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Towards a framework for pastoral systems research

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Introduction

The International Livestock Centre for Africa (ILCA) has adopted a systems approach to research since its inception in 1975. This strategy originated from ILCA's Foundation Report, which stated that 'technical answers are available to many of the specific problems facing livestock development in Africa, but the major constraint lies in introducing change into existing socio-economic systems, exacerbated by inexperience in adapting technology to suit local conditions' (Nestel et al,1973). The approach was reinforced by the growing realisation as experienced in development projects that the results of classical on-station research, whether in Africa or elsewhere, and Western technology could not be transferred directly to African traditional systems. A better understanding of those systems, and adaptive research was necessary to identify relevant improvements.

When ILCA started its research no methodology for livestock systems research (LSR) was readily available, and a considerable amount of time and resources was spent on developing methods of studying and understanding the complexity of livestock production systems, and on defining ways in which available technology could best be tested within a particular production system. With the emergence of a farming systems research (FSR) methodology (Gilbert et al,1980; Byerlee et al,1980; Shaner et al,1982),ILCA has attempted to develop a systems approach analogous to the framework used in FSR, although the greater genetic variability of livestock, the lower degree of control because of mobility, the daily rather than seasonal inputs required for livestock, their multiple usages, and the greater influence of individual management makes LSR more complex than cropping systems research. Additionally in pastoral systems the greater mobility of people and livestock, problems of land tenure, and the

limited scope for improvements, adds to the complexity in the application of the approach.

This paper gives an overview of the ILCA research framework and highlights some of the results obtained. It focuses on pastoral systems of arid and semi-arid zones, but also includes the linkages with cropping in agropastoral systems. It uses mainly examples from ILCA's own field research in the Sahelian environment of Mali, and the semi-arid areas of Kenya and Ethiopia but also incorporates other situations in more humid areas or where ILCA was only indirectly involved.

Objectives of livestock systems research

The objective of livestock systems research (as in FSR) is to assist in the generation of relevant improvements for the well-being of a certain target population. These improvements can be technical and socio-economic in nature. LSR is not responible for the extension of a new technology, or for making complete baseline surveys or management plans for a certain region. These distinctions should be emphasised, as it immediately puts limits on the number of producer units and the kind of parameters under study, the level of details in observations made, the frequency of data collection, etc.

For example in a pastoral area, LSR would describe the relationship between water resources and rangelands utilisation, diagnose labour and sanitary constraints for the extraction and use of the different types of water points, assess the effect of those constraints on animal productivity and identify users' rights. It would then use this information to design and test relevant technology, which could overcome those constraints. It would not make a complete inventory of all water points in the region, nor conduct a hydrological study of all underground water available. The latter tasks are clearly the responsibility of a development agency, which should use the technology developed and tested through LSR to design and implement water improvement schemes for the region.

Stages in LSR

LSR as defined above consists of a sequence of stages, designed to identify constraints in a particular system, and through experimentation or available knowledge identify possible solutions. These solutions are then tested in real life situations, initially with a high degree of scientific control, and as positive effects are noted with increasing producer participation and decreasing scientific involvement and control. Table 1 gives the different terms used in each of the stages.

Table 1. *The terms used in the stages of livestock systems research*

Stage	Object of observations
1. Descriptive	Natural, livestock and human resources, production systems
2. Diagnostic	Constraints, in order of priority research requirements, chances of success to overcome them
3. Design researcher managed/ executed	Possible solutions through on-station experimentation or body of knowledge
4. Testing	
a. researcher managed/ farmer executed	Producer management of improvements
b. farmer managed/farmer executed	Acceptability of improvements
5. Extension	Evaluation of technical and socio-economic impact of improvement

Source: Adapted from Shaner et al (1982) and Norman (1982).

Three points should be emphasised in this context :

1. The different stages can overlap, e.g. it is not necessary to complete the whole diagnostic phase before any design or testing activity can take place.

2. Although the classical approach is to start with the descriptive phase, the research process can be initiated at any stage.

3. Continuous data analysis is essential for feed-back of results and rapid progress from the descriptive/diagnostic phase to the testing phase. Micro-computers can play a useful role in this process. If no computing facilities are available, the data collection system should be organised in such a way that calculators can do the analysis.

Some considerations on sampling framework in LSR

With the increasing limitation on funds and the pressure from development agencies on research institutes to provide improvement the emphasis is on using rapid and low-cost appraisal techniques. Sample selection can be an important tool in enhancing the cost effectiveness of the diagnostic and testing phase. ILCA's results indicate that the following parameters are important in determining the management strategy, and therefore the profile of possible improvements, and should be considered in the sampling framework.

1. The livestock/man ratio ("rich vs poor"). It becomes increasingly apparent that a different degree of livestock wealth results in different management. For example, in the pastoral areas of Niger, Wilson and Wagenaar (1983) found a marked decrease in offtake with increasing herd size (see Table 2).

Table 2. *Relation between herd size and offtake of WoDaaBe herds in Northern Niger (1983)*

Herd size	Offtake* (%) per year
5-10	5.9
11-15	10.9
16-20	4.7
21-25	4.3
>25	3.5

* Sales, slaughter and gifts

Source : Wilson and Wagenaar (1982).

In this example the category owning between 11 and 15 animals also sold females which indicated that they were forced to sell. The poorest category could not sell, and practised migratory labour. Further examples of the importance of livestock/man ratio, and a rapid method of assessing the relative wealth will be given by Bekure and Grandin later in the workshop.

2. Men vs women. As shown by ILCA's subhumid programme in northern Nigeria (ILCA, 1982) there is often a conflict of interest in the male and female economic sphere particularly over milk offtake and sales. Milk offtake normally benefits the women, whereas the proceeds of livestock sales go directly to the men. Improvements like supplementary feeding, which are financed by men, therefore should not only result in increased milk offtake, but also in increased rates of calf survival, and at a later phase improvements should benefit both groups in order to avoid future inequities. In pastoral systems research, both groups should therefore be included in the sampling framework.

3. 'On-road' vs 'off-road' producers. Especially in agro-pastoral systems research activities tend to focus on the easily accessible 'on-road producer. Access to a road, as shown in Table 3 for the Ethiopian highlands, to a considerable extent affects producers' strategy, and therefore should be one of the considerations in selecting the sample.

Table 3. *Average livestock holdings per household of on-road and off-road producers* in the Ethiopian highlands*

Livestock	'On-road'	'Off-road'*
Cows :		
Local breeds	2.1	1.6
Crossbreeds	0.4	-
Oxen	1.8	1.6
Sheep	4.9	8.5
Goats	0.2	0.3
Donkeys	1.0	1.2

* Minimum of 2.5 hours away from an all-weather road.

Source : Gryseels (per. comm.).

Descriptive and diagnostic phase

The descriptive phase consists of a literature review and a general reconnaissance of the resources and production systems of the target region. It will generally provide an indication of the nature of the constraints but not a quantitative assessment of their importance or their priority ranking. The descriptive phase should be kept short (one to six months) to move as soon as possible into the diagnostic phase.

The different methods used by ILCA in the descriptive and diagnostic phase for resource assessment, and the measurement of vegetation, vegetation trends, animal productivity, importance of diseases, nutrition, resource allocation within the producers' units, and marketing will be presented in detail in this workshop, and are therefore not reviewed in this paper. Some results which merit special mention and which have assisted in developing ILCA's overall programme are :

1. Herd and flock management practices by individual owners seems to be one of the most important single factors affecting productivity. For example, Wilson et al (1982) found in central Mali the ratios of the production index (production kg per year per kg metabolic weight of breeding female) given in Table 4.

Table 4. *Ratios of production index of small ruminants in the agropastoral system of central Mali*

Source of variation	Ratio	Goats	Sheep
Overall mean		1.47	2.31
Parity	All parities/ first	1.40	1.23
Season of birth	Best/worst	1.23	1.14
System	Rice/millet	1.58	1.33
Flock (millet)	Best/worst	2.43	
(rice)	Best/worst	5.58	

Source : Wilson et al (1982).

Similar results were obtained in ILCA's Kenyan programme both with cattle and small ruminants. This is all the more surprising because grazing is communal to all and different owners have the same access to this principal resource. Individual management skills therefore seem to play a more important role than previously reported. However, ILCA has not yet defined the components which determine those management practices. In view of their overriding importance, more attention is presently being given to quantify these factors. Indeed if those parameters could be better quantified, and if through extension the management of the below-average flocks and herds could be raised to higher levels, considerable productivity gains could be obtained.

2. Strong linkages already exist between livestock and cropping, and the enhancement of these linkages merits a high priority in research, because they form a relatively easy entry point for improvement.

On an Africa-wide scale Brumby (1983) observed a significant correlation between the increase of total cereal production and cattle numbers, e.g. that each extra number in the cattle population was associated with an extra 0.25 ha of crop land and about 200 kg of annual grain output. On a regional basis, the strong relationship between livestock and cropping was shown by ILCA's aerial survey work in several systems. For example, Table 5 demonstrates this integration for central Nigeria.

Table 5. *Relationship between livestock and cropping in central Nigeria*

% area cultivated	Cattle density	
	wet season	dry season
< 10	7.7	40.0
10-34	16.6	48.5
35-60	21.4	50.6
> 60	22.4	45.7

Source: Miligan, 1980.

The beneficial nature of this relationship expresses itself differently in the various situations. For example ILCA's systems studies in central Mali demonstrated a very clear effect of livestock ownership on millet yields, probably through the manure linkage (see Table 6).

Table 6. *Relation between village field millet yields (kg/ha) and livestock ownership in central Mali*

Year	Millet yield (kg/ha)	
	Households with cattle	Household without cattle
1980	679	440
1981	637	439

Source : Fulton and Toulmin (1982).

A similar close relationship in the field of animal traction was found by Gryseels (1983) in the Ethiopian highlands. His results clearly show a marked increase in the crop area cultivated by each family as well as a significant change in cropping patterns to higher value cereals as oxen numbers increase (see Table 7). Similar trends were observed by ILCA's central Mali studies (Fulton and Toulmin, 1982).

Table 7. *Relationship between area cultivated, cropping pattern and oxen ownership in the Ethiopian highlands*

No. of oxen per farmer	Area cultivated (ha)	Area under cereals (%)	Area under pulses (%)
0	1.2	54	46
1	1.9	44	56
2	2.7	67	33
3 or more	3.6	92	8

Source : Gryseels (1983).

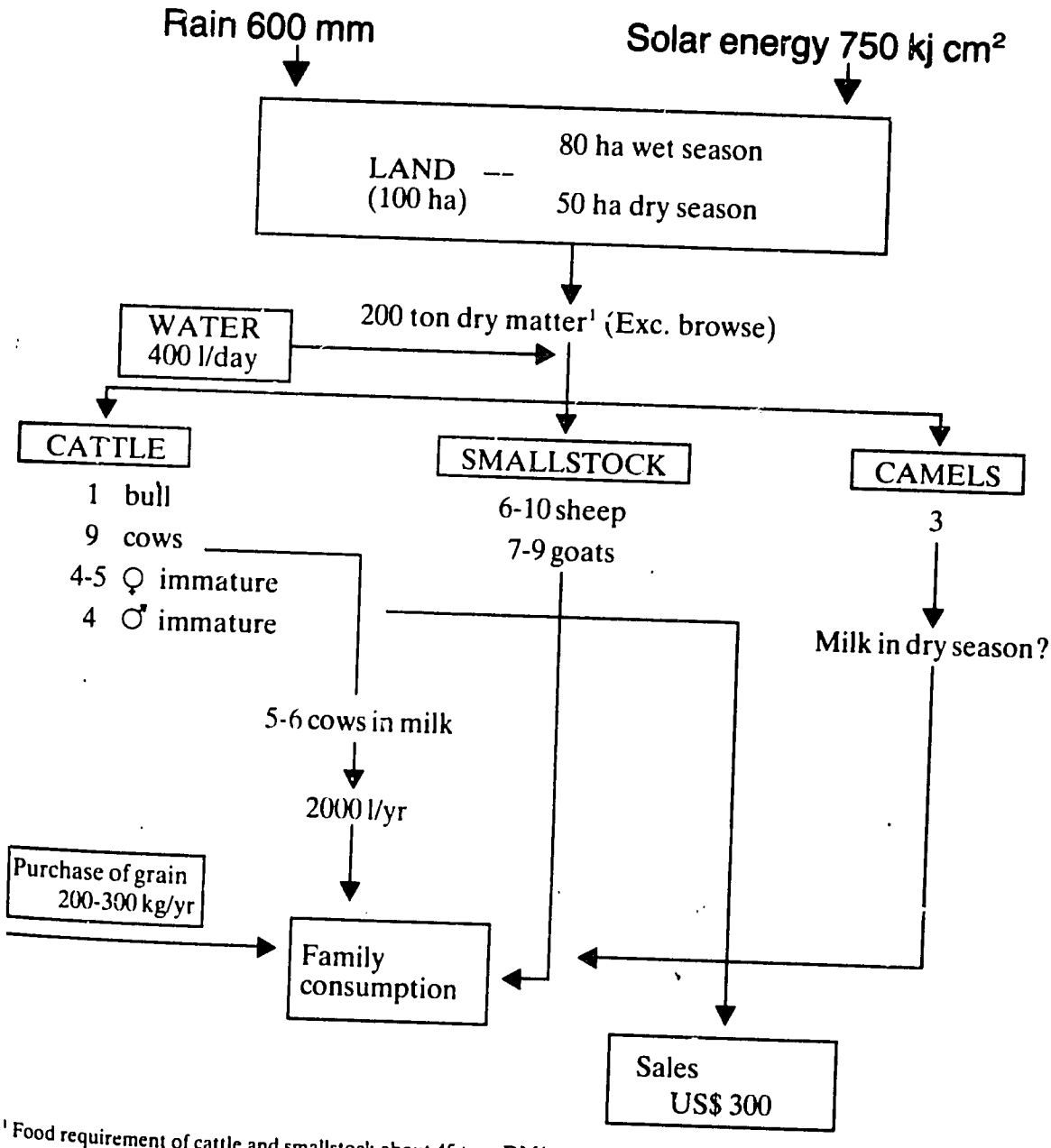
These findings have directed to a considerable extent the focus of ILCA's research thrust; for example, activities aimed at strengthening the integration of crops and livestock (legume agronomy, animal traction) are receiving approximately 150 % more funding in 1983 than in 1981.

Even more important than the specific results, although less tangible, is the understanding ILCA staff have gained of systems and systems research after five years of work.

The identification of improvements

Possible improvements are identified and designed by the systems team, tentatively during the descriptive phase, but increasingly during the diagnostic phase. It should be emphasized that the identification of improvements and their priority ranking must be a team effort. Quantitative models describing the input/output relationships at the different systems levels are useful in assisting the team in the decision-making process.

The plant/animal sub-component is adequately represented by ILCA's herd productivity model. This model is being used to estimate the effect of supplementation or management strategies, such as the effect of early weaning, watering frequencies and distance to water on livestock productivity, and can therefore be used to rank the priorities for field research (Konandreas and Anderson, 1982; Konandreas et al, 1983). A simple example of an input/output model at the producers' unit level for the Ethiopian Borana system is graphically represented in Figure 1.



[1] Food requirement of cattle and smallstock about 45 tons DM/yr.

Figure 1: *Input/output relationships of a Borana pastoral production unit in southern Ethiopia*

This particular example also illustrates the multi-disciplinary approach to the identification of improvements. In the Borana system the herd demography study revealed a significant differential mortality between female and male calves (see Table 8). This is caused by a heavy reliance of the Borana on milk for subsistence, which probably forces them to slaughter male calves to enable a faster reproduction and to allow less suckling to increase the amount of milk available for human consumption. However, this strategy conflicts with government objectives aimed at increasing the meat offtake from these rangelands. An obvious way therefore to reduce this calf mortality, and to increase total offtake from this particular system, is to increase either the total milk yield or the amount of available grain to reduce dependence on milk. The joint ILCA/RDP (Ethiopian Rangelands Development Project) team therefore will shortly be testing the feasibility of millet cultivation around the heavily manured permanent dry-season camps and has started work on legume introduction for dry-season supplementation.

Table 8. *Age/sex distribution (%) of cattle herds in southern Ethiopia (dry and lactating herds combined)*

	Age/sex distribution (%)	
	Female	Male
Calf	12.2	9.3
Immature	14.7	6.3

Source : Cossins (pers. comm.).

The design phase

The assumption that the new technology for improving Africa's traditional livestock production systems would be available, is only partially true. Generally it can be said that in the field of animal health and animal nutrition there exists a whole range of improvements, which can immediately be tested under pastoral con-

ditions. However, in the field of range management and in the integration of forage production into cropping systems, the available body of knowledge is still extremely scarce, and no clear-cut solutions to identified constrains are available. Production parameters have to be established, therefore, initially under controlled conditions, e.g. in on-station research. It is therefore essential that LSR has access to good research station facilities. One major distinction between LSR and classical research station experiments relates to the identification of the treatments. In LSR the treatments are defined by the socio-economic and political framework determined in the diagnostic phase. If for example the supply of fertilizer or agricultural equipment is not expected in the near future, such inputs would not be used in the experimental design.

The testing phase

Once the improvements have been formulated they have to be tested under producers' conditions. The object of these tests is to obtain scientifically valid conclusions regarding the effect of improvements and to assess producers' acceptance. The first objective distinguishes systems research from extension. In extension improvements are normally introduced without control groups, and without built-in scientific comparisons. In systems research the objective is not to cover the whole target population, but to make a scientifically valid comparison regarding the effect of certain treatments (improvements) on a minimum required sample size.

This means that systems research should always have a with/without comparison on a representative sample, simultaneously carried out under similar environmental conditions. A before/after comparison as carried out in many development projects will always have the confounding effect of different environmental conditions.

For this comparison, matched pairs of animals with similar characteristics within a herd or flock are preferred when inputs are very easily administered. ILCA is following this experimental procedure for example in the case of animal health inputs, and in concentrate supplementation in northern Nigeria. If the improvements

proposed require major changes in management strategies, or different organisational structures, then comparisons have to be carried out on a whole farm, or whole herd, basis. Examples of this procedure are to be found in ILCA's programme testing the use of fodder banks in northern Nigeria, and forage production and crossbreeding for dairy production in the Ethiopian highlands.

The latter programme, although not a pastoral system, illustrates the value of continued systems research. Although the initial results (Gryseels and Anderson, 1983) showed a very positive impact of the introduction of crossbreds and forage production (annual milk yield increased sevenfold to 2300 kg, cash income fourfold to US $ 800, food grain production by 40 %), changes in the cropping pattern clearly demonstrated the need for more research on forage production. It was shown that farmers: 1. replaced their crop yielding the lowest gross margin (pulses) to grow forages with a resulting negative long-term effect on soil fertility; 2. allocated labour for soil preparation first to cereal crops, rather than the forages; and 3. applied fertilizers only to cereal crops because of recent increases in fertilizer prices. This in turn has caused ILCA to allocate more resources to the search for leguminous pasture plants requiring low labour and low fertilizer input. The first on-farm trial with a perennial grass legume mixture will start in 1983.

Improved range management practices are particularly difficult to test under pastoral conditions, and generally new organisational forms are required *a priori*. Even so, a good understanding of a traditional system frequently offers opportunities:

1. In the Malian delta, traditional forms of land tenure offer the possibility of establishing pastoral units which would enable the introduction of improved grazing schemes (ODEM/CIPEA, 1983 Wilson et al, 1983).

2. In Niger, building upon traditional water rights, a promising grazing scheme developed on a government station will be tested with a small number of experimental herders associations. Soon to be established water points under the control of those herders associations form the mechanism for testing this grazing scheme.

3. In the Kenyan group ranches, individual ownership of certain pastures allows the introduction of legume fodder banks to overcome the dry-seaon nutritional stress. ILCA plans to introduce fodder banks in on-herd trials in 1983.

Extension phase

Once the improvement has been satisfactorily tested under producers' conditions in farmer managed, farmer executed trials, it can pass to the extension service for further implementation. This will generally be carried out in the framework of a development project.

It is important to evaluate the improvement and, in this phase especially, its socio-economic impact. The direct involvement of a research institute in this evaluation is questionable. Ideally the project or extension structure will include the capabilities for the technical and socio-economic evaluation of the improvement. In the absence of such a structure and the information still being required, it should be national research institutes who take responsibility for this often politically sensitive task. The degree of ILCA's direct involvement is an open question.

In any case, the evaluation procedures should be simple and be focused on the specific improvement introduced. If a particular improvement is to be successful, it should produce a considerable gain in productivity and income, or added security. The data collection system to study the impact could therefore be reduced in sampling frequency and size. Qualitative information allowing the identification of trends in this case might be given more emphasis.

ILCA's future role in LSR

Livestock systems research is location specific, focusing on a particular target zone. It cannot be the role of an international centre like ILCA to take direct responsibility for the whole African production system. Rather, ILCA sees its role as 1. further developing the systems methodology for each of the major ecological zones, 2. developing improvements for the constraints identified in those zones, and 3. simultaneously assisting national research and develop-

ment agencies in establishing their own in-house capabilities. The interest which has recently emerged is encouraging.

- In northern Nigeria, ILCA is actively cooperating with scientists from the National Animal Production Research Institute (NAPRI) in establishing an LSR group, which focuses on an agropastoral system near Shika.

- In Mali, ILCA has recently signed a contract with the Institute National de Recherche Zootechnique Forestier et Hydro-biologique (INRZF) to assist in the establishment of a LSR group in the institute to focus on smallholder mixed farmers in southern Mali.

- Negotiations are at an advanced stage with the Directorate of Research and Special Services in Zimbabwe to assist them in the establishment of an LSR capability, focusing initially on two mixed farming systems, in high and medium potential areas respectively.

- The Government of the Cameroons has recently approached ILCA to assist them in developing LSR capabilities in the Institute de Recherche Zootechnique (IRZ) focusing initially on three different production systems there.

Summary

The complexity of livestock production systems in sub-Saharan Africa, and the multiple objectives of its producers requires that whole systems rather than components be studied. Livestock systems research, as practised by ILCA over the last year, represents an approach to such studies. By applying this approach ILCA has gained considerable knowledge of the constraints and opportunities in pastoral and agropastoral systems.

The testing of improvements under producers' conditions is a crucial and essential part of this approach. Livestock systems present particular difficulties in implementing these tests. Some experience has been gained but more methodology development is still required for this phase.

ILCA sees its role as that of further exploring these issues, assisting national agencies in developing systems research capabilities, and developing relevant improvements to the constraints

identified. With this combination of research thrusts ILCA believes that a sustained gain in African livestock productivity and overall food production can be achieved.

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