determinant explaining the choice of genotype than higher milk production *per se*.	*	*	
	(34) Exotic germplasm is introduced into the herds of smallholder dairy farmers before improved management systems		*	
	(35) Disease risk, germplasm availability and feed resources are key factors limiting the increased use of exotic germplasm		*	
	(36) Exotic germplasm predominates among smallholder market-oriented dairy farmers		*	
	(37) Significant productivity gains (litres/cow) can be obtained with pure indigenous breeds			*
	(38) Cost efficiency (including cost of risk) of milk production by crossbred cows is lower than that of indigenous cows			*
Disease and reproduction	(39) Availability and utilisation of veterinary services for curative interventions increase with intensification	*	*	
	(40) Patterns of disease incidence change as dairy production intensifies		*	
	(41) Acuity of reproductive wastages increases with the degree of utilisation of exotic germplasm		*	
	(42) Reducing reproductive wastage will have the single most significant impact on milk production			*
	(43) For dairying vs other livestock enterprises, disease-risk control is cost-effective			*

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Research on the characterisation of dairy systems and on ways to enhance their development will be conducted at sites chosen on the basis of criteria identified in the typification phase. This will ensure a satisfactory representation of the variety of dairy system types.

The relevance of experiments for the various locations where the characterisation (phase 2) is conducted will determine the most appropriate experimental sites to carry out on-farm experimentation in phase 3. The use of similar methodologies in phases 2 and 3 will allow the comparison of results in phase 4.

The characterisation phase 2 concerns all enquiries aimed at understanding systems and constraints, while phase 3 concerns all activities aimed at seeking solutions to constraints, including refining diagnoses. Phase 2 is therefore using the contribution of a wide range of disciplines, while in phase 3, the degree of involvment of each discipline depends on the type of intervention which is sought.

Organisation

A number of research projects will find their justification in this framework and will contribute to the accomplishment of the overall objectives.

The entities managed by or through ILCA, whose projects might fit in this research framework are the ILCA zonal sites (currently 4); the collaborative research networks (cattle, small ruminants feed resources) and ILCA Headquarters. Other institutions intervening in SSA might also implement research projects benefiting or contributing to this framework (figures 3)

Figure 3: *The contribution of the conceptual framework to organising dairy research projects.*
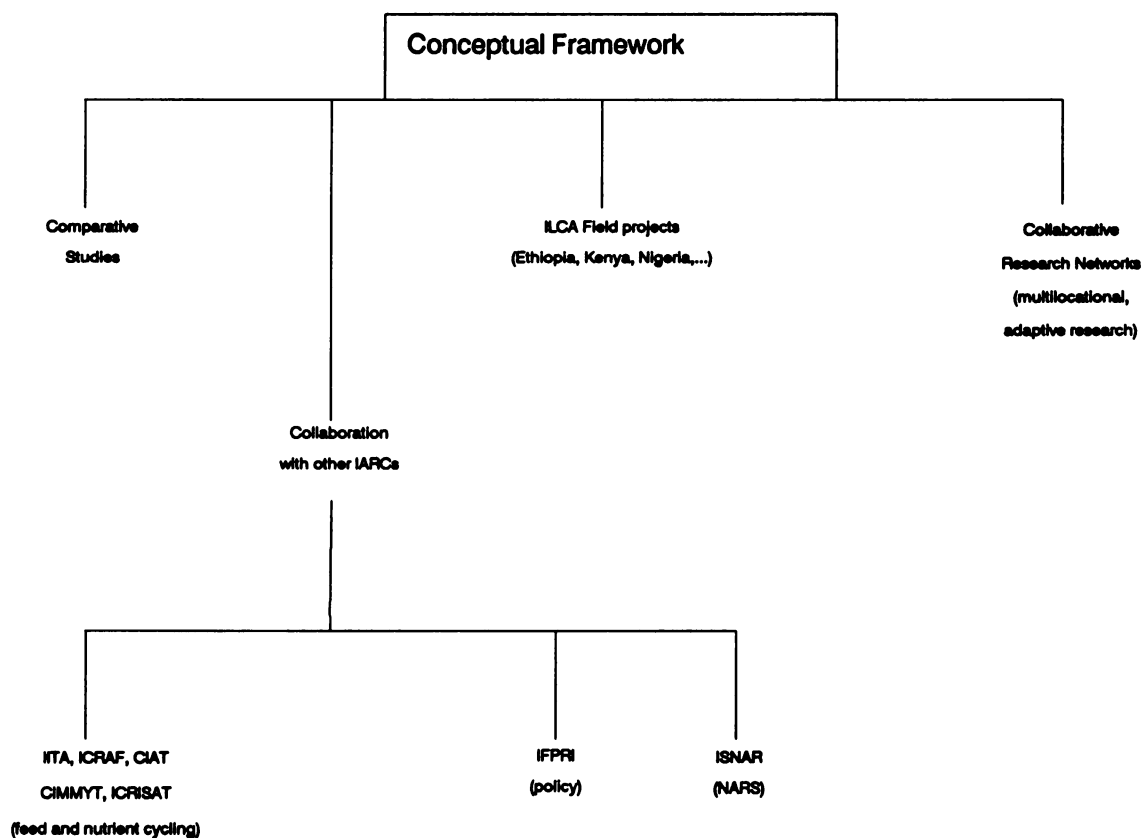
This conceptual framework for research on dairy systems helps structure the contribution of the various institutions involved and provides means of integrating results of different sites. A coordination committee might be established to regulate those interactions. It would consist of the different project leaders and be chaired by the leader of the project based at ILCA headquarters.

Conclusion

Research aimed at the development of market-oriented smallholder dairying is a partial answer to the growing concern about providing urban centres with food. Its importance results from the high ranking given to dairy products among food commodities.

The assessment of ILCA experience gained from previous work indicated the value of using consistent methods across sites. This conceptual framework for research on dairy systems has been developed in response to the concern for research relevance and impact. Although initially developed for use in sub-Saharan Africa, the principles of this conceptual framework are valid for other ecoregions as well. The methodologies developed for each phase and presented in subsequent working documents of the ILCA market oriented smallholder dairy research theme might equally prove useful in those other regions.

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