# R6606
# A Decision Support System for Sustainable Resource Use in Bolivian Smallholder Dairy Systems

## Final Technical Report

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## 1. Executive Summary

The objective of this project was to study the relationships between technological use and farm and farmer characteristics in dairy and dual purpose farms in Santa Cruz, Bolivia. Quantitative and qualitative data related to farm dimensions, land use, pasture, nutrition, reproduction and health management and farm household social characteristics, access to information and technical assistance were collected from 319 farms in the main dairy producing regions of Santa Cruz. Data were analysed by multiple correspondence analysis (MCA) in order to establish relationships amongst management intensity and variables related to farm structure, productive orientation and the farmers social conditions and information exposure to technical aspects. A cluster analysis was then carried out to identify groups of farms with similar characteristics within the sample population. The analyses demonstrated clear relationships between management intensity, the farms' dimensions and the farmers' social conditions and access to information. Results are discussed in respect to the importance of farm characterisation for defining target groups and delivering research outputs and extension policies more effectively.

The economic results of these systems were related to the physical resources of the farm. Large commercial livestock farms obtained the highest Income, Gross Margin and Net Margin. Medium size agricultural farms obtained intermediate level in Income and Gross Margin, although Net Margin was very close to the previous group. Small semi-commercial mixed farms obtained the lowest Income, Gross and Net Margin. A high proportion of these farms could be considered under the level of poverty. The structure of Income and Costs were also very different between groups. Group 1 was characterised by the high contribution of milk sales to total income. This Group was also defined by high replacement, feeding and permanent labour costs. In Group 2 the most important income came from agriculture, mainly soya bean, and the most relevant costs were cropping costs. Group 3 was characterised by mixed agriculture-animal production systems, although income came basically from animal products due to the on-farm consumption of agricultural products. The highest costs were labour costs. Agricultural farms (Group 2) were more intensive in terms of inputs per ha and obtained the highest unitary Income and Net Margin. Small semi-commercial mixed farms were very low-input systems but the unitary Income and Net Margin were similar to the ones obtained by Group 1, which occupied an intermediate position in terms of inputs per ha. The methodology used in this work was useful in selecting target farmer groups and identifying recommendation domains in order to implement more focused development and extension policies.

## 2. Background

The inception of the this project can be traced back to 1992 when CIAT staff members visited the Herd Health Proect in Costa Rica, institution where the first author used to belong to. At that time CIAT were interested in livestock monitoring systems for implementing them in Santa Cruz but at that stage a funding source could not be identified to establish the links for collaboration.

In 1996, CIAT Santa Cruz started a project called Improved Management of Dairy Farms with funds from the local Government. The main objectives of this project were to provide farmers with a range of management interventions (mostly related to grazing, feeding and herd management) for improving their systems. The DFID funded Project R6606 started at the same time as a complement to the activities of this government funded project. The aim was to provide the methodological frameworks for an adequate bio-economic analysis of possible interventions to be field tested and to establish adequate research protocols and mechanisms for disseminating the best bet strategies found. The project established links with a range of institutions such as farmers organisations (AGANORTE, ASOPLE) and local and international NGOs working in different sites in Bolivia.

During the last years of this century, important changes must start taking place in the three areas that compose sustainability: environmental, economical and social. Global trends in environmental problems like the non sustainable consumption of resources, global warming, erosion, water mismanagement, deforestation, loss of biodiversity, etc. have initiated a change towards an increased environmental awareness, even though this has lead to only a small change in attitudes and developmental patterns of the global population.

On the economical side, market globalization, with the decrease in subsidies and the reduction in tariffs, together with new market restrictions based on quality of production process instead of products (ISO standards) is having and will have an increasing impact on developing countries' economies.

Placement of man as the center of development and assessing development with "new" standards - for example the Human Development Indicators from the United Nations Development Program instead of Gross Product - are changing development priorities. Factors such as loss of social well-being, concentration of wealth and decision taking, reduction in governability, social insecurity, transculturization and loss of cultural identity will play increasing roles in future development policies. Food security and health are growing concerns, especially in less developed countries where population growth is still the most important limitation for a sustainable development.

Animal production has formed part of human development since the beginning and will still play an important role in the future, especially in less industrialized countries and even more under the scope of "natural" production systems, where yields will be - at least in the near future - lower than those obtained with the chemical agriculture of the green revolution.

Existing information of the possibility of increasing soil fertility and actual recuperation of degraded land using agroforestry systems with animal production leads to a new impulse of a not so new focus of animal production. Increased productivity must be accomplished on the basis of maintaining or actually increasing availability of resources for future generations. Traditional production systems based on food sources that compete with man, such as grains, passing them through a significant reduction in metabolic value through an inefficient transformation into animal protein will tend to

loose importance. The use of food sources that do not compete with human consumption (tree, shrub or grassland forages or residues from the agroindustry for example) will play an important role in the near future. The need to increase the production of wood as a source of CO2 fixation in the Climatic Change Agreements also confirms the need to develop production processes compatible with reforestation or forest regeneration, which additionally to reducing the danger of global warming, main interest of industrial countries, also satisfies the need of the poorer nations of feeding their populations.

The need to conduct research in the area of animal-plant interface is relevant because the livestock production from forages largegy depends on effciency of converting forrages into products. The success of the production systems will depend on the quality and quantity of forage produced, the animal's capacity to eat and utilise the forage, and on the ability of the farmer to manage the resource. The better the management, the better the chances of being a sustainable enterprise. On the other hand, understanding grazing management systems require understanding of the production system as a whole.

The contribution of the project to the development of tropical livestock production systems is expected to have a positive social, economic, and ecological impact in different regions of Latin America. As our knowledge in pasture management and it's economical impact in the region increases, our research aims to make the farmers aware of the problems thus allowing us to undertake farmer-oriented research. Ultimately, the research proposal is meant to support an improved use of the land resource and hence, to contribute to a reduction of deforestation. The research training for local staff which is part of the proposal will provide competent researchers to guarantee an international scientific level and assurance continuity of the programme once the project terminates.

Finally, it is also important to consider that when aspects of sustainability have to be considered, including the production of new technologies, it is essential that technology development be done under local conditions. This will increase the feasibility of application by the final users.

The general systems modelling framework is presented in figure 1 (Herrero et al. 1995). It consists of adapted components representing individual biological processes (grass growth, pasture-animal interface and cow models), population dynamics (stochastic herd model), management practices and the socio-economic environment (databases and surveys) and a validation element (livestock and pasture databases). These components interact so that the output of one is used as the input for another one or has an influence on it.

The simulation system consists of an adapted mechanistic grass growth model (Johnson & Thornley 1985) representing the growth, structure and chemical composition of a sward under rotational grazing with responses to N fertiliser applications, temperature and light interception throughout the year. The function of this model is to determine the effects of different grassland management options on pasture dry matter (DM) production, chemical composition and sward structure. In a rotational grazing system, the typical examples of management practices that could be examined deal with the length of the regrowth period, the amount and timing of fertiliser applications, the effects of defoliation regime on subsequent sward growth and structure and their interactions. The importance of this model being mechanistic and driven by environmental variables is that it provides a basis to study seasonal effects on pasture growth and it makes the adaptation to different grass species and different climatic regimes or latitudes a viable option.

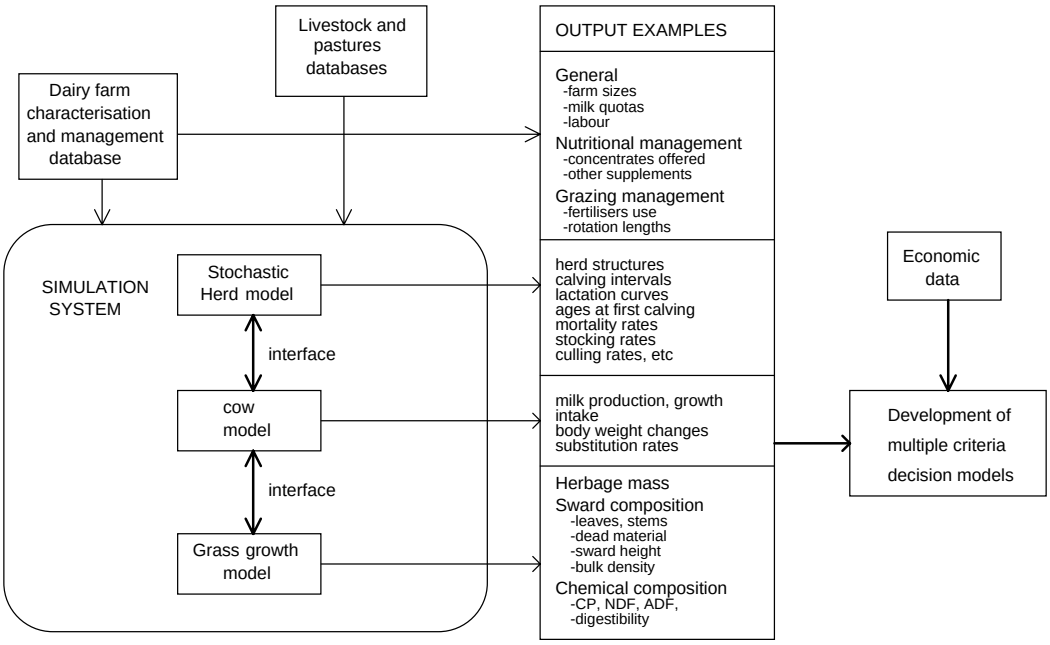


*Figure 1. General dairy systems modelling framework*

The grass growth model is linked via an interface representing the grazing process and the effect of sward characteristics upon animal intake to a dairy cow model which calculates nutritional requirements (based on AFRC 1993) according to the cow's physiological state, milk production, body weight and body weight changes. The dairy cow model also represents the factors controlling the fibre digestion kinetics of the ruminant and simulates digesta clearence and availability of nutrients. The representation of the plant-animal interface is one of the most critical developments for the system because the sensitivity and accuracy of the prediction of the productive responses to nutrients by the dairy cow is largely determined by a good estimate of pasture intake. While recent systems of feeding standards (i.e. AFRC 1993) have estimated the nutritional requirements of ruminants with some degree of accuracy, they have not dealt satisfactorily with intake prediction. Most of the proposed empirical relations are descriptions of specific datasets which broadly reflect practical conditions but which are not sufficiently precise to be used in the farm management context (see Forbes 1993), especially with grazing ruminants where aspects related to the physical quantity and structure of the sward also have an influence on the amount of pasture eaten (Hodgson 1985). This interface should therefore attempt to describe the basic components of voluntary pasture intake, and linked to the dairy cow model, to be able to test the effects of different grazing or supplementation strategies on the cows' productive performance.

After analysis of livestock databases including different farms from a region in study, herds are simulated by an stochastic population model. The function of this model is to provide the herd characteristics of a particular farm (i.e. number of animals, herd structures, calving intervals, culling and mortality rates) and the individual animal variables which drive the dairy cow model (i.e. body weight, milk production, physiological state) considering the random variation existing in the real systems. Its importance lies in the representation of the effects of changes in management practices on herd production and economic performance (Sorensen et al. 1992).

Data from farm surveys provide additional inputs influencing the production responses from the biological models (i.e. concentrates allowance, fertilisers use, paddock rotation lengths) and the relevant farm and management characteristics (i.e.

farm size, milk quotas, young stock rearing practices) that are linked to the herd model or that constrain the system.

Validation of the simulation system against real farm data is done with animal performance and grazing databases obtained from available farm monitoring services, farm records or experiments. The important variables to validate are the outputs of each individual model, those variables with a high sensitivity to changes in management practices or those which largely determine the economic efficiency of the system. For example, herbage production, individual milk production or herd structures.

Finally, the validated outputs of alternative simulations are combined with economic data and are used as inputs in MCDM's. The dairy farm simulation system is run under different scenarios associated with changes in grass production, grazing strategy, nutritional or herd management and land use options and the MCDM's examine the different simulation runs and identify the management strategies which produce the most viable compromise between the farm's resources according to the established objectives. MCDM's have the advantage that users can assign subjective weights to represent the importance of the multiple activities in the system. Therefore if these weights represent the priorities of the decision maker (usually the farm household unit at a farm level), then better advice could be given as the resource compromise could reflect more accurately the farmer's objectives.

Although the methodology presented here is given in relation to the dairy farm, it could be adapted to other ruminant production systems (i.e. beef or dual purpose cattle, sheep, goats) which could be represented by adjusting the time steps of management events, the biological cycles, or the production objectives. The creation of this system as individual modules linked by appropriate interfaces also permits the use of each model independently if required.

## Project purpose

The project was designed in 1995 to satisfy ODA's Strategy for Research on Renewable Natural Resources through the Livestock Production Programme in the Forest/Agriculture Interface. At that stage the overall mandate of the project was to contribute to the strengthening and sustainability of Bolivian livestock systems through improved utilisation of local resources. The project shifted its focus to a more poverty – oriented framework in 1997 (1.5 years into the project) after DFID changed its mandate to poverty reduction by 2010.

## Research Activities

This project was conducted in the main dairy region of Santa Cruz, Bolivia. This area comprises four subregions, namely Area Integrada, Sara-Ichilo, San Javier and Zona de Expansión. This is one of the most important milksheds of Bolivia, producing between 180 – 185 million litres/per year.

Santa Cruz is one of the main agricultural departments of Bolivia and produces 34.5% of the national agricultural GDP. Livestock contributes to 21.6% of the agricultural GDP and utilises 29% of the total departmental area (approximately 371 thousand $km^2$). Intensive crop and cereal production account for 39.7% and 19.3% of the agricultural GNP of Santa Cruz, respectively. They cover 11.4% of the total area (CAO, 1998).

The region under study has a tropical climate with a well defined dry season (April – October). Annual rainfall varies from 1200-1800 mm, while temperature fluctuates between 25 – 35 $^oC$ (Vargas, 1996).

in the provinces of Sara, Ichilo, Warnes and Andres Ibanez which cover the main milkshed of Santa Cruz and is the second most important milk producing region of Bolivia (Figure 1).

Research activities were planned to cover 5 outputs:

1. Characterisation of smallholder dairy and dual purpose systems to help extension agents and policy makers target their needs more effectively.
2. A livestock monitoring system implemented in Santa Cruz. This would improve the extension capacity of local services and their relationship to the farmers.
3. A validated decision support system for Bolivia smallholder dairy and dual purpose systems.
4. Options for improved management and production of cattle production systems provided.
5. Trained personnel.

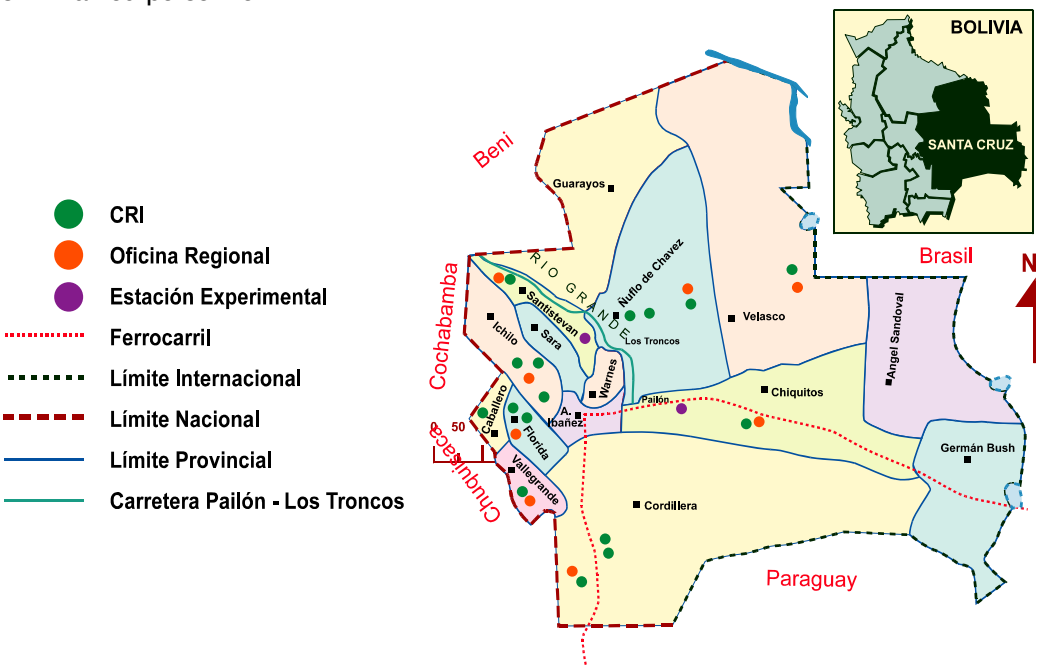


**Figure 1 - Map of Santa Cruz, Bolivia**

## Systems characterisation – the survey

The main reasons for conducting a survey for characterisation of dairy production systems were:

- lack of existing baseline data from which to define recommendation domains for the project
- lack of studies providing the basic characteristics of the different systems in which milk production was an important component of livelihoods strategies of farmers
- need for identifying where poorer farmers were in the region and what characterised their systems and livelihood strategies

### *Data collection*

The initial information before starting the survey was gathered through visits to all dairy farmers associations in the regions under study, to FEDEPLE (Federación Departamental de Productores de Leche), FEGASACRUZ (Federación Ganaderos de Santa Cruz), Comité Central Menonita and to several NGOs (CEPAC,Winrock). The total number of farms in the area of study was 7446 (FEGASACRUZ, 1996). A sample of 418

farms (5.6%) stratified by district and productive orientation (dairy or beef systems), was used. Data was collected in a series of farm visits using direct structured interviews to farmers. The study referred to a period of time of one year and collected quantitative and qualitative information about 1. family and education level; 2. labour availability and work distribution; 3. crops, pastures and other resources; 4. herd structure; 5. facilities and machinery; 6. decision making and technical services; 7. pasture and nutrition management; 8. reproductive and milking management; 9. health management and pathology; 10. economic and physical inputs and outputs. After a preliminary analysis, pure beef farms (6.2%) and incomplete or non-reliable data (17.5%) were eliminated. Therefore, the final size of the sample was 319 farms.

Three basic studies were conducted with these data:

1. Descriptive statistics of dairy production systems by province.
2. A study on the relationships between management intensity and structural and social variables
3. A study on farm economics and the intensification process of mixed crop-dairy systems in Santa Cruz, Bolivia

CIAT saw the first study as a very important output for disseminating information at a local level due to their close relationships with the dairy farmers groups, NGOs and departamental famers associations. Studies 2 and 3 were designed to define recommendation domains, especially targetting poorer farmers, for the project, for CIAT and for the dairy subsector in general.

## Outputs

## Characterisation of dual purpose and smallholder dairy systems in Santa Cruz Bolivia

### Introduction

Extension and development policies have traditionally being directed to the 'average farmer', without taking into account the social, cultural, economic and environemental conditions in which they live (Skerrat, 1995). Several authors (Dent and Thornton, 1988; Chambers et al. 1993; Dent et al. 1994; Ferreira, 1997) believe this to be one of the main reasons for the lack of adoption of certain technologies at the farm level.

Characterising livestock production systems under a multidisciplinary framework is a fundamental step for acknowledging these differences, for understanding the systems, and for guiding and targeting the development of policies and extension messages adaptable to the wide variety of existing farming systems and farming styles (Jones, 1991, Osty, 1994). Characterisation studies have usually focused on descriptions of the farms available resources and their management, but seldomly have studied the complex realtionships between the farms' resources, the farmers' managerial capacity, which is in part determined by their social conditions and information access, and the management intensity they implement in their farms (Ferreira, 1997). The objectives of this study are to examine these relationships using farm level quantitative and qualitative variables obtained from dairy and dual purpose systems in Santa Cruz, Bolivia.

## Study 2 - Relationships between management intensity and structural and social variables in dairy and dual-purpose systems in Santa Cruz, Bolivia

### Data Analyses

Since a large proportion of collected data were qualitative, Multiple Correspondence Analysis (MCA), a methodology able to deal with both qualitative and quantitative data was used. MCA allows analysing large quantitative data matrixes and it is a weighted principal component analysis of a contingency table (Greenacre, 1984; Sanchez, 1984). Before the technique can be used, it is necessary to transform quantitative variables into classes. Quantitative variables were analysed individually to check if they have a normal distribution. The variables were then divided into three classes using the quantiles (Q) position (Q1=25% lower observations; Q2=50% intermediate observations; Q3=25% higher observations). All analyses were done using SAS statistical software (SAS Institute, 1997).

The variables and classes used in the analysis were divided in six groups.

#### *2.3.1. Pasture and nutrition management*

Three variables were chosen as representative of pasture and nutrition management. The variables were (Table 1):

*Use of Concentrates* was a binomial variable that expressed whether the farmer used concentrates for any of his animals or not.

*Metabolisable Energy* was the amount of metabolisable energy (Mcal) supplied per lactating cow per day in the dry season and in both dry and rainy seasons.

*Cultivated Pastures* was the land area of cultivated pastures expressed as a percentage of total pastures.

### *2.3.2. Reproductive Management*

The variables referring to some of the more relevant aspects of reproductive management are explained in Table 2. These variables are:

*Calving Assistance* was a score of different control practices in calving as, assistance during parturition, use of a specific calving room, hygienic conditions, disinfecting of umbilical cord, surveillance of calostrum intake and support with vitamins and minerals.

**Table 1. Variables and classes of pasture and nutrition management**

| Variable | Classes | Code | No. of observations |
|---|---|---|---|
| Use of concentrates | Yes | ConcenY | 82 |
| | No | ConcenN | 237 |
| Metabolisable energy | 0 Mcal | SupN | 123 |
| | <1707 Mcal in dry season | SupDryLw | 10 |
| | 1707-4816 Mcal in dry season | SupDryI | 18 |
| | >4816 Mcal in dry season | SupDryH | 14 |
| | <2323 Mcal in both seasons | SupYearLw | 36 |
| | 2323-5485 Mcal in both seasons | SupYearI | 71 |
| | >5485 Mcal in both seasons | SupYearH | 47 |
| Cultivated pastures | <33% | ImpPastLw | 51 |
| | 33-67% | ImpPastI | 35 |
| | >67% | ImpPastH | 233 |

*Breed* specified the main breed of animals present in the farm. The different breeds were aggregated as Crossbreed, *Bos taurus*, *Bos indicus* and Criollo (local Breed).

*Mating* indicated whether the farms used natural mating or artificial insemination.

*Reproductive Control* was a binomial variable that indicated whether any reproductive control measure such as gestation control or rectal palpation was used for determining pregnancy and reproductive efficiency.

*Selection Criteria* reflected the criteria followed by farmers to select the replacement animals from the own farm. The criteria were milk yield of the mother, pedigree, conformation of the animal, breed, reproduction performance of the mother and none.

*Replacement Origin* expressed the main origin of replacement animals. It could be from the farm, from other farms in the region or in the country and both options.

### *2.3.3. Health management*

Table 3 presents the selected variables referring to health management of the farms. These variables were:

*Mastitis* was a score of hygienic measures for mastitis prevention calculated from the presence or absence of: udder cleaning before milking, udder disinfection after milking,

cleaning and disinfection of milking machine, mastitis prevention tests and treatment at drying-off.

*Ectoparasites Control* indicated the number of treatments per year corrected by the percentage of animals treated.

*Endoparasites Control* indicated the number of treatments per year corrected by the percentage of animals treated.

*Vaccines* was the number of different vaccines applied to the animals.

**Table 2. Variables and classes of reproductive management**

| Variable | Classes | Code | No. of observations |
|---|---|---|---|
| Calving Assistance | <2.1 | CalvAssLw | 134 |
| | 2.1-4.1 | CalvAssI | 179 |
| | >4.1 | CalvAssH | 28 |
| Breed | CrossBreed | CrosBreed | 140 |
| | *Bos taurus* | Btaurus | 137 |
| | *Bos indicus* | Bindicus | 14 |
| | Criollo | Criollo | 28 |
| Mating | Artificial insemination | AI | 26 |
| | Natural mating | Mating | 293 |
| Reproductive Control | Yes | RepConY | 68 |
| | No | RepConN | 251 |
| Selection Criteria | Milk yield of the mother | SeCrMiYi | 214 |
| | Pedigree of the animal | SeCrPedi | 6 |
| | Conformation of the animal | SeCrConf | 18 |
| | Breed of the animal | SeCrBree | 4 |
| | Reproductive performance of mother | SeCrRepr | 10 |
| | None | SeCrNone | 67 |
| Replacement Origin | Own replacement | ReplaOwn | 226 |
| | Purchased replacement | ReplaBuy | 57 |
| | Both | ReplaBoth | 36 |

**Table 3. Variables and classes of health management**

| Variable | Classes | Code | No. of observations |
|---|---|---|---|
| Mastitis | 0 | MastPrN | 99 |
| | ≤2 | MastPrLw | 42 |
| | >2 | MastPrH | 178 |
| Ectoparasites | <6 treatments | EctoPrLw | 182 |
| | 6-12 treatments | EctoPrI | 77 |
| | >12 treatments | EctoPrH | 60 |
| Endoparasites | <0.5 treatments | EndoPrLw | 95 |

| | | | |
|---|---|---|---|
| | 0.5-2 treatments | EndoPrI | 165 |
| | >2 treatments | EndoPrH | 59 |
| Vaccines | <2 treatments | VaccineLw | 92 |
| | 2-4 treatments | VaccineI | 175 |
| | >4 treatments | VaccineH | 52 |

### *2.3.4. Performance and Control Records*

Variables related to farm performance and control records are presented in Table 4. These variables are:

*Record:* a binomial variable indicating the absence or presence of an animal recording system in the farm.

*Type of Record* indicated the type of system used. Categories were individual records, notebook or diary, computer system or none.

**Table 4. Variables and classes of performance and control records**

| Variable | Classes | Code | No. of observations |
|---|---|---|---|
| Record | Yes | RecordY | 119 |
| | No | RecordN | 200 |
| Type of Record | Individual records | RecInd | 22 |
| | Notebook or dairy | RecBook | 94 |
| | Computer system | RecCompu | 15 |
| | None | RecN | 188 |

### *2.3.5. Structure and productive orientation*

The variables considered when defining the more relevant aspects of structure and production orientation were (Table 5):

*System* indicated the orientation of production in terms of relative importance of milk, meat and agriculture outputs from total farm outputs of the farm. This variable had 4 classes depending on agriculture *versus* livestock orientation and specialised milk *versus* dual-purpose herds.

*Herd* indicated the size of the herd in terms of number of lactating cows.

*Other Species* indicated the relative importance of Livestock Units (LU) of other species such as sheep, horses, pigs, hens and ducks in the total number of LU of the farm.

*Milk Outputs* indicated the average milk yield per milking cow of the farm per year.

**Table 5. Variables and classes of structure**

| Variable | Classes | Code | No. of observations |
|---|---|---|---|

| | | | |
|---|---|---|---|
| System | Agriculture – dairy | AgrDairy | 33 |
| | Agriculture – dual purpose | AgrDualP | 60 |
| | Livestock – dairy | LivDairy | 72 |
| | Livestock – dual purpose | LivDualP | 154 |
| Herd | <8 lactating cows | HerdS | 92 |
| | 8-25 lactating cows | HerdM | 134 |
| | >25 lactating cows | HerdL | 93 |
| Other Species | 0% | OtherSpN | 151 |
| | ≤18.5% | OtherSLw | 90 |
| | >18.5% | OtherSpH | 78 |
| Milk Outputs | <776.5 litres per cow per year | IncomeLW | 79 |
| | 776.5-3212 litres per cow per year | IncomeI | 160 |
| | >3212 litres per cow per year | IncomeH | 80 |

### *2.3.6. Sociologic characteristics and information seeking*

The variables defining social and information seeking aspects of the farmers are presented in Table 6. These variables are:

*Farmer Education* indicated the level of education of farmers. It was categorised as low (illiterate), medium (primary or secondary school) and high (technical education or university).

*Distance* reflected the distance of the farm to the closest population centre.

*Technical Advice* was a score measuring the use of technical advice services by farmers. It was calculated adding every type of technical adviser used by the farmer (health, reproduction, nutrition, pastures and crops advisors).

*Information* was a score reflecting the openness of farmers for seeking information for making their decision. The possible sources considered were: technical advice, farmers associations, publications, radio, TV, extension and field-out days. This types were weighted by the intensity of the seeking (none=0, low=1 or high=2).

**Table 6. Variables and classes of sociologic characteristics and information seeking**

| **Variable** | **Classes** | **Code** | **No. of observations** |
|---|---|---|---|
| Farmer Education | Illiterate | EducLw | 19 |
| | Primary/secondary school | EducI | 246 |
| | Technical/university | EducH | 54 |
| Distance | <2km | <2km | 89 |
| | 2-20km | 2-20km | 152 |
| | >20km | >20km | 78 |
| Technical Advice | 0 | TechAdN | 109 |
| | ≤2.5 | TechAdLw | 184 |
| | >2.5 | TechAdH | 26 |
| Information | <10 | OpenLw | 88 |
| | 10-18 | OpenI | 179 |

| | | | |
|---|---|---|---|
| | >18 | OpenH | 52 |

After classification of the six groups of variables, two MCAs were carried out to identify the relationships between management variables (Tables 1-4), structure and production orientation variables (Table 5) and sociologic and information seeking characteristics of the farmers (Table 6). Then, eight MCAs were carried out to compare 1. pasture and nutrition, 2. reproductive, 3. sanitary and 4. performance recording technologies with both 5. structure and production orientation and 6. sociologic characteristics and information seeking of the farms.

Finally, a Cluster Analysis using the Centroid Distance as method of aggregation was carried out to classify the farms. A new MCA was done with all the variables, and the coordinates of the management variables with reference to the structural and sociologic and information seeking dimensions of the MCA were used in the Cluster Analysis.

## 3. RESULTS AND DISCUSSION

### 3.1. Systems characterisation and relationships between structural, production orientation, sociological and information seeking variables

The farms under study could be separated into three mayor groups according to both structural and social aspects. Following Figure 1 clockwise, the MCA showed that large farms were related to more specialised livestock production systems towards milk production. They were more commercial farms since their proportion of animals of species other to bovine was zero (Upper left corner). A second group (lower left corner) was characterised by small farms, low production per cow/year. They were more diversified farms with agriculture and dual purpose production systems. This group was closer to the category of high proportion of the animals of other species. Finally, the third group were medium size mixed crop/dairy farms, with intermediate income per cow/year and dairy production oriented to specialised dairying. These farms have intermediate and high proportions of animals of other species in the farm.

According to this characterisation, three labels could be assigned to each group as follows: Large Specialised Commercial Farms (**GCE**); Small Mixed Crop/Dual Purpose Farms (**PSD**) and Medium Mixed Crop/Dairy Farms (**MSCL**) respectively.

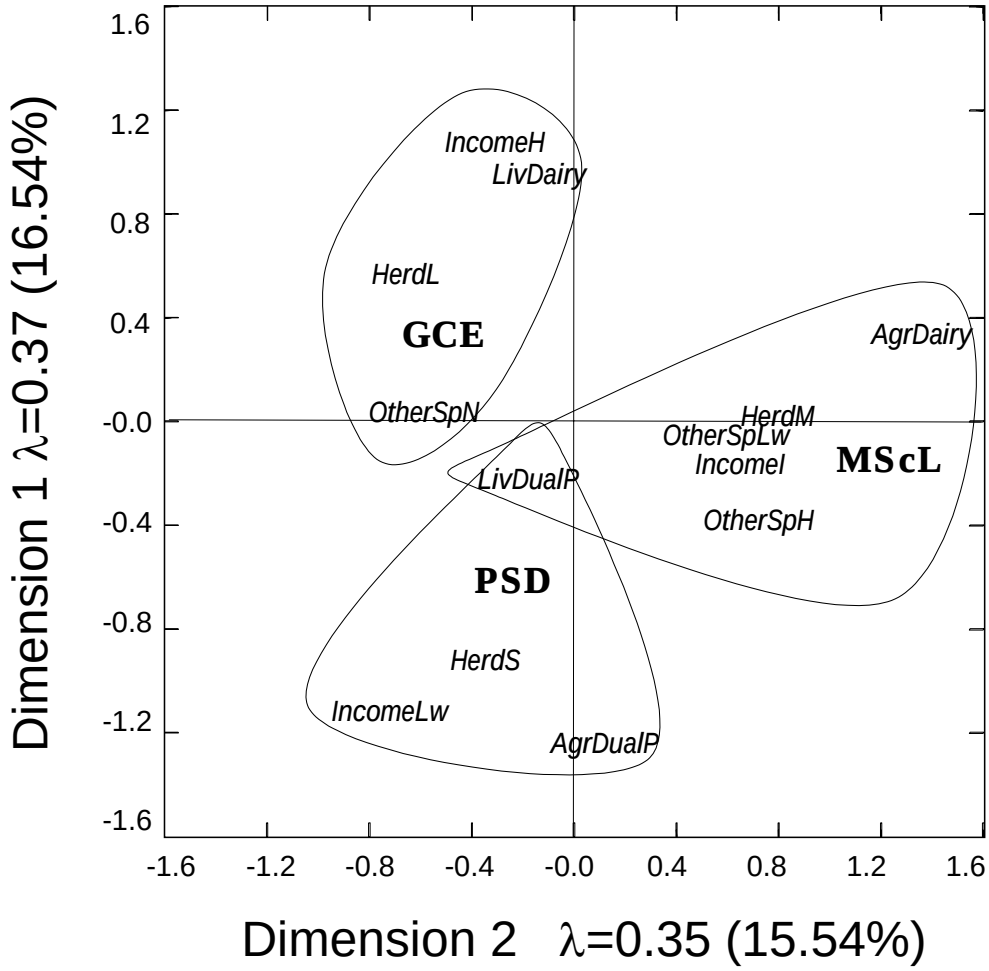


**Figure 1. Relationships between variables related to structural dimensions and productive orientation of the farms (λ=inertia).**

In terms of sociological and information seeking variables, Figure 2 shows that there is a clear relation between the nearness of the farm to towns, the level of information seeking by the farmers and the level of technical advice received. Farms located from 0 to 2 km from towns are related to farmers which have a high level of information seeking and high levels of technical advice. This specific group of farmers seem to have high levels of education (upper right corner in Figure 2). Farms farther than 2 km but less that 20 km from towns have less access to information and technical advice, while farms far away to population centres do not have any technical advice or access to information. These last two groups of farms are related to illiterate farmers or with relatively low educational levels (up to high school).

Similarly to the structural characterisation, farms could be defined by three different groups: Highly Informed and Advised Farmers (**AIA**); Medium Informed and Advised Farmers (**MIA**) and Non Informed nor Advised Farmers (**NIA**).

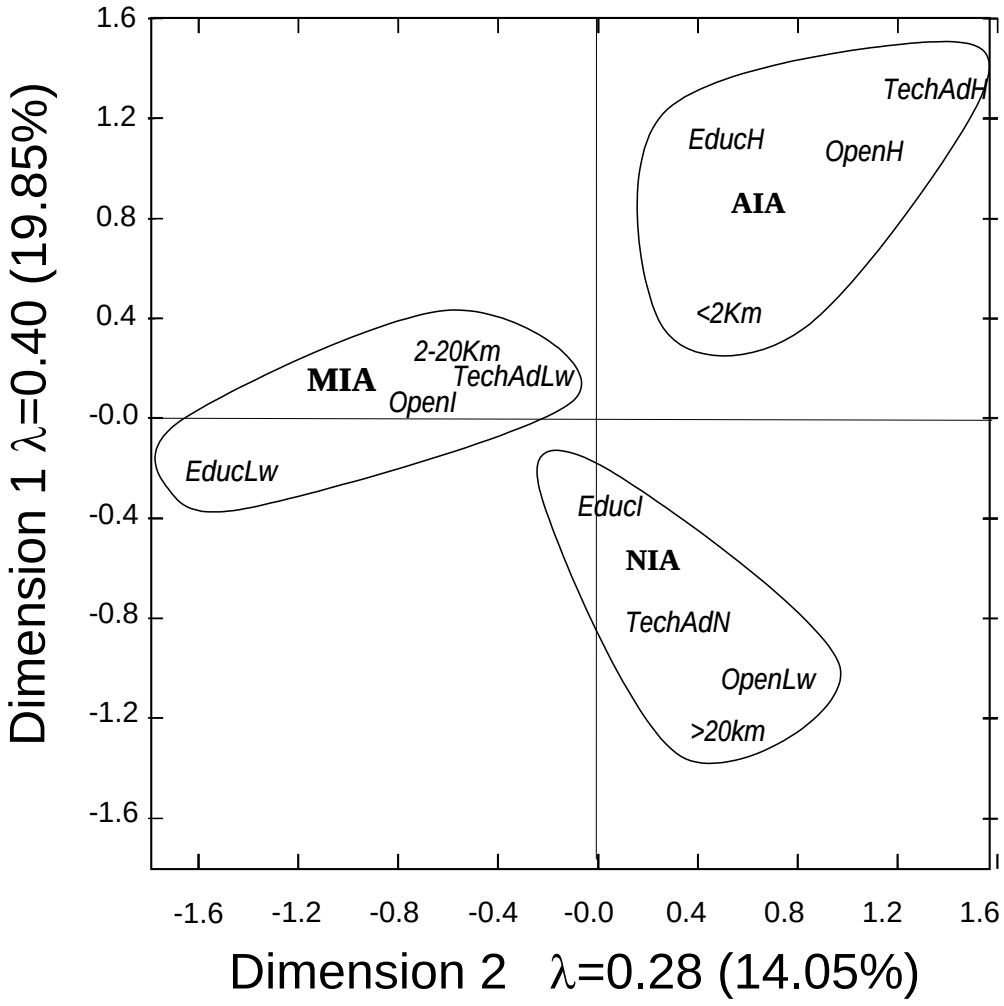


**Figure 2. Relationships between farmers sociological characteristics and information seeking and technical advice**

### 3.2. Use of technologies in nutritional and pasture management

The MCA analysis showed a consistent relation among variables of structural dimensions and productive orientation of the farms and variables related to pasture and nutrition management. The upper left corner of the Euclidian in Figure 3 locates farm characteristics corresponding to farms labelled **GCE**. These farms tend to have either a high supplementation level throughout the year or high during the dry season and therefore have th highest milk productions and income. Supplementation seems to be mostly based on concentrates. However, evidence of a high use of improved pastures was not evident in **GCE** farms. The lower left corner of the figure contains farm characteristics belonging to the group **PSD**. These farms do not supplement and tend to have low or intermediate proportions of their areas with improved pastures. Finally, the lower right and upper right spaces locate the characteristic of farms labelled **MSCL**. High proportions of the pasture areas in these farms are covered with improved pasture while a high variation in terms of supplementation level was found in this group. A

range between low and intermediate levels of supplementation throughout the year or low supplementation only in the dry season is likely to be found in these farms.

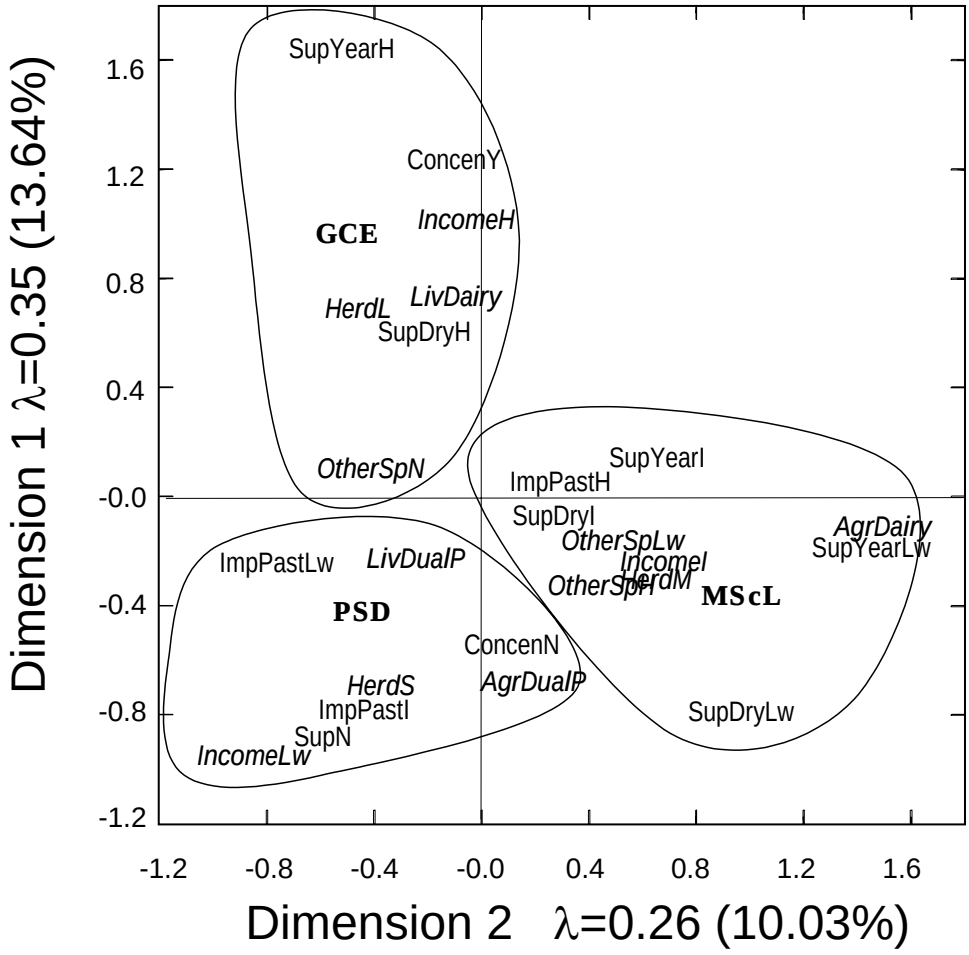


**Figure 3. Relationships between pasture and nutrition management and structure and production orientation variables (in bold italics)**

Differences in production between these groups are caused mostly by the levels of supplementation used, since the quality of the improved pastures is very low independent of the type of farm (ANON 1998). These high levels of supplementation are associated with higher production and are also related to more specialised dairy systems. However, although mixed crop/dairy systems do not use a high proportion of concentrates, they also use crop by products for supplementing their animals.

It was clearly found that regardless of the structural and productive orientation of the farms, sociological and information-seeking aspects have an impact on the use technologies in nutrition and pasture management (Figure 4). Highly Informed and Advised Farmers (AIA) seemed to use higher levels of supplementation throughout the year or high supplementation during the dry season. Again, this supplementation was related to concentrates which is not surprinsing considering the fact that most nutritional advice is provided by concentrate manufacturers and milk processing plants which also manufacture concentrates.

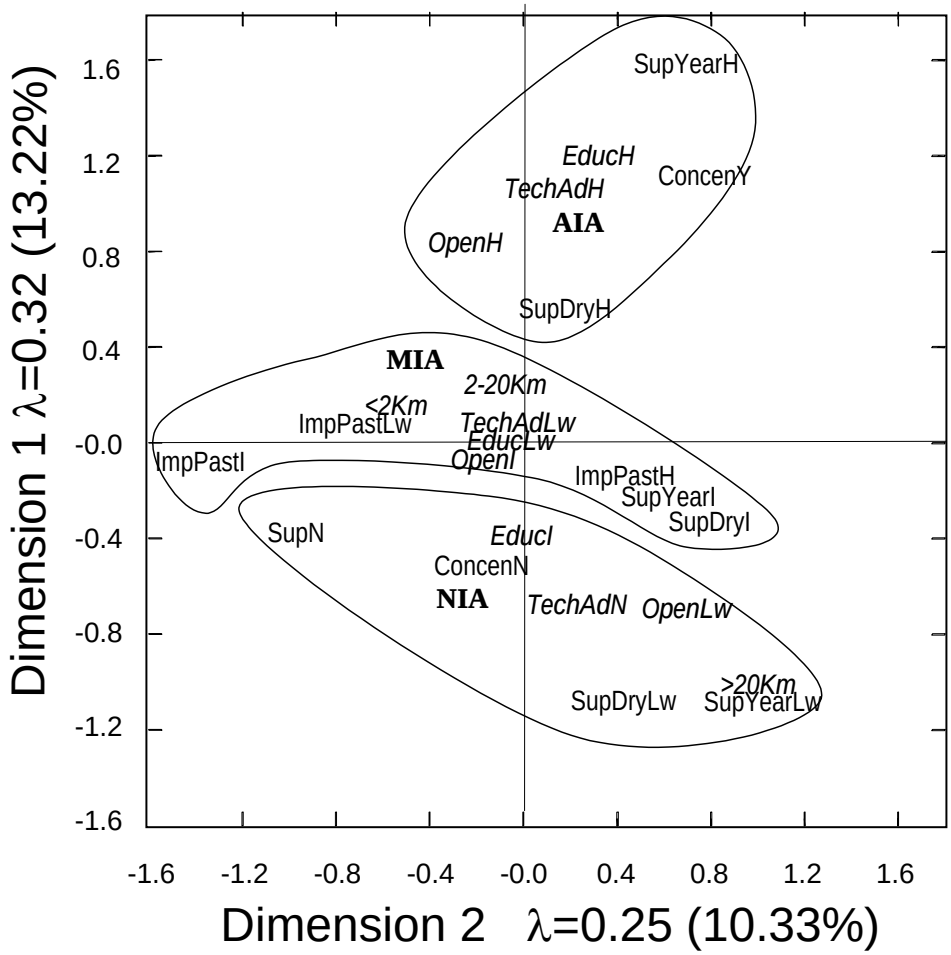


**Figure 4. Relationships between pasture and nutrition management and farmers sociological and information seeking characteristics (in bold italics)**

Farmers who had the highest level of education and technical advice used higher levels of supplementation. These relationships were quite generic, in the sense that as the level of education and advice diminished, the nutritional management of the farms also decreased.

### 3.3. Use of technologies in reproductive management

Reproductive management practices such as high calving assistance, reproductive control, and artificial insemination are related to farm characteristics present in the category of **GCE** (upper left and right corner in figure 5). Farms labelled as **PSD** or **MSCL** do not have any reproductive control management and have natural mating. The **PSD** farms tend to have an intermediate calving assistance and the selection criteria is mostly based on pedigree (lower left corner). A possible explanation for this is that since these farmers have fewer animals, they recognise the importance of each individual animal within their system and therefore value the importance of calving assistance due to its relationship to survival of the dam and calf. There is no a clear relation between this group of farms and a specific breed but they are closer to crossbred animals.

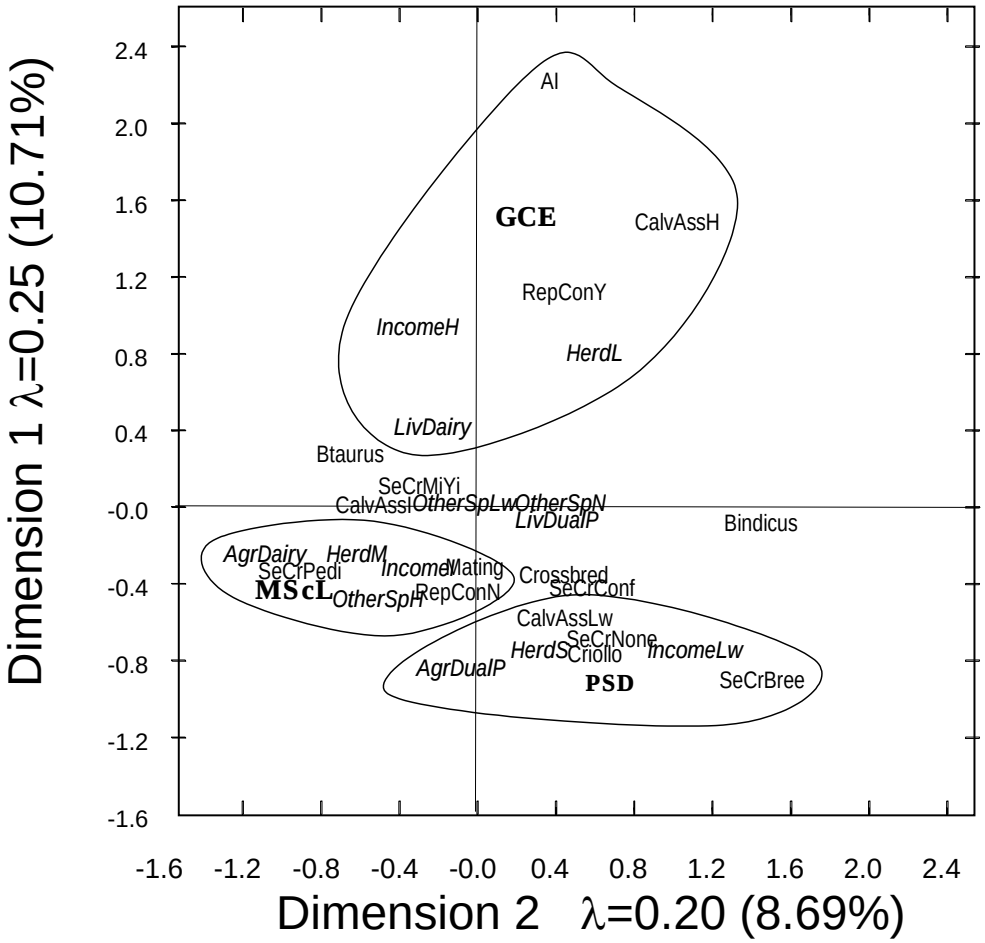


**Figure 5. Relationships between reproductive management and structural dimension and productive orientation of the farms (in bold italics)**

Characteristics of **MSCL** farms were related to low calving assistance, and these farmers did not apply a selecion criteria or based it on breed only. The relationship between these farm characteristics and the use of Criollo breed was evident (lower left corner).

High calving assistance, reproductive control, artificial insemination were related to **AIA** farmers (upper right and left corners in Figure 6) while low and intermediate calving assistance, natural mating and non reproductive control were related to farmers with characteristics related to **MIA** and **NIA**. There are were further obvious relations among other social and information seeking variables and reproductive management.

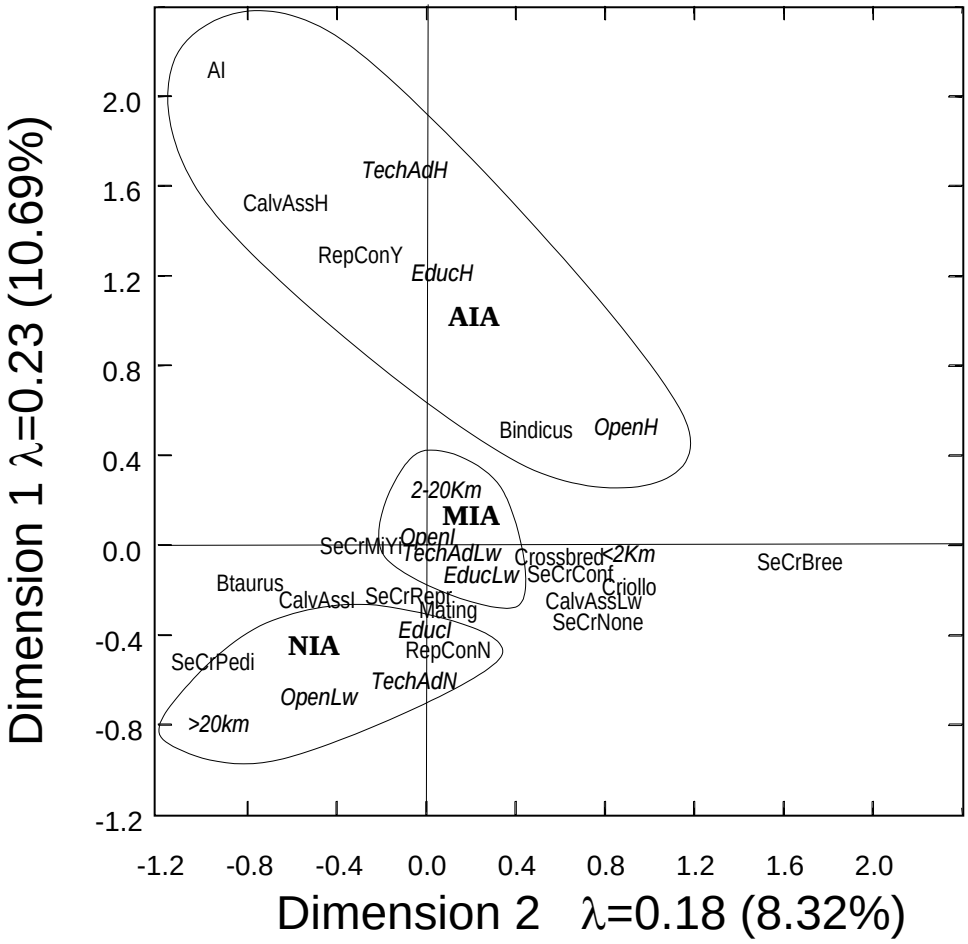


**Figure 6. Relationships between variables related to reproductive management and farmers sociological and information seeking characteristics (in bold italics)**

### 3.4. Use of technologies in herd health management

Figure 7 shows that health management could be easily related to structural and productive orientation of the farm since high scores of mastitis prevention, ecto- and endo-parasites control treatments and vaccination were related to **GCE** farms (upper right and left corners) while intermediate and low scores were related to **PSD** (lower right and left corners) and **MSCL** (near to the x axis) farms respectively. Similar results were found in terms of the relation between social and information seeking and health management showing that **AIA**, **MIA** and **NIA** farmers characteristics were related to high, medium and low scores of parasites control and vaccination scores respectively (Figure 8). In terms of mastitis prevention, **AIA** related farms have an intermediate level of mastitis prevention while **MIA** and **NIA** had high and low respectively.

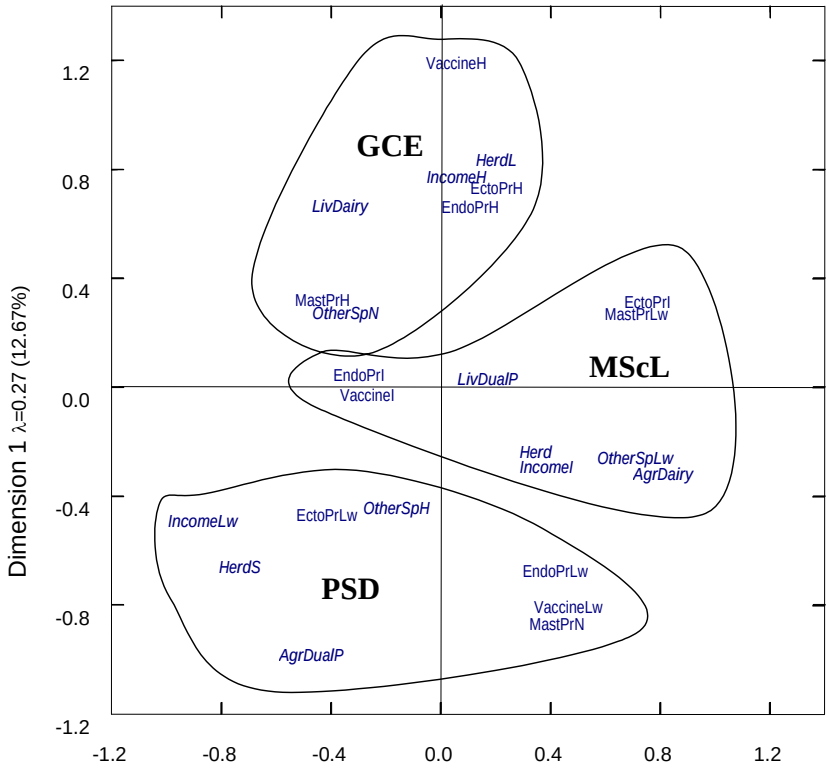


**Figure 7. Relationships between variables related to health management and structure and production orientation (in bold italics)**

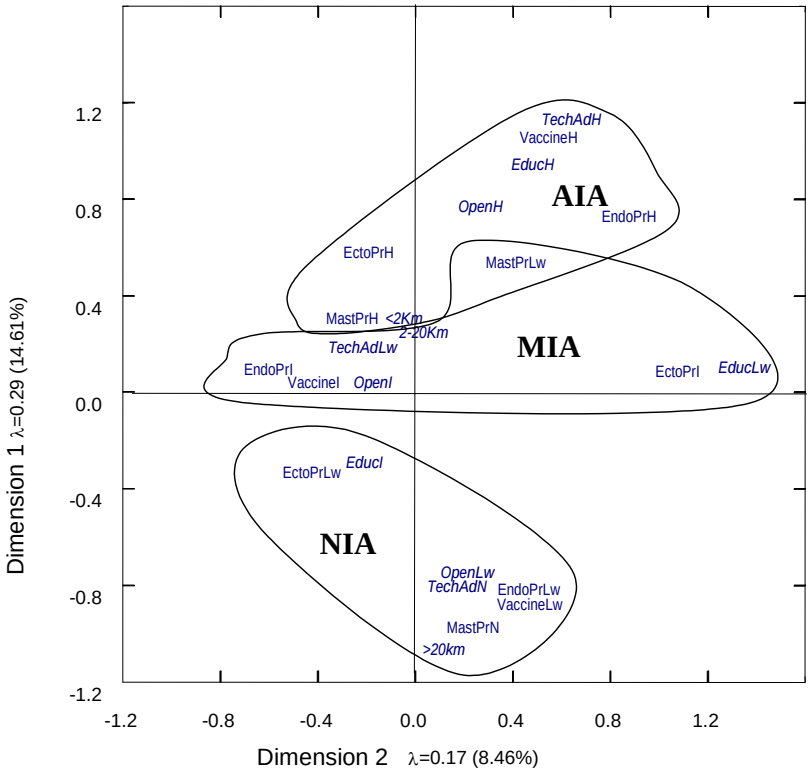


**Figure 8. Relationships between variables related to health management and sociologic characteristics and information seeking (in bold italics)**

### 3.5. Use of records

The use of performance records of any kind, including computerised records, seems to be related to farms with characteristics of the label **GCE**, while lack of use of records was related to **PSD** and **MSCL** (Figure 9). These were the only clear relations between use of records and sociological and information seeking aspects

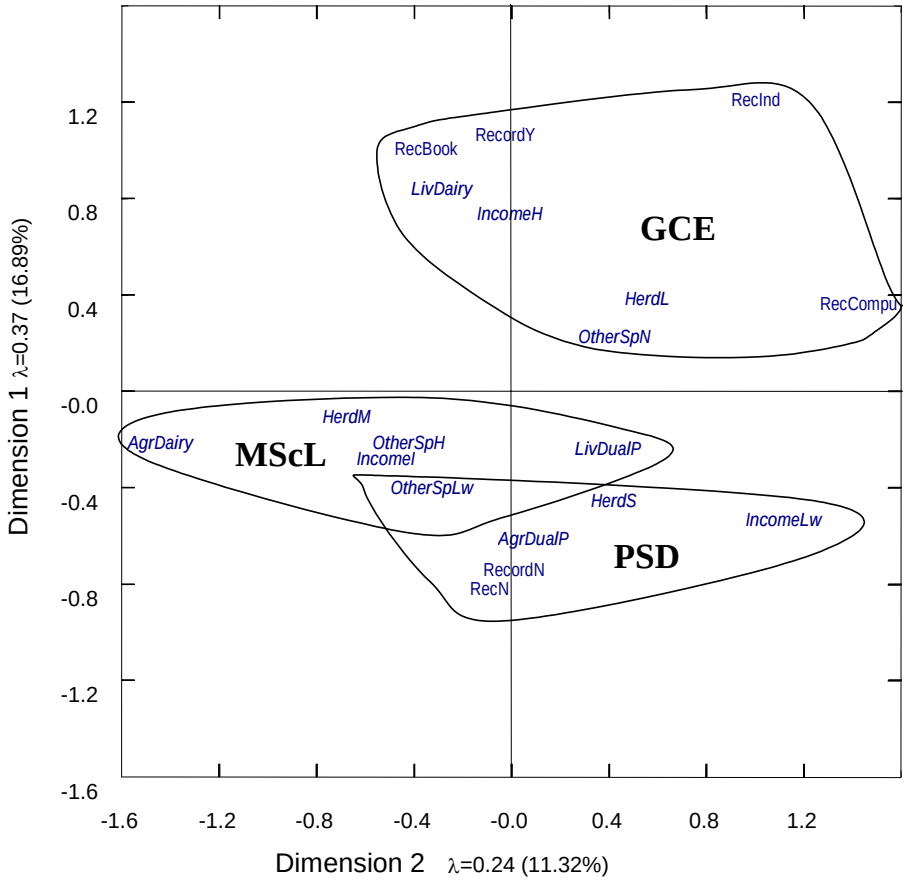


**Figure 9. Relationships between variables related to performance performance and control records, and structure and production orientation**

### 3.6. Cluster analysis

Three well-defined groups of farms according to the general used of technologies were produced by the cluster analysis (Figure 10). This visual interpretation is consistently supported by several clustering statistics (Table 7) which demonstrated that three groups were sufficient to characterise the prevailing production systems, as judged by a high $r^2$, a strong increment in the Cubic Criterion of Clustering, and Pseudo F Statistic and a strong decrease in the Pseudo T Statistic. This combination shows that the groups formed at this stage had the minimum variance within groups and the maximum variance among groups and therefore demonstrate how different they are. This combination of statistics has been reported to be the best way in deciding the proper number of cluster (SAS 1990). When plotted against structural and productive variables and sociological and information seeking variables, it is evident that farms belonging to the cluster 1 (86 farms) (lower left corner in Figure 10) are farms with label **PSD** while cluster 2 (143) (lower right corner) are farms with label **MSCL**. There is not a clear

difference between cluster 1 and 2 in terms of sociological and information seeking, so it can be said that farms belonging to theses groups could be considered a combination of **MIA** and **NIA** farmers. Finally, cluster 3 (90 farms) (upper corners) are farms considered as **GCE** and **AIA** showing that sociological and information seeking aspects are still important in defining the technological level of the farm.

**Table 7. Clustering statistics according to different number of farm groups**

| No. of cluster | $R^2$ | CCC | PSF | PST |
|---|---|---|---|---|
| 10 | 0.879 | -5.01 | 250 | 6.6 |
| 9 | 0.864 | -5.21 | 246 | 40.1 |
| 8 | 0.820 | -80.55 | 202 | 100 |
| 7 | 0.813 | -60.56 | 226 | 200.0 |
| 6 | 0.773 | -70.56 | 213 | 750.0 |
| 5 | 0.733 | -70.31 | 215 | 960.5 |
| 4 | 0.728 | -20.58 | 281 | 40.6 |
| 3 | 0.705 | 30.18 | 378 | 220.2 |
| 2 | 0.350 | -10.81 | 171 | 372 |
| 1 | 0.000 | 00.00 | . | 171 |

CCC=Cubic Criterion of Clustering
PSF=Pseudo F Statistic
PST=Pseudo T Statistic

## 4. CONCLUSIONS

From the evidence shown it can be concluded that livestock production systems in the studied zones could be described into three different groups in terms of structural characteristics and productive orientation. These three groups could be labelled as Large Specialised Commercial Dairy Farms (**GCE**); Small Subsistence Dual Purpose Farms (**PSD**) and Medium Semi-commercial Dairy/Dual Purpose Farms (**MScL**). On the other hand farms can be grouped into three categories according to sociological and information seeking aspects labelled as Highly Informed and Advised Farmers (**AIA**); Medium Informed and Advised Farmers (**MIA**) and Non Informed nor Advised Farmers (**NIA**).

The use of technologies in the nutritional, reproductive, health management and records use is clearly defined by these two different classification systems of the farms. This study demonstrated that obvious relations exist between the availability and access to natural, economic and human resources and the possibility of the farms to adopt technologies and improve their management.

This study shows provides strong evidence that the structural characteristics and productive orientation of the systems are closely related to the sociological and information seeking characteristics of the farmers managing them, and that these aspects play a substantial role in deterimining the management intensity under which the systems operate.

If technological adoption is to be increased, these issues are of fundamental importance when defining target groups and extension and development policies for them.

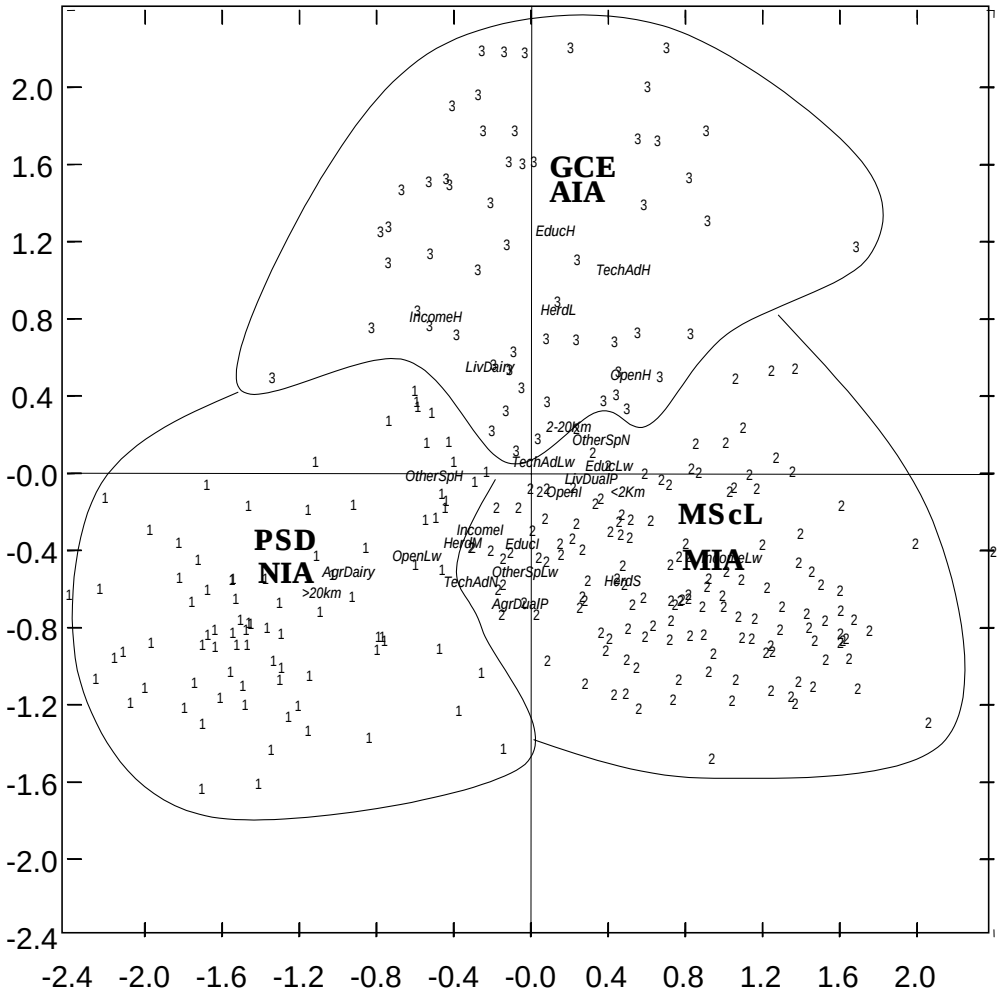


**Figure 11. Relationships between variables of structure and production system (in bold italics), sociologic characteristics and information seeking (in bold italics) and farms belonging to each cluster.**

### Study 3 - Farm economics and the intensification process of mixed crop-dairy systems in Santa Cruz, Bolivia

Introduction

In developing countries, commercial farming activities are quickly evolving towards more intensive and technological developed systems (de Haan et al., 1997; Udo, 1997), but traditional semi-commercial and subsistence farming is still very important (Preston and Murgueitio, 1994; DFID, 1998). Despite the diversity of farming systems, extension activities and agricultural policies have been traditionally developed for the “average farmer” (Skerrat, 1995), without taking into account the social, cultural, economic and environmental characteristics of different geographic areas or systems of production. This phenomenon partly explains the failure of new technologies in the adoption stage (Preston and Leng, 1987; Jones, 1991; Chambers et al., 1993; Chambers, 1995). Development and agricultural policies should be specific for different systems of production under diverse socio-economic, technical and environmental conditions (Ferreira, 1997).

In the tropical areas of South America, the increase of production of meat, milk and agricultural products was mainly caused by an expansion of agricultural land for pastures and crops with destruction of natural ecosystems (Preston and Murgueitio, 1994; de Haan et al., 1997). However, in the 1990s there has been a process of intensification of production (genetic improvement of forages and animals, better management, etc.) that has also contributed to this increase (de Haan et al., 1997; Lascano and Holmann, 1997; Udo, 1997).

Despite this intensification process, semi-commercial subsistence farming systems are still very important in Bolivia. The importance of animal husbandry on the family economy and its subsistence has been well recognised (Jahnke, 1982; Preston and Leng, 1987; Payne, 1990; Waters-Bayer and Bayer, 1992; Preston and Murgueitio, 1994), but little quantitative information is available in the literature.

When studying these farming systems, in particular their economic features, one of the main handicaps is the lack of scientific data and official information from administrative bodies. In these cases, surveying a representative sample of the population is often the only method for data collection. Due to the qualitative nature of some information, especially in surveys carried out on semi-commercial traditional systems, methodologies able to deal with both quantitative and qualitative information are necessary for data analysis.

The objectives of this study were 1. - to characterise the livestock farming systems in the area of study, from the point of view of their social, economical and structural characteristics; 2.- to analyse levels, sources and structure of incomes and costs, paying special attention to the relative importance of livestock and agriculture on farm economics; 3.- to analyse the process of intensification of farming in this area.

## Data analysis and characterisation of systems

A high proportion of collected data was qualitative. Therefore, a methodology able to deal with both qualitative and quantitative data was used. Multiple Correspondence Analysis (MCA) is a multivariate statistical method that allows analysing large quantitative data matrixes (Greenacre, 1984). The purpose of MCA is to derive a small number of combinations (dimensions or factors) of a set of variables that retain as much of the information in the original variables as possible. MCA is a weighted principal component analysis of a contingency table. It finds a low-dimensional graphical representation of the association between rows and columns of this table (SAS, 1994).

Variables referring to farm structure and production, sociological characteristics and technical support and economical performance were considered. An analysis of correlation was done to check the level of association between variables. Only independent variables were used for multivariate analysis.

Before the technique can be used, it is necessary to transform quantitative variables into classes. Quantitative variables were analysed individually to check if they had a normal distribution. The normal variables were then divided into three classes using the quantiles (Q) position (Q1=25% lower observations; Q2=50% intermediate observations; Q3=25% higher observations) (E.A. Hunter, personal communication 1998).

The variables considered for the analysis are explained below:

## Farm structure and production variables

Seven variables were chosen as representative of structure and production of the farms. The variables were (Table 1):

- *Agricultural Land* was the number of hectares (ha) of land used for agricultural and livestock purposes. This variable is highly correlated (r=0.89) to total area of the farm (including forestland).

- *Pasture* was the land area of pastures expressed as a percentage of total area. Since it was a percentage, the variable was divided into classes with fixed limits. The percentage of land used for agriculture is complementary to this variable.

- *Herd* indicated the size of the herd in terms of number of livestock units (LU). It was calculated as follows: [(lactating cows×1.2) + (dry cows) + (culling cows) + (preweaning calves×0.2) + (1-2 years old heifers×0.4) + (2-3 years old heifers×0.8) + (pregnant heifers) + (1-2 years old steers×0.6) + (2-3 years old steers) + (bulls×1.2)].

- *Labour* represented the number of permanent workers (family and contracted) in the farm.

- *Machinery* was a score that represented the level of mechanisation of the farm. It was calculated by adding with the same value the different types of machines (i.e. tractors, cultivators, seed drills, etc.) present in the farm. This variable was not normal so fixed limits were used to divide into classes.

- *System* indicated the orientation of production in terms of relative importance of milk, meat and agriculture income in the total income of the farm. This variable has 4 classes depending on agriculture *versus* livestock orientation and specialised milk *versus* dual-purpose herds.

- *Milk Production* indicates intensification of milk production and is expressed as the milk yield (l) per milking cow of the farm per year.

### 2.3.2. Sociological characteristics and technical support

Two variables referred to social and technical advice aspects were chosen (Table 2):

- *Farmer Education* indicates the level of education of farmers. It was categorised as low (illiterate), medium (primary or secondary school) and high (technical education or university).

- *Technical Advice* was a score measuring the use of technical advice services by farmers. It was calculated adding every type of technical adviser used (animal health, reproduction, nutrition, pastures and crops adviser) with a value of one each.

### 2.3.3. Economic performance

Economic indicators were correlated so only one variable was used as representative of the economic dimension of the farms (Table 3). This variable was:

- *Gross Margin* (US$/year) was calculated by subtracting variable costs (feeding costs, non-permanent labour, croping costs, technical advice costs, sanitary costs and other variable costs) from agricultural and livestock outputs.

**Table 1. Variables and classes of structure and production of the farms**

| Variable | Classes | Code | No. of observations |
|---|---|---|---|
| Agricultural Land | < 20 ha | FarmS | 83 |
| | 20-90 ha | FarmM | 154 |
| | >90 ha | FarmL | 82 |
| Pasture | <50% | PastureLw | 98 |
| | 50-90% | PastureI | 98 |
| | >90% | PastureH | 123 |
| Herd | <20 livestock units | HerdS | 78 |
| | 20-64.7 livestock units | HerdM | 150 |
| | >64.7 livestock units | HerdL | 91 |
| Labour | <3 labour units | LabourS | 75 |
| | 3-6 labour units | LabourM | 155 |
| | >6 labour units | LabourL | 89 |
| Machinery | 0 machines | MachiN | 114 |
| | ≤5 machines | MachiLw | 109 |
| | >5 machines | MachiL | 96 |
| System | Agriculture – dairy | AgrDairy | 33 |
| | Agriculture – dual purpose | AgrDualP | 60 |
| | Livestock – dairy | LivDairy | 72 |
| | Livestock – dual purpose | LivDualP | 154 |
| Milk Production | <776.5 litres per cow per year | MilkLw | 79 |
| | 776.5-3212 l per cow per year | MilkI | 160 |
| | >3212 litres per cow per year | MilkH | 80 |

**Table 2. Variables and classes of social and technical advice characteristics**

| Variable | Classes | Code | No. of observations |
|---|---|---|---|
| Farmer Education | Illiterate | EducLw | 19 |
| | Primary/secondary school | EducI | 246 |
| | Technical/university | EducH | 54 |
| Technical Advice | 0 | TechAdN | 109 |
| | ≤2.5 | TechAdLw | 184 |
| | >2.5 | TechAdH | 26 |

After the classification of variables, a MCA was carried out with all variables to identify the dimensions (groups of classes and variables) that explained the maximum inertia of the sample. The concept of *inertia* in correspondence analysis is analogous to the concept of variance in principal component analysis, and is proportional to the chi-square information (SAS, 1994).

A Cluster Analysis, using the Centroid Distance as method of aggregation, was carried out to classify the farms. The Centroid Distance was chosen as method of aggregation because uses the same metrics as MCA, i.e. Euclidean distances (SAS, 1994). The co-ordinates of the observations to the first two dimensions of the MCA were used in the Cluster Analysis.

**Table 3. Variable and classes of economic performance of the farm**

| Variable | Classes | Code | No. of observations |
|---|---|---|---|
| Gross Margin | <2,137.4 US$ | GroMargLw | 79 |
| | 2,137.4 –16,905.0 US$ | GroMargI | 156 |
| | >16,905.0 US$ | GroMargH | 84 |

1 American dollar = 5 Bolivianos

### Economic analysis

A detailed economic analysis was carried out in every Group. Mean values and Coefficients of Variation were calculated for the most relevant economic variables. The amount and composition of incomes and costs were studied and related with other non-economic characteristics of the farming systems. Gross and Net Margins were also studied. The within-Group distribution of farms in terms of Income and Net Margin was analysed and the Gini index was calculated to measure the inequality of distribution of income. Economic ratios expressing the level of intensification of the different farming systems were calculated and analysed.

## 3. Results and discussion

Table 5 shows the statistical indicators for the cluster analysis, while the main characteristics of each Cluster are found in Table 6.

**Table 5. Statistical indicators for the Cluster analysis**

| No. of Group | $R^2$ | CCC | PSF | PST |
|---|---|---|---|---|
| 10 | 0.874 | -5.84 | 239 | 97.5 |
| 9 | 0.863 | -5.44 | 243 | 34.6 |
| 8 | 0.850 | -4.72 | 252 | 36.9 |
| 7 | 0.824 | -5.28 | 244 | 84.5 |
| 6 | 0.815 | -3.08 | 275 | 14.4 |
| 5 | 0.761 | -4.76 | 249 | 93.1 |
| 4 | 0.713 | -3.91 | 261 | 70.2 |
| 3 | 0.703 | 3.01 | 375 | 8.8 |
| 2 | 0.383 | 0.29 | 197 | 393 |
| 1 | 0.000 | 0.00 | . | 197 |

CCC=Cubic Criterion of Clustering
PSF=Pseudo F Statistic
PST=Pseudo T Statistic

Cluster 1 was made up of 98 farms that could be defined as *large commercial livestock farms*. They were the biggest farms, both in terms of animals (172 Bovine LU) and hectares (207 ha of agricultural land), and were dairy commercially oriented. Most of the land was dedicated to pastures (90% of agricultural land), specially cultivated pastures. These farms had a high availability of forestland, which hypothetically would allow them to increase further the agricultural land. They had a high availability of labour and machinery; farmers had a high level of education (technical education-university) and technical support. In this Group, farmers and/or other members of the family often had other professional activities out of the farm and, in some cases,

farming was only a secondary activity. Milk production per cow and Gross Margin were the highest (3369 l/ cow/ year and $30,894/ year, respectively) (Table 6).

Cluster 2 was made up of 101 farms that could be defined as *medium size agricultural farms*. These were agricultural farms in which 68% of the land was dedicated to industrial crops, while dairying was a secondary activity. The land area and the herd size were intermediate (44 Bovine LU and 91 ha of agricultural land, respectively) (Table 6). Pastures were only 32% of agricultural land, but most of them were cultivated. They had small areas of forest, suggesting a more aggressive use of land. They also had high availability of labour (family labour, as will be seen below) and machinery but, contrarily to group 1, farmers had a very low level of education (illiterate-primary school) and technical support, and pluriactivity is very low. To a great extent, this can be explained due to a high proportion of Mennonite farmers, which have particular and homogeneous social and farm management features (Severiche, 1992). Milk production and Gross Margin were intermediate (2505 l/ cow/ year and $16,656/ year, respectively).

**Table 6. Mean values and Coefficient of Variation of the variables used in the MCA and other variables describing the Groups.**

| Variables MCA | Group 1 N=98 Mean | CV | Group 2 N=101 Mean | CV | Group 3 N=120 Mean | CV |
|---|---|---|---|---|---|---|
| **Herd** | 172.75 | 1.14 | 43.73 | 1.05 | 26.84 | 0.75 |
| Land | 207.04 | 1.32 | 91.12 | 1.16 | 25.40 | 1.10 |
| Pasture (%) | 90.57 | 0.15 | 32.48 | 0.74 | 79.01 | 0.30 |
| Labour | 5.69 | 0.80 | 5.59 | 0.65 | 3.36 | 0.52 |
| Machinery | 4.01 | 0.84 | 5.61 | 0.55 | 0.70 | 2.07 |
| Farmer Educ. | 3.68 | 0.40 | 2.03 | 0.33 | 2.09 | 0.30 |
| Tech. Advice | 1.42 | 0.93 | 0.62 | 0.93 | 0.84 | 1.17 |
| Milk Outputs | 3369.38 | 0.83 | 2505.32 | 0.62 | 1382.06 | 0.99 |
| Gross Margin (US$) | 30893.67 | 1.38 | 16656.27 | 2.03 | 3642.09 | 2.16 |
| **Other variables** | | | | | | |
| Crops (ha) | 23.6 | 2.8 | 66.9 | 1.4 | 5.0 | 1.4 |
| Cultivated pastures (ha) | 147.5 | 1.6 | 18.7 | 1.0 | 11.9 | 1.1 |
| Natural pastures (ha) | 36.0 | 2.7 | 5.5 | 4.0 | 8.5 | 2.8 |
| Forest (ha) | 124.48 | 2.36 | 14.01 | 2.95 | 21.89 | 3.01 |
| Pluriactivity* | 8.52 | 1.19 | 4.08 | 1.87 | 7.8 | 1.57 |

* Expressed in number of months of work out of the farm by members of the family.

Cluster 3 was made up of 120 farms that could be defined as *small semi-commercial mixed farms*. These were subsistence farms with diversified agriculture-milk-beef activities. The integration of different activities is contemplated as a security measure that helps small farmers to avoid risk (Jahnke, 1982; Seabright, 1992; Waters-Bayer and Bayer, 1992; Bhende and Venkataram, 1994; Matthewman and Castelán, 1996; Castelán et al, 1997). They were very small farms (25 ha) and had a small number of bovines (27 LU) (Table 6). A great extension of the land was dedicated to pastures (79%), but in this case, natural pastures were nearly as important as cultivated pastures. Farms had a potential for increasing agricultural land due to the relative importance of forestland. They had little availability of labour, which can explain the relatively small number of hectares dedicated to crops, but a high level of pluriactivity. Castelán et al. (1997) and Beets (1990) have also reported a high degree of pluriactivity in small subsistence farming systems. This is due to the need for out-farm income to

support the family. Machinery was nearly null. As in the previous group, farmers had low level of education (illiterate-primary school) and technical support, but in this case the reasons were related to social and economical isolation. Milk production per cow was very low (1,382 l/ cow/ year) as was the Gross Margin ($3,642/ year).

Economic analysis

The economic results and the structure of income and costs were very different in the groups of farms (Table 7). As would be expected, economic dimension was related to the physical size of the farms i.e. number of ha of agricultural land and number of animals. Group 1 obtained substantially higher income and GM than Group 2 and around 10 times that of Group 3. This relationship was not as clear in terms of NM because of the different importance of variable and fixed costs between groups (see below).

**Table 7. Mean values and Coefficient of Variation of the variables: Gross Margin; Net Margin; Incomes and Costs, per Group.**

| Variable | Group 1 N=98 Mean | CV | Group 2 N=101 Mean | CV | Group 3 N=120 Mean | CV |
|---|---|---|---|---|---|---|
| Total Income (US$) | 52011.6 | 1.2 | 37041.4 | 1.7 | 5254.3 | 1.5 |
| % Income Livestock [1] | 91.4 | 0.2 | 40.1 | 0.7 | 83.2 | 0.3 |
| % Income Milk | 61.4 | 0.5 | 29.9 | 0.8 | 50.0 | 0.7 |
| % Income Beef | 26.9 | 1.0 | 7.4 | 1.4 | 29.1 | 1.1 |
| % Income Small Liv. | 3.0 | 3.7 | 2.8 | 1.7 | 4.15 | 3.4 |
| % Income Agriculture [1] | 8.6 | 2.1 | 59.9 | 0.5 | 13.4 | 1.8 |
| % Income Soya Bean | 0.2 | 6.0 | 39.4 | 0.9 | 1.9 | 5.6 |
| % Income Sugar Cane | 6.5 | 2.3 | 8.2 | 2.7 | 0.3 | 11.0 |
| % Income Rice | 1.1 | 6.3 | 6.5 | 3.0 | 6.3 | 2.7 |
| Total Costs [2] (US$) | 40017.4 | 1.6 | 25107.3 | 2.1 | 2784.6 | 1.0 |
| % Replacement Costs | 14.7 | 1.4 | 2.6 | 2.6 | 14.7 | 1.8 |
| % Feeding Costs | 25.1 | 0.9 | 8.0 | 1.4 | 16.7 | 1.4 |
| % Permanent Labour | 27.0 | 0.7 | 6.4 | 2.3 | 16.5 | 1.7 |
| % Occasional Labour | 7.5 | 1.6 | 5.3 | 2.0 | 15.3 | 1.4 |
| % Cropping Costs | 7.2 | 1.8 | 45.5 | 0.5 | 18.2 | 1.4 |
| % Variable Costs | 52.6 | 0.4 | 82.3 | 0.3 | 57.9 | 0.6 |
| % Fixed Costs | 47.4 | 0.5 | 17.7 | 1.2 | 42.1 | 0.8 |
| Gross Margin (US$) | 30893.7 | 1.4 | 16656.3 | 2.0 | 3642.1 | 2.2 |
| Net Margin (US$) | 11994.2 | 3.3 | 11934.0 | 2.6 | 2469.7 | 3.2 |

[1] Only the more important animal products and crops have are considered in the table.

[2] Only the more important costs have are considered in the table.

When we consider the distribution of the farms in terms of Total Agricultural Income and NM in every Group, the differences can be fully appreciated. In Group 1, *large commercial livestock farms*, high incomes are frequent, as can be seen along the horizontal axis in Figure 1a. Thirty seven per cent of farms obtained between $20,000 and $50,000 of income per year and 31.6 obtained more than $50,000 (12.2% obtained more than $100,000). When we consider NM, it can be pointed out that in 20.4% of farms this variable was negative. Thirty per cent of farms obtained NM less than $10,000; 18.4% between $10,000 and $20,000; 19.4% between $20,000 and $50,000 and 11.2% obtained more than $50,000.

In Group 2, *medium size agricultural farms*, intermediate incomes are more frequent (Figure 1b). Forty per cent of farms obtained an income of $20,000 to $50,000, which is a similar figure to Group 1. In contrast with this Group, the second most important class were farms with $10,000 to $20,000 of income (27.7%) and only 15.8% of farms obtained more than $50,000. In terms of NM, there were fewer farms with negative results (14.8%) that suggested a better capability to face difficult conditions in mixed farms as a result of more constant incomes. Nevertheless, there was a higher proportion of farms with NM less than $10,000 (44.5%) and only 4% obtained NM greater than $50,000.

Differences in Group 3 were bigger. In these *small semi-commercial mixed farms* low incomes and NM are very frequent (Figure 1c). Eighty seven per cent of farms in this Group obtained less than $10,000, the rest, with the exception of one farm, obtained less than $20,000. Nearly 30% of farms had negative NM and 67.5% obtained less than $10,000. In Figure 4 it can be appreciated that 38 farms (31.6%) obtained less than $2,000 of income per year and 74 farms (61.7%) had a negative NM or less than $2,000. These results indicated a high economic stress in these farms.

If we apply the indicator of poverty for tropical regions of Bolivia given by the International Fund for Agricultural Development (IFAD) i.e. 2,570 US$ of income per year (Warmenbol, 1997), 35.8% of farmers in Group 3 were in a situation of poverty. This figure would increase to 68.3% if NM were considered instead of income.

The Gini index calculated for the studied sample was 0.84, much higher than the value for Bolivia as a whole, which in 1997 was 0.42 (World Bank, 1997). This means an extreme inequality in the distribution of incomes in the agricultural sector in Santa Cruz. When calculated per Group, large commercial livestock farms showed a higher inequality index than Group 2 and 3, which suggested great variability in the economic results obtained (0.70, 0.47 and 0.52, respectively). Again, the lower Gini index of Group 2 suggested that mixed farms were more homogeneous in terms of incomes perceived.

The sources of income were also very different between groups (Table 7 and Figure 2). In the Group of *large commercial livestock farms*, 91.4% of the income came from livestock, and milk was the main product, as 61.4% of total income came from milk sales. Beef sales represented 26.9% of income. Agriculture had little relevance (8.6% of income); only sugar cane had a substantial contribution of 6.5%.

By contrast, in the Group 2 of *medium size agricultural farms*, most of the income came from agriculture (59.9%), mainly from industrial crops such as soya bean (39.4%), although sugar cane was also important. Nevertheless, milk sales were still important, as they contributed with 29.9% of total income.

In the *small semi-commercial mixed farms* (Group 3), the main income came from livestock farming (83.2%). Milk was the main product, as it contributed to 50% of income. Milk plays a very important role in the subsistence of these farms as it generates cash flow on a regular basis (Jahnke, 1982; Castelán et al., 1997). Beef (sales of animals for meat or to intermediate producers) was also important (29.1% of total income). But in this case, the role of animals could be related to family savings (Payne, 1990; Beets, 1990; González y Arriaga, 1996) that can maintain the household in times of crisis (Webb et al, 1992) or can be spent during social and religious festivities. Incomes derived from small livestock were more important than in the other Groups, but still very low, which suggested an on farm consumption of these products.

Although 21% of land was dedicated to crops and cropping costs were very important (Table 7), agriculture only contributed to 13.4% of the total income, rice being the most important crop (47.0% of agricultural income). Agricultural production is very important is these subsistence systems, but these products are not sold in markets and subsequently do not generate big returns. Most agricultural products are consumed on the farm by the family. Similarly to these results, Ingawa (1986) found that in mixed agriculture-livestock systems in Nigeria, crops are the base of human subsistence and livestock generated more than 50% of the income.

a. Group 1

b. Group 2

c. Group 3

**Figure 1 - Distribution of farm Income and Net Margin (US$) per Group**

Costs were also size-dependent as shown in Table 7. Those farms with more land and larger herds had the highest costs and vice versa. But there were also substantial

differences between groups in the structure of costs (Figure 2). The group of *large commercial livestock farms* had the highest proportion of fixed costs (47.4%), of which permanent salaried labour was the most relevant one (27% of total costs). As mentioned before, this was the main reason for relatively low Net Margins in this Group, which were slightly higher than in Group 2. Feeding costs were also comparatively important (25.1% of total costs and 47.7% of variable costs). This is related to a main orientation towards milk production, although these figures are substantially lower than 33% of total costs reported by CAO (1997) for milk production systems in Santa Cruz and lower than in specialised dairy systems in the tropics, where feeding costs can be as high as 65% of the variable costs (CATIE, 1990; Pomareda, 1994). Costs that correspond to animal purchases were high (14.7%), which indicated a higher proportion of out-farm replacements. Costs of non-permanent labour were low in this group due to the fact that most labour was contracted on a permanent basis. As would be expected, this group had the lowest proportion of cropping costs due to the little relevance of agriculture.

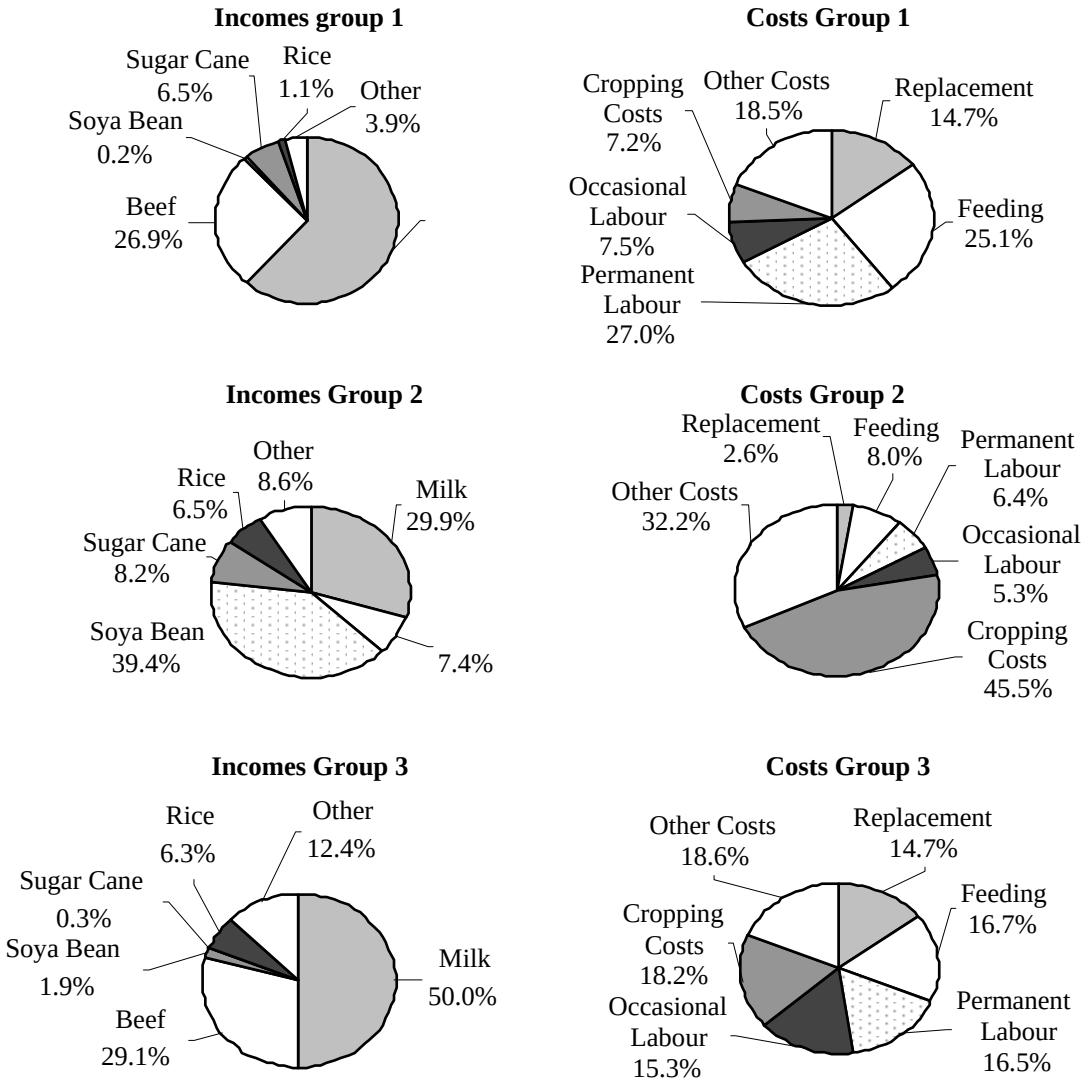


**Figure 2 - Sources on Income and Costs per Group**

The Group of *medium size agricultural farms* had a low proportion of fixed costs (18%); therefore, the Net Margin obtained was close to the Gross Margin. Cropping costs were the highest, both in-group and between-groups (45.5%). Both permanent and non-permanent labour costs were very low, which meant that contracted labour was unusual. Nevertheless, availability of labour, as seen in Table 6, was high because these farms use the family labour force. Replacement costs were nearly zero, which indicated on-farm replacement strategies and feeding costs were also small (8% of total costs and 9.7% of variable costs) due to the agricultural orientation of these farms and because the foodstuffs used came mainly from on-farm agricultural production.

*Small semi-commercial mixed farms* had very low total costs, but a high level of fixed costs (40%). Out-farm purchases of animals were frequent (14.7% of total costs), but in this case it should not be considered as replacement, but mainly as an investment when there is a cash surplus. Feeding costs were low, but comparatively important (16.7% of total costs and 28.8% of variable costs) that could be related to the scarce or even null availability of forages in the dry season, which forced farmers to buy foodstuffs. Labour, permanent and non-permanent, was the highest cost in this group (31.8%). Especially relevant was the cost of non-permanent labour, much higher than in the other groups, which was related to higher necessities of labour at sowing and harvest time, and therefore should be assigned to agriculture rather than livestock farming. Cropping costs were the highest in this group (18.2%). Considering the last two cost components, it can be affirmed that in these semi-commercial/ subsistence systems most costs are related to food production for on-farm consumption, although most income comes from livestock production i.e. milk and sale of animals. This indicates the importance of livestock as a route out of poverty.

### 3.3. Intensification level

Although the positive relationship between the economic dimension and the physical size of the farms has been pointed out, when economic indicators were calculated on a per-hectare basis the economic results differed (Table 8).

Group 2 obtained higher unitary Gross Margin and, mainly, Net Margin than Group 1 ($131/ ha versus $57.9/ ha per ha) due to lower proportion of fixed costs (permanent labour costs). The unitary GM of Group 1 and 3 were similar, but when NM was considered, Group 3 obtained substantial higher returns per ha ($97.3/ ha versus $57.9/ ha).

**Table 8. Intensification indicators for each Group.**

| Indicator | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| Gross Margin/ ha agricultural land | 149.2 | 182.8 | 143.5 |
| Net Margin/ ha agricultural land | 57.9 | 131.0 | 97.3 |
| Total Income/ ha agricultural land | 251.2 | 406.5 | 207.1 |
| **Agriculture Income/ ha crops** | 426.7 | 409.9 | 142.8 |
| **Livestock Income/ ha pastures** | 228.7 | 397.0 | 222.7 |
| **Milk Income/ ha pastures** | 144.3 | 301.0 | 136.8 |
| **Beef Income/ ha pastures** | 77.7 | 68.3 | 49.0 |
| Total Costs/ ha agricultural land | 193.3 | 275.5 | 109.7 |
| Feeding Costs/ LU | 50.2 | 26.4 | 17.2 |

| | | | |
|---|---|---|---|
| Feeding Costs/ litter of sold milk | 0.07 | 0.03 | 0.03 |
| Cropping Costs/ ha crops | 176.8 | 165.7 | 108.8 |

Similarly, the highest unitary income was obtained by Group 2 ($406.5/ ha) and Group 1 and 3 had similar figures. Unitary agricultural income (per ha of crops) was similar in Group 1 and in Group 2 ($426.7 and $409.9/ ha crop respectively), which could be explained by the similar productivity of the more relevant crops in these groups i.e. sugar cane and soya bean respectively. Group 3 obtained much lower agricultural income per ha ($142.8/ ha crops), which confirmed the on-farm use of these products. Paradoxically, animal products, especially milk, produced higher income per ha of pasture in Group 2 than in Group 1 ($397 and $228.7/ ha pasture). This was due to the higher (more intensive) use of on-farm foodstuffs for milk production such as sorghum and maize by Group 2. The productivity of pastures in terms of livestock products, especially milk, was similar for Group 1 and 3 ($228.7 and $222.7/ ha pasture respectively), although Group 1 had higher proportion of cultivated pastures.

Total Costs could also be considered as farm size dependent (Table 7), but when calculated per ha they were related more to the degree of intensification in terms of used inputs. This inputs were substantially higher in *medium size agricultural farms* ($275.5/ ha) while very low inputs per hectare were characteristic of *small semi-commercial mixed farms* ($109.7/ ha). Group 1 of *large commercial livestock farms* had intermediate unitary inputs ($193.3/ ha). Group 1 had higher feeding costs per livestock unit and per litter of sold milk than Group 2 because in this group foodstuffs came from on-farm agricultural production. Feeding cost per livestock unit and per litter of commercialised milk were very low in Group 3, which indicated systems based mainly on grazing or cut-and-carry forages. Unitary cropping costs were high in Group 2, as would be expected, and also in Group 1, suggesting similar costs levels in the most typical crops o these groups, soya bean and sugar cane respectively. By contrast, this cost was much lower in Group 3, which again indicated the low-input nature of the subsistence crops of these farms.

## 4. Conclusions

Three types of systems were clearly differentiated in the areas of the study. They can be generically defined as: *large livestock commercial farms*, *medium size agricultural farms* and *small semi-commercial mixed farms*. These different systems had very different structural, social, productive and economic characteristics.

Economic results were related to the physical size of the farm, but also, to the land use, type of production (milk-meat-agriculture), structure of costs and level of intensification. The highest incomes derived from milk production in large livestock farms, but due to higher fixed costs (mainly labour) the Net Margin was reduced. These systems were extensive in terms of land use (large pastoral areas) and also in economic terms (low economic margins, incomes and costs per ha). The high availability of agricultural land allowed these systems to operate obtaining low margins per ha, but if economic growth were necessitated, it would force them either to intensify the production processes or to increase agricultural land destroying the forestland available.

Mixed crop/ livestock systems obtained the highest profitability per unit of land, mainly because they had very low permanent labour costs due to high availability of family labour. Net economic returns would decrease if this situation changed. These systems were based on a few industrial crops, mainly soya bean, although milk production was a complementary income with variable importance. These systems were substantially

more intensive in land use and could be considered as high-input systems. This could be partly explained by the limited availability of land. Diversified crop/ livestock activities resulted in more constant income, which could mean better chances to cope with risk situations in these systems.

Semi-commercial and subsistence farms obtained the lowest economic results and a high proportion of them could be considered under the poverty level. Although these systems were very diversified, they were very sensitive to adverse environmental situations, due to the small physical dimension and the lack of economic resources to intensify farming activities. Both livestock and agricultural activities played very important but different roles: livestock products were used for cash-flow (milk) and capital savings (beef) and agricultural products were mainly consumed on-farm by the families. Also, small animals, which were very important in this Group, contributed to the subsistence of the families. These systems could be considered extensive in terms of economic returns obtained and, mainly, in terms of inputs.

The methodology used in this work (multivariate analysis of qualitative data and cluster analysis followed by economic analysis) has proved to be useful in selecting target farmer groups and identifying recommendation domains in order to implement more focused development and extension policies.

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Appendices

Appendix 1 – Survey used in the project

Proyecto: **UN SISTEMA DE APOYO PARA TOMA DE DECISIONES DE MANEJO EN FINCAS GANADERAS EN SANTA CRUZ, BOLIVIA**

**-Centro de Investigación Agrícola Tropical - Santa Cruz - Bolivia**
**-Institute of Ecology and Resource Management - University of Edinburgh - Scotland**
**-Escuela de Medicina Veterinaria - Universidad Nacional - Costa Rica**

**Cuestionario para la caracterización de los sistemas de producción de bovino lechero y doble propósito en el área de Santa Cruz (provincias de San Javier, Zona de Expansión, Area Integrada y Sara-Ichilo)**

---

Finca demostrativa de CIAT SI ¦ NO ¦

Número de cuestionario: .....

Encuestador .....

Fecha .....

Nombre del encuestado .....Edad .....

Es el encuestado administrador ¦ o propietario ¦ o ambos ¦ ?

Dirección .....Teléfono .....

Localidad.....Provincia .....

Zona ecológica .....

---

**1. INFORMACION GENERAL**

1. Orientación productiva: lechería ¦ doble propósito ¦ carne ¦ agricultura ¦

2. Procedencia del ganadero .....

3. Vive en la finca? SI ¦ NO ¦

Si no es así, que distancia hay desde su casa a la finca?.....(km)

4. Distancia de la finca a la población más cercana .....(km). Población.....

5. Tiene acceso a la finca por camino principal? SI ¦ NO ¦

Si no es así, distancia de la finca al camino principal más cercano.....(km).

6. Tiene electricidad en casa? SI ¦ NO ¦

Si es así, de que tipo (CRE, generador, panel solar, etc.) .....

7. Fuente de agua potable (red general, río, pozo, noria, etc.) .....

8. Tiene acceso a servicios educativos para su familia? SI ¦ NO ¦ Distancia (km).....

Si es así, que nivel? Primaria ¦ Secundaria ¦ Técnica ¦ Universidad ¦

9. Tiene acceso a servicios de salud para su familia? SI ¦ NO ¦ Distancia (km).....

Si es así, que tipo? .....

**2. ESTRUCTURA FAMILIAR Y NIVEL DE EDUCACION**

10. Número de personas que componen la familia .....

| Miembro | Edad | Nivel de Educación [1] | Vive en casa? (si/no) |
|---|---|---|---|
| Finquero | | | |
| Esposa | | | |
| Hijos (no. .....) | | | |
| Hijas (no. .....) | | | |
| Abuelos | | | |
| Otros (especificar) | | | |
| ..... | | | |
| ..... | | | |
| ..... | | | |

[1] Analfabeto; Primaria; Secundaria; Técnica; Universidad

11. Es miembro de alguna asociación de productores? SI ¦ NO ¦ Cuál? .....

Si es así, ocupa algún cargo directivo? SI ¦ NO ¦ Cuál? .....

12. Ha recibido algún curso de formación recientemente? SI ¦ NO¦

Si es así, qué cursos? .....

13. Recibe información técnica (revistas, publicaciones, radio, TV)? SI ¦ NO ¦

Si es así, cuales? .....

.....

**3. DISPONIBILIDAD Y DISTRIBUCION DEL TRABAJO**

14. Cuantas personas trabajan en la finca? De la familia ..... Contratados .....

15. Distribución del trabajo en la finca entre los miembros de la familia

| Miembro | Actividades que realiza | Días por semana |
|---|---|---|
| Finquero | | |
| Esposa | | |
| Hijos | | |
| Hijas | | |
| Abuelos | | |
| Otros | | |

16. Algún miembro de su familia realiza trabajos fuera de la finca? SI ¦ NO ¦ Si es así,

| Miembro | Actividades que realiza | Meses |
|---|---|---|
| Finquero | | |
| Esposa | | |
| Hijos | | |
| Hijas | | |
| Abuelos | | |
| Otros | | |

17. Tiene mano de obra fija contratada? SI ¦ NO ¦ Si es así,

| Actividades que realiza | Meses | Costo/mes |
|---|---|---|
| | | |

18. Tiene mano de obra ocasional contratada? SI ¦ NO ¦ Si es así,

| Actividades que realiza | Meses | Costo/ha |
|---|---|---|
| | | |

19. Toma usted vacaciones? SI ¦ NO ¦

**4. RECURSOS DE LA EXPLOTACION: PASTOS Y CULTIVOS**

20. Superficie total de la finca ..... ha

Propio .....ha Alquilado .....ha Al partido .....ha Otros .....ha

21. Cuantos parcelas diferentes posee? ..... Las maneja integradas? SI ¦ NO ¦

22. Distancia de las parcelas al núcleo de la finca: <0.5 km. .....

0.5 - 1 km. .....

1 - 3 km. .....

> 3 km. .....

23. Alquila parte de su tierra a otros finqueros? SI ¦ NO ¦

Si es así, no. de ha ..... uso de dichas tierras .....

24. Tierras cultivadas el último año .....ha

| **Cultivo** | **Superficie (ha)** | **Rendimiento kg/ha** |
|---|---|---|
| Soja | | |
| Maíz | | |
| Caña de azúcar | | |
| Trigo | | |
| Algodón | | |
| Frijol | | |
| Sorgo | | |
| Arroz | | |
| Barbechos | | |
| Otros ..... | | |

25. Pastos cultivados .....ha

| **Tipo de pasto** | **Superficie (ha)** | **Condición*** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

*Bueno, regular, malo.

26. Pastos naturales .....ha Especies predominantes .....

.....

27. Superficie de bosque .....ha Especies predominantes .....

.....

28. Pasan ríos por la finca? SI ¦ NO ¦ Si es así, cual? .....

29. Tiene manantiales? SI ¦ NO ¦ Si es así, cuantos? .....

30. Tiene pozos? SI ¦ NO ¦ Si es así, cuantos? .....

31. Tiene atajados? SI ¦ NO ¦ Si es así, cuantos? .....

**5. ESTRUCTURA Y DINAMICA DEL HATO**

32. Efectivos ganaderos. Número total de animales.....

| **Tipo** | **Número** | **Raza** |
|---|---|---|
| Vacas paridas | | |
| Vacas secas | | |

| | | |
|---|---|---|
| Vacas de desecho | | |
| Terneras lactantes | | |
| Terneras de 1 a 2 años | | |
| Vaquillas de 2 a 3 años<br>Vaquillas preñadas | | |
| Terneros lactantes | | |
| Novillos de 1 a 2 años | | |
| Novillos de 2 a 3 años | | |
| Toros | | |
| Bueyes | | |
| Otras especies: Ovinos | | |
| Caprinos | | |
| Caballos | | |
| Burros | | |
| Cerdos | | |
| Gallinas | | |
| Otros | | |

33. Origen de los animales de cria (vacas, vaquillas, toros):

Reposición propia ¦ Compra en hatos cercanos ¦

Compra fuera de la región ¦ Compra fuera del país ¦

34. Animales comprados el último año. No..... tipo ..... precio .....

35. Número de animales muertos en el último año

| **Tipo** | **Número** | **Causas** |
|---|---|---|
| Vacas | | |
| Vaquillas | | |
| Terneras lactantes | | |
| Terneros lactantes | | |
| Novillos de 1 a 2 años | | |
| Novillos de 2 a 3 años | | |
| Toros | | |

36. Animales descartados en el último año

| **Tipo** | **Número** | **Causas*** |
|---|---|---|
| Vacas | | |
| Vaquillas | | |

| | | |
|---|---|---|
| Terneras lactantes | | |
| Terneros lactantes | | |
| Novillos de 1 a 2 años | | |
| Novillos de 2 a 3 años | | |
| Toros | | |

*Vejez; Problemas reproductivos; Baja producción; Enfermedad (especificar); Otros (especificar)

**6. INSTALACIONES Y MAQUINARIA**

37. **Instalaciones:**

Corrales SI ¦ NO ¦ no. ..... $m^2$ ..... antigüedad .....

Depósitos SI ¦ NO ¦ no. ..... $m^2$ ..... antigüedad .....

Galpones SI ¦ NO ¦ no. ..... $m^2$ ..... antigüedad .....

Graneros SI ¦ NO ¦ no. ..... $m^2$ ..... antigüedad .....

Brete SI ¦ NO ¦ Baño antiparasitario SI ¦ NO ¦ Pesa SI ¦ NO ¦

Sala de ordeño SI ¦ NO ¦ $m^2$ ..... tipo y número de animales .....

Tanque refrigerador de leche SI ¦ NO ¦ Capacidad .....(litros)

Otros (especificar) .....

38. **Maquinaria:**

Tractor Número ..... Potencia (C.V.) ..... antigüedad .....

Cosechadora ¦ antigüedad ..... Abonadora ¦ antigüedad .....

Sembradora ¦ antigüedad ..... Cultivador ¦ antigüedad .....

Arado ¦ antigüedad ..... Rastra ¦ antigüedad .....

Picadora ¦ antigüedad ..... Subsolador ¦ antigüedad .....

Desbrozadora ¦ antigüedad ..... Molino ¦ antigüedad .....

Chata ¦ antigüedad ..... Camión ¦ antigüedad .....

Bombas ¦ antigüedad ..... Automóvil ¦ antigüedad .....

Equipo de tracción animal: arado ¦ rastra ¦

Otros (especificar) .....

**7. ASISTENCIA TECNICA Y TOMA DE DECISIONES**

39. Recibe algún tipo de asistencia técnica? SI ¦ NO ¦ Si es así,

| | Frecuencia | Tipo de técnico[1] | Organización[2] |
|---|---|---|---|
| Salud animal | | | |
| Reproducción | | | |
| Nutrición | | | |
| Manejo pastos | | | |
| Cultivos | | | |

[1] Veterinario; Agrónomo; Nutricionista; Agente de extensión agraria; Otros (especificar)
[2] Gobierno; FEGASACRUZ; FEDEPLE; PIL; CIAT; ONG; Privado; Asociación local; Otros (especificar)

40. Indique la importancia de las siguientes fuentes de información para el manejo de la finca:

técnicos mucho ¦ poco ¦ nada ¦
asociación mucho ¦ poco ¦ nada ¦
publicaciones mucho ¦ poco ¦ nada ¦
radio mucho ¦ poco ¦ nada ¦
TV mucho ¦ poco ¦ nada ¦
días de campo mucho ¦ poco ¦ nada ¦
otros finqueros mucho ¦ poco ¦ nada ¦
criterio propio mucho ¦ poco ¦ nada ¦
criterio familiar mucho ¦ poco ¦ nada ¦
otros (especificar)..... mucho ¦ poco ¦ nada ¦

41. Cual miembro de su familia colabora en la toma las decisiones?

Ninguno ¦ Esposa ¦ Hijo mayor ¦ Otros hijos ¦ Otros (especificar) .....

**8. MANEJO DE PASTOS Y ALIMENTACION**

42. En cuantos grupos de animales divide el hato? .....

especifique 1..... 2.....
3.....
4..... 5.....
6.....

43. Prácticas de manejo y tipo de pastos por grupo en los potreros (marcar v):

| | **Grupo1** | **Grupo2** | **Grupo3** | **Grupo4** | **Grupo5** | **Grupo6** |
|---|---|---|---|---|---|---|
| Rotacional | | | | | | |
| Continuo | | | | | | |
| Pasto natural | | | | | | |
| Pasto mejorado ..... | | | | | | |
| Pasto mejorado ..... | | | | | | |
| Pasto mejorado ..... | | | | | | |

44. Número y dimensión de los potreros:

| **Area** | **No. de potreros** | **Area** | **No. de potreros** |
|---|---|---|---|
| Area total (ha) | | 10-20 ha | |
| <1 ha (número) | | 20-50 ha | |

| | | | |
|---|---|---|---|
| 1-2 ha | | 50-100 ha | |
| 2-5 ha | | > 100 ha | |
| 5-10 ha | | | |

**Preguntas generales:**

45. Fertilización: SI ¦ NO ¦ Si es así, cuando lo hace? .....

en cuales pastos? .....

tipo de fertilizante ..... cantidad por ha .....

46. Rotación con cultivos anuales: SI ¦ NO ¦ Si es así, frecuencia .....

47. Tiene malezas? SI ¦ NO ¦ Si es así, qué especies? .....

Que porcentaje de tierra esta afectado? .....

Como calificaría su presencia? Alta ¦ Media ¦ Baja ¦

Lo considera un problema importante? mucho ¦ poco ¦ nada ¦

Que método de control utiliza? ..... frecuencia .....

48. Otras labores realizadas: quema cuando la hace? .....

otras..... .....

49. Observa disminución de la producción de pasto en los últimos 5 años? SI ¦ NO ¦

Que porcentaje de tierra esta afectado? .....

Tipo de pastos afectados .....

Si es así, como calificaría la gravedad del problema? Alta ¦ Media ¦ Baja ¦

Lo considera un problema importante? mucho ¦ poco ¦ nada ¦

50. Observa compactación del terreno (pisoteo) en los últimos 5 años? SI ¦ NO ¦

Que porcentaje de tierra esta afectado? .....

Tipo de pastos afectados .....

Si es así, como calificaría la gravedad del problema? Alta ¦ Media ¦ Baja ¦

Lo considera un problema importante? mucho ¦ poco ¦ nada ¦

51. Observa erosión (presencia de canales) del terreno en los últimos 5 años? SI ¦ NO ¦

Que porcentaje de tierra esta afectado? .....

Si es así, como calificaría la gravedad del problema? Alta ¦ Media ¦ Baja ¦

Lo considera un problema importante? mucho ¦ poco ¦ nada ¦

52. Ha abierto nuevas superficies de pastos en los últimos 5 años? SI ¦ NO ¦

Si es así, número de ha .....

Método utilizado: quema ¦ arado ¦ cadenas ¦ tala ¦ otros .....

Vegetación original .....

Porqué lo hace? .....

Considera esta práctica nociva para el medio ambiente: mucho ¦ poco ¦ nada ¦

**Conservación de forrajes:**

53. Rastrojos SI ¦ NO ¦ Si es así, qué superficie .....ha

De que cultivo? .....

Epoca de aprovechamiento .....(meses)

Cuantos animales le mantiene ..... Cuales animales .....

..... Cuanto tiempo? .....

54. Pasto seco SI ¦ NO ¦ Si es así, qué superficie .....ha

De que especies .....

Cuanto tiempo cierra el potrero?.....

Epoca de aprovechamiento .....(meses)

Cuantos animales le mantiene ..... Cuales animales .....

..... Cuanto tiempo? .....

55. Pasto de corte SI ¦ NO ¦ Si es así, qué superficie .....ha

Cuando lo hace? .....(meses)

De que especies .....

Cuantos animales le mantiene ..... Cuales animales .....

..... Cuanto tiempo? .....

56. Silo SI ¦ NO ¦ Si es así, qué superficie .....ha

Cuando lo hace? .....(mes)

De que especies .....

Epoca de aprovechamiento .....(meses)

Cuantos animales le mantiene ..... Cuales animales .....

..... Cuanto tiempo? .....

57. **Calendario de pastoreo:**
Especificar manejo general de pastoreo: 1=pasto natural; 2=pasto mejorado; 3=rastrojos; 6=monte; 4=estabulación; 5=suplementación; 7=otros (especificar)

| | **Epoca lluviosa** | **Epoca seca** |
|---|---|---|
| Grupo 1 ..... | | |
| Grupo 2 ..... | | |
| Grupo 3 ..... | | |
| Grupo 4 ..... | | |
| Grupo 5 ..... | | |
| Grupo 6 ..... | | |

58. **Suplementación adicional.** Especifique tipo de alimento, cantidad aproximada en kg y cuando se ofrece a los animales.

| | Epoca seca | | | Epoca húmeda | | |
|---|---|---|---|---|---|---|
| **Tipo de animal** | **Alimentos** | **Cantidad** | **Meses** | **Alimentos** | **Cantidad** | **Meses** |
| Grupo 1 ..... | | | | | | |
| Grupo 2 ..... | | | | | | |
| Grupo 3 ..... | | | | | | |
| Grupo 4 ..... | | | | | | |
| Grupo 5 ..... | | | | | | |
| Grupo 6 ..... | | | | | | |

59. Cuantas veces alimenta al día? Vacas lactantes ..... Resto de animales .....

**Suplementación mineral:**

60. Utiliza sal mineral? SI ¦ NO ¦ Si es así, libre disposición ¦ racionado ¦

Donde? en potreros ¦ en los corrales ¦ en ambos ¦

cuando? .....Para qué animales? .....

frecuencia de suplementación .....

61. Utiliza sal común? SI ¦ NO ¦

Si es así, donde? en potreros ¦ en los corrales ¦ en ambos ¦

cuando? .....Para qué animales? .....

frecuencia .....

**Manejo de aguas:**

62. De donde se obtiene el agua para los animales a lo largo del año?

| **Fuente** | **Ene** | **Feb** | **Mr** | **Abr** | **My** | **Jun** | **Jul** | **Ag** | **Sep** | **Oct** | **Nov** | **Dic** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

63. Tiene agua en todos los potreros? SI ¦ NO ¦

Si no es así, cual es la distancia media de los potreros a los puntos de agua? .....

64. En que época tiene escasez de agua?..... (meses)

El problema de agua le parece: muy serio ¦ poco ¦ nada ¦

Como resuelve el problema? .....

**Otras medidas de manejo:**

65. Destete SI ¦ NO ¦ Si es así, a que edad? .....

66. Castración SI ¦ NO ¦ Si es así, a que edad? ..... época .....

67. Descorne SI ¦ NO ¦ Si es así, a que edad? ..... época .....

68. Marcado SI ¦ NO ¦ Si es así, a que edad? ..... época .....

**9. MANEJO REPRODUCTIVO Y CRIA**

69. Criterios para seleccionar sus reemplazos (numerar en orden las más importantes):

| | | | |
|---|---|---|---|
| producción de la madre | | rusticidad (resistencia) | |
| reproducción de la madre | | docilidad (facil manejo) | |
| por su padre | | cuernos | |
| por sus hermanos | | belleza física | |
| peso | | otros ..... | |
| tamaño | | ..... | |

70. Sistema de cruzamiento: Alterno ¦ Absorvente ¦ Terminal ¦

Otros ¦ (especificar) .....

71. Edad a primera monta ..... meses Criterio edad ¦ peso ¦

72. Edad al primer parto ..... meses

73. Tipo de monta: Continua ¦ Discontinua ¦ Si es discontinua, épocas .....

IA ¦ Monta natural ¦ Ambas ¦

74. Si practica ambas, en cuantos animales insemina? .....

en cuales animales? .....

75. Si es monta natural, cual es la relación vacas/toro? vacas lactantes.....

vacas secas y

novillas.....

76. Tras el parto, cuanto espera a la próxima monta .....

77. En que épocas hay mayor número de partos?:

| **Epoca** | **número de partos** |
|---|---|
| | |

| | |
|---|---|
| | |
| | |
| | |

78. Practica algún método de control reproductivo? SI ¦ NO ¦ Si es así,

Palpaciones ¦

Detección de celos ¦ Si es así, que método? .....

79. Número de vacas que no parieron en el último año .....

80. Número de vacas que abortaron en el último año ..... Causas?.....

.....

81. Número de terneros muertos en la primera semana después del parto .....

82. Que medidas de atención al parto practica? vigilancia ¦ cambio a lugar de maternidad ¦

limpieza ¦ desinfección cordón umbilical ¦ toma de calostros ¦

apoyo vit-mineral ¦ otras (especificar).....

83. Practica la lactancia artificial? SI ¦ NO ¦ Si es así,

de que tipo?: leche en polvo ¦ leche natural en balde ¦

cantidad de leche .....(l/día) edad de destete .....

84. A que edad ofrece alimentos sólidos al ternero?..... que tipo? .....

.....

85. Tipo de alimentación tras el destete. Alimento y cantidad .....

.....

**10. ORDEÑO**

86. Sistema de ordeño Mecánico ¦ Manual ¦

Si es manual, donde ordeña?.....

87. Cuantas veces ordeña al día? ..... A que hora? .....

88. Presenta el ternero antes del ordeño? SI ¦ NO ¦

89. Deja el ternero mamar después del ordeño? SI ¦ NO ¦

Si es así, cuantas horas? .....

Cuanta leche le deja al ternero? un cuarto ¦ leche residual ¦ nada ¦

90. Medidas de higiene que practica:

Limpieza de pezones antes del ordeño SI ¦ NO ¦

Baño y sellado de pezones tras el ordeño SI ¦ NO ¦

Limpieza y desinfección de la máquina SI ¦ NO ¦ Si es así, frecuencia .....

91. Hace diagnóstico de mamitis? SI ¦ NO ¦ Si es así, que método emplea? .....

92. Enfria la leche? SI ¦ NO ¦ Si es así, que sistema tiene?.....

93. Método de secado de los animales: .....

94. Tiene alguna medida sanitaria al secado? SI ¦ NO ¦ Si es así, cual? .....

95. Cual es la duración media de la lactación en meses? .....

96. Cual es la duración media del periodo seco en meses? .....

97. Que producción obtiene por vaca/día? estación seca .....litros

estación lluviosa ..... litros

**11. MANEJO SANITARIO**

98. En su opinión, cuales son los mayores problemas sanitarios de los animales en su zona?

.....

.....

99. **Vacunaciones practicadas:**

Brucelosis SI ¦ NO ¦

Aftosa SI ¦ NO ¦

Carbunco hemático o lengueta SI ¦ NO ¦

Carbunco sintomático o gangrena SI ¦ NO ¦

Rabia o cadera SI ¦ NO ¦

Neumoenteritis SI ¦ NO ¦

Otras (especificar) .....

100. **Control de garrapatas:**

Inmersión ¦ Aspersión ¦ Preinmunización ¦ Vacuna específica ¦ Otros ¦

Número y frecuencia de aplicaciones .....

Meses de aplicación .....

Otros ectoparásitos: boro ¦ mosca negra ¦ mosca brava ¦ otras ..... ¦

101. **Control de endoparásitos:**

Parásitos digestivos SI ¦ NO ¦ Si es así, método utilizado .....

a cuales animales? .....

número de aplicaciones ..... épocas .....

Parásitos pulmonares SI ¦ NO ¦ Si es así, método utilizado .....

a cuales animales? .....

número de aplicaciones ..... épocas .....

Otros (especificar) .....

**12. ENFERMEDADES: INCIDENCIA Y MORTALIDAD**

102. Enfermedades sufridas en el último año:

| **Enfermedad** | **No. de afectados** | **No. de muertes** | **Tratamiento** |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

103. Principales problemas sanitarios y brotes de enfermedades sufridos en los últimos 5 años:

| Enfermedad | No. de afectados | No. de muertes | Tratamiento |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**13. RESULTADOS TECNICO-ECONOMICOS Y COMERCIALIZACION**

104. Número y tipo de animales vendidos el último año:

| Tipo de animal | Número | Precio | Epoca de venta |
|---|---|---|---|
| Terneros destete: peso ..... | | | |
| Novillos 1-2 años: peso ..... | | | |
| Novillos 2-3 años: peso ..... | | | |
| Animales destetados | | | |
| Animales de descarte | | | |
| Animales para reproducción | | | |
| Otros ..... | | | |

105. Venta de productos animales en el último año:

| Producto | Cantidad | Precio | Epoca de venta |
|---|---|---|---|
| Leche | | | |
| Quesos | | | |
| Cueros | | | |
| Otros ..... | | | |
| | | | |

106. Venta de otros productos ganaderos en el último año:

| Tipo de animal | Cantidad | Precio | Epoca de venta |
|---|---|---|---|
| Corderos | | | |
| Cabritos | | | |
| Caballos | | | |
| Cerdos | | | |
| Otros ..... | | | |
| | | | |

107. Autoconsumo: Número de bovinos ..... Ovinos ..... Cerdos ..... Otros .....

108. Venta de productos agrícolas en el último año:

| **Producto** | **Cantidad** | **Precio** | **Epoca de venta** |
|---|---|---|---|
| Soja | | | |
| Maíz | | | |
| Caña de azúcar | | | |
| Trigo | | | |
| Algodón | | | |
| Frijol | | | |
| Sorgo | | | |
| Arroz | | | |
| Otros ..... | | | |

109. Ha prestado algún servicio a terceros el último año? SI ¦ NO ¦

Si es así, cual y que ingreso obtuvo? .....

110. Si alquila tierra a otros finqueros, cual fue el precio obtenido por ha? .....

111. Otros ingresos fuera de la ganadería .....

**Comercialización:**

112. Practica la venta ¦ el trueque ¦ ambos ¦

113. Donde vende sus animales? En la finca ¦ Los lleva a vender ¦

114. A quien vende los animales? Otros finqueros ¦ Intermediario ¦ Comerciante ¦
Matadero ¦ Consumidor ¦

115. El matadero es: privado ¦ estatal ¦ de una asociación ¦ otros .....

116. Donde vende la leche? En la finca ¦ La lleva a vender ¦ a donde? .....

117. A quien vende la leche? PIL ¦ venta directa ¦ otros .....

118. Tiene problemas para vender los animales? SI ¦ NO ¦

Si es así, cuales? Falta de comprador ¦ Lejanía de mercados ¦ Bajos precios ¦
Malas comunicaciones ¦ Otros .....

119. Tiene problemas para vender la leche? SI ¦ NO ¦

Si es así, cuales? Falta de comprador ¦ Lejanía de mercados ¦ Bajos precios ¦
Malas comunicaciones ¦ Otros .....

120. Quién y como define el precio de los animales? .....

121. Quién y como define el precio de la leche? .....

122. Como se informa de los precios? Revistas ¦ Servicio de extensión ¦ Otros finqueros ¦

Comercios locales ¦ Asociación de productores ¦ Otros .....

123. Elabora quesos u otros derivados lácteos? SI ¦ NO ¦

Si es así, cuales y a quién los vende .....

**14. COSTOS DE EXPLOTACION**

124. Compras de animales

| **Tipo de animal** | **Cantidad** | **Precio por unidad** |
|---|---|---|
| Vacas reproductoras | | |
| Toros | | |
| Terneros destetados | | |
| Novillas de reemplazo | | |
| Novillos en desarrollo | | |

125. Compras de alimentos

| **Tipo de alimento** | **Cantidad** | **Precio por unidad** |
|---|---|---|
| ..... | | |
| ..... | | |
| ..... | | |
| ..... | | |
| ..... | | |

126. Otros

| **Tipo** | **Cantidad** | **Precio por unidad** |
|---|---|---|
| Minerales | | |
| Combustible | | |
| Fertilizante | | |
| Semillas | | |
| Sanidad (vacunas, antib., etc.) | | |
| Semen | | |

127. Arrendamientos .....

128. Impuestos y tasas .....

129. Salarios fijos (por persona) dinero ..... especie .....

130. Salarios ocasionales dinero ..... especie .....

131. Servicios técnicos .....

132. Mantenimiento de instalaciones .....

133. Mantenimiento de maquinaria .....

134. Mantenimiento de cercas .....

135. Mantenimiento de caminos .....

136. Costos de los cultivos:

| Cultivo | Costo por ha del cultivo |
|---|---|
| Soja | |
| Maíz | |
| Caña de azúcar | |
| Trigo | |
| Algodón | |
| Frijol | |
| Sorgo | |
| Arroz | |
| Otros ..... | |

137. Crédito agrícola:

Posee algún crédito agrícola SI ¦ NO ¦

Si es así, procedencia ..... Para que es el crédito? .....

Monto ..... Fecha de concesión .....

Duración ..... Interés .....

**15. DINAMICA DE LA EXPLOTACION**

138. Años de experiencia en el campo .....

139. Hace cuanto tiene la finca? .....años

140. Modo de adquisición: herencia ¦ comprada ¦ asentamiento ¦ otros .....

141. Hace cuanto se dedica a la ganadería .....años

142. Actividad anterior a la ganadera .....

143. Se considera satisfecho de ser ganadero (y agricultor) SI ¦ NO ¦

144. Considera que el ingreso es: muy bueno ¦ bueno ¦ aceptable ¦ malo ¦

145. Cuales de los siguientes objetivos considera importantes?

Mejorar ingresos económicos SI ¦ NO ¦

Mejorar la calidad de la vida de la familia (salud y educación) SI ¦ NO ¦

Tecnificar su trabajo (mejorar maquinaria de equipos) SI ¦ NO ¦

Mantener la finca para los hijos SI ¦ NO ¦

Mejorar la vivienda de la finca SI ¦ NO ¦

Mejorar y/o agrandar el hato SI ¦ NO ¦

Ser un ganadero de prestigio SI ¦ NO ¦

Mejorar los cultivos SI ¦ NO ¦

Mejorar los pastos SI ¦ NO ¦

Vivir en la ciudad SI ¦ NO ¦

Aumentar la producción SI ¦ NO ¦

No tener deudas SI ¦ NO ¦

| | | |
|---|---|---|
| Comprar movilidad | SI ¦ | NO ¦ |
| Tomar vacaciones | SI ¦ | NO ¦ |
| Invertir en otras actividades no agrarias | SI ¦ | NO ¦ |
| Tener más tiempo libre para la familia | SI ¦ | NO ¦ |
| Diversificar con nuevas actividades | SI ¦ | NO ¦ |
| Comprar más tierra | SI ¦ | NO ¦ |
| Ahorrar algún dinero | SI ¦ | NO ¦ |
| Elaborar y comercializar sus propios productos | SI ¦ | NO ¦ |
| Mejorar estado de los animales (salud, reproducción, alimentación) | SI ¦ | NO ¦ |
| Conseguir trabajo fuera de la finca | SI ¦ | NO ¦ |
| Tener animales bonitos y gordos | SI ¦ | NO ¦ |
| Utilizar el máximo de recursos disponibles | SI ¦ | NO ¦ |
| Conservar los recursos de la finca | SI ¦ | NO ¦ |
| Conservar el medio ambiente de su zona | SI ¦ | NO ¦ |

146. Ha invertido en la finca en los últimos años? SI ¦ NO ¦

Si es así, en que invirtió? .....

porqué? .....

Si no, porqué? .....

147. Ha cambiado los cultivos en los últimos años? SI ¦ NO ¦

Si es así, qué cambios? .....

.....

148. Ha cambiado el manejo en los últimos años? SI ¦ NO ¦

Si es así, qué cambios? .....

.....

149. Piensa seguir con la actividad ganadera? SI ¦ NO ¦

Si es así, diga porqué? le gusta la forma de vida ¦ le parece rentable ¦

por vocación ¦ tiene tierra disponible ¦ por tradición ¦ no tiene otra alternativa ¦

expectativas de futuro ¦ Otros (especificar) .....

Si no, diga porqué? no hay quien continúe al frente ¦ no es rentable ¦

tiene poca tierra ¦ no hay expectativas de futuro ¦ falta de mano de obra ¦

difícil comercialización ¦ trabajo muy duro ¦ quiere cambiar de vida ¦

Otros (especificar).....

150. Piensa invertir en la finca en los próximo años? SI ¦ NO ¦

Si es así, en que va invertir? .....

porqué? .....

Si no, porqué? .....

151. Va a cambiar los cultivos próximamente? SI ¦ NO ¦

Si es así, qué cambios? .....

152. Va a cambiar el manejo próximamente? SI ¦ NO ¦

Si es así, qué cambios? .....

153. Piensa diversificar las actividades de su finca SI ¦ NO ¦

Si es así, qué actividades nuevas? .....

154. Que prácticas de manejo considera que son las claves para conseguir sus objetivos?

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155. En su opinión, cuales son los principales problemas del agro en la zona? .....

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.....

156. En su opinión, cuales son los principales problemas de su finca? .....

.....

.....

157. En su opinión, qué mejoras técnicas son necesarias para mejorar la producción en la zona?

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158. En su opinión, qué mejoras técnicas son necesarias para mejorar la producción en su finca?

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159. En su opinión, que opción agrícola o ganadera le parece más rentable en su zona?

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160. En que aspecto le gustaría tener más asistencia técnica? .....

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161. Quién debería ofrecer esa asistencia? .....

162. Observaciones .....

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**ENCUESTA BOVINO LECHERO EN BOLIVIA** (esquema general)

**1. INFORMACION GENERAL**
**2. ESTRUCTURA FAMILIAR Y NIVEL DE EDUCACION**
**3. DISPONIBILIDAD Y DISTRIBUCION DEL TRABAJO**
**4. RECURSOS DE LA EXPLOTACION: PASTOS Y CULTIVOS**
**5. ESTRUCTURA Y DINAMICA DEL HATO**
**6. INSTALACIONES Y MAQUINARIA**
**7. ASISTENCIA TECNICA Y TOMA DE DECISIONES**
**8. MANEJO DE PASTOS Y ALIMENTACION**
**9. MANEJO REPRODUCTIVO Y CRIA**
**10. ORDEÑO**
**11. MANEJO SANITARIO**
**12. ENFERMEDADES: INCIDENCIA Y MORTALIDAD**
**13. RESULTADOS TECNICOS Y ECONOMICOS Y COMERCIALIZACION**
**14. COSTES DE EXPLOTACION**
**15. DINAMICA DE LA EXPLOTACION**