# Adaptive strategies of cattle livestock farmers facing multiple uncertainties in a district of the Argentinian pampa

Delsalle L. [1, 2, 5], Perez R. [3], Dedieu B. [1], Girard N. [2], Hang G. [4], Larrañaga G. [4], Magda D. [2]

1. INRA-SAD, UMR METAFORT, Centre de Clermont-Theix, 63122 Saint-Genes-Champanelle, FRANCE
2. INRA-SAD, UMR AGIR, B.P. 52627 Auzeville, 31326 Castanet Tolosan, FRANCE
3. INTA (Instituto Nacional de Tecnologia Agropecuaria) - IPAF (Instituto de investigacion y desarollo tecnologico para la Pequena Agricultura Familiar) in the Pampeana region, ARGENTINA
4. Universidad Nacional de La Plata (UNLP) - Facultad de Ciencias Agrarias y Forestales, La Plata, ARGENTINA
5. AgroParisTech, Paris Institute of Technology for Life, Food and Environmental Sciences, 16 rue Claude Bernard, 75231 Paris cedex 05, FRANCE

***Corresponding author:*** *lison.delsalle@agroparistech.fr*

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**Abstract**

*In Argentina, livestock farming systems are faced with great uncertainty due to the financial crisis and to recent severe climatic events (e.g. drought in 2008-2009). In such context, what are the different strategies and adaptations which livestock systems develop in front of climatic uncertainties and in particular, what is the role of forage resources used or created by these systems to adapt?*

*Our study aims at investigating how feeding systems adapt themselves to climatic events. Choosing this focus, our central hypothesis is that resources diversity may play an important role in the flexibility of these systems faced with severe climatic changes. Our objective is then to investigate how the use and the management of forage resources contribute through time to endow these systems with adaptive capacities to face climatic crisis.*

*Within a joint Argentinian-French cooperation program, our study was undertaken in Magdalena district (south-east of La Plata, province of Buenos Aires), which is part of the humid Pampa and where various types of agriculture (financial as well as family ones) coexist. As a conceptual basis, we chose a functional viewpoint on farming systems acknowledging the complexity of their socio-technical nature. Data were collected within family farms with a comprehensive procedure (semi-directive interviews with farmers) allowing us to characterize farmers' strategies developed around their feeding system and their reactions in face of severe climatic crisis. We illustrate the preliminary results of this on-going study with illustrative case studies of family farms in Magdalena district.*

## 1. Introduction: theoretical background and research focus

The adaptation of farming systems facing various hazards and especially climate change is at stake. In our European contexts, stability was more or less the rule when steering farming systems, partially thanks to regulation mechanisms and public policies supporting agriculture. Draw-

ing lessons from a distant context where variations and instability are the norm since a long time is the perspective chosen by this paper.

### 1.1. Our conceptual references regarding farming system adaptation

The adaptation of farming systems in front of hazards (the unforeseeable nature of financial and health crisis, the instability of prices, the increased risk of extreme climatic events) has been investigated through the flexibility concept coming from management sciences (Tarondeau, 1999; Chia and Marchesnay, 2008 and Darnhofer et al., 2010). Whereas *strategic flexibility* refers to long-term choices and to the capacity to change structure, resources or competencies of the system to co evolve with the environment (Mignon, 2001), *operational flexibility* refers to the system capacity, its configuration being stable for a while, to cope with perturbations at a short range. In this paper, we focus our analysis on:

1) Operational flexibility of livestock farming systems (LFS) with its three lines of analysis: sensitivity (of the system to hazards); regulations (properties emerging from the operation of the system under perturbations); adaptive management options (Dedieu, 2009). Some researches detail one or another of these lines (e.g. Cournut and Dedieu, 2004, Puillet et al., 2010 for the operation of LFS; Milestad and Darnhofer, 2003, Lievre, 2012 for adaptive management; Ingrand et al., 2007 for the sensibility), but the combination of the three is rare;
2) The livestock feeding system, connecting livestock and resource management strategy and the climate variability. We here assume to neglect other elements that are contributing to the farming system flexibility (for example external sources notably such as the networks of the farmers) and other types of perturbations (financial, politics…) in order to question the role of natural resources.

To investigate the feeding systems, some authors like Girard and Hubert (1996) have proposed to analyze the farmers' "realized strategies" (Mintzberg and Waters, 1985) that is the routine combination of practices which they actually carry out to manage their farm. The diversity of farmers' herd feeding realized strategies has been showed in various countries and productions (Tefera et al, 2004; Beyene et al, 2006; Girard et al, 2008) and can be related to the diversity of farmers' production objectives, and more widely to local soil and climate and socio-economic contexts. Nevertheless, this diversity has been rarely connected to the flexibility of these farms to adapt to climate change with its severe perturbations and increased frequency of extreme events.

### 1.2. Objectives and questions

In this paper, we propose to analyze the feeding strategies and their sensibility through their flexibility and to assess how these strategies adapt in face of climatic events. Farmers practices do not only refer to what do they do a given year, but how they prevent (enhancing regulations capacities within the system) and to how they adapt their management to climate variability. The "sensibility" line of analysis aims at understanding the tensions given to the system by i) the production choices (intense growth rhythms required for products, early age for first calving…); ii) the configuration of the system and especially the annual stocking rate. Regulations refer to the way resource management cope with drought. Adaptive management qualifies adjustments in livestock production or feeding sequences programming in order to face exceptional severity of climate events.

We thus propose here to connect the qualification of feeding strategies and flexibility in Argentina, and more precisely in the Pampean region which is strongly impacted by climatic pressures, and

where the traditional natural resources and extensive production schemes are no more supposed to be the evident response to climatic (and more general) hazards. We focus on how farmers with suckling herd design and manage their feeding system (forage resource and livestock management), examining how they combine the different resources (crops, sown and campo natural) and livestock production schemes (numbers, age at first calving, calving periods, type of products, batching) to develop feeding system strategy in coherence with their productive objectives.

## 2. The relevance of Argentina to study farming systems adaptation

In Argentina, livestock farming systems have to face both severe economic and climatic crisis for several years. The economic model adopted by the Argentinean state since the beginning of the 2000s and the following crisis (2001, 2008) have impacted strongly small and medium livestock producers (Reca and Parellada, 2001) which represent the majority of livestock farms Pampean region. Livestock production in the Pampean region has already been through significant changes in productive orientations (e.g. progress cultivation of soya; emergence of feedlots), and the development of industrial agriculture comes into asymmetrical competition with family agriculture[1] which can place small farms in peril (Cialdella et al, 2010). Some public policies have thus intended to support this production sector. For example, in the province of Buenos Aires, the Ministry of Land Affairs has been running for several years a Livestock Plan for the strengthening of small milk and meat producers, promoting technology transfer (seed and other inputs for planting annual and perennial pastures) and training in addition to financial contributions. Moreover, the regulation of exportations of beef meat provides farmers with the opportunity to export a percentage of production (Carricart et al., 2010). Intensification (of stocking rate, of production schemes) appears to be, for main stream research and extension the efficient response to such a context. It includes a low interest to natural resources, supposed to be inappropriate to intensification.

But these national and provincial policies did not provide to family farmers sufficient means to face of high uncertainties and severe crisis of the latest years, making these farms more sensible to perturbations. Since a few years, livestock farmers also have to face climatic changes, expressed through severe drought events as the “drought of the century” of 2008 and 2009. The scarcity of forage resources during this latest event has had a significant impact on cattle herd, because of the fall of pregnancy rates, of high mortality rates and of massive slaughters. These events question the intensification scheme and suggest paying attention to the flexibility and its levers.

## 3. Materials and methods

### 3.1 Description of the studied area

This study was carried out in the district of Magdalena, located east of La Plata in the Buenos Aires Province, in the temperate humid Pampa, ecosystem characterized by hot summer and without dry season. This small area, where the average annual precipitations is 900-1000mm, is characterized by a landscape with little slope and a high spatial heterogeneity of soil types and associated natural vegetation communities. This area is predominantly a livestock farming region, and nowadays a diversification of productions and farming systems can be observed with weaned calf, cattle fattening, mixed milk-suckling systems, mixed sheep-cattle systems... Since milk herds are managed with very similar practices in the farms of this area, we have chosen to focus our

[1] We consider ‘family farmers’ as producers who have a daily relation to their farm (even if they may live elsewhere) and who draw an important income for their family. Moreover, they may employ farm workers but they also work by themselves on their farm.

work on feeding systems of suckling herds and our results show the diversity of management ways for these suckling herds.

The proximity of large cities greatly influences the social organization of farming systems in the area: nearly 70% of the producers live outside the district and in general have adopted an entrepreneurial management of their farm. Taking into account this specificity and the high stake of maintaining such family systems, we have chosen to focus on the so-called “family farms” because they cannot take too much risk and must develop strategies to adapt to situations of uncertainty and ensure the subsistence of the family.

### 3.4 Our approach

The study used a case-based method (Mitchell, 1983), in which 10 cattle farms were analyzed in depth. Case studies were chosen to reflect the diversity of farming systems in the district. The knowledge of development agents working in the area for long has been taken into account, because they have an accurate knowledge of the current situation of agriculture and its development over the past 30 years. A sample of 10 family farms has been chosen according to structural criteria such as farmland size, its location in the district, the predominant soil type in the farm, the main product (weaned calf, young bull...) and the importance of pastures in the feeding system.

Data collection was based on two or three interviews using semi-structured questionnaires, entering the following topics: farm history, technical management of the various productions and of forage resources for the years 2010 to 2011. A final section of the interview was devoted to understanding how the farmer has reacted when confronted to economic crises and the dry summer of 2008-2009. Interviews were recorded and the data were compiled for each case in monographs with schematic timing diagram of farmland or batching.

In a first step, individual management practices has been analyzed with a within-case approach (Miles and Huberman, 1994) to abstract the “realized strategy” of each farmer, i.e. the combination of practices he implements (Mintzberg and Waters, 1985; Girard and Hubert, 1996). In a second step, we compared the practices and strategies with a cross-farm analysis (Miles and Huberman, op.cit.): within an inductive approach and an abstraction process that is deeply rooted in what farmers currently do, and not in a priori literature-driven categories, we thus characterize different strategies and ways in which these farming systems adapt faced with a same uncertain situation. We used the method proposed by Girard et al (2001; 2008) based on the knowledge engineering technique known as "repertory grids" (Fransella et al., 2004). It consists of defining a set of criteria expressing the various practices carried out by interviewed farmers on an axis opposing two extreme practices. Intermediate values are thus characterized and farmers are classified by a point on this axis. In a second stage, we defined types of feeding systems that express different combinations of practices. RepGrid software (http://repgrid.com/) was used to perform the multivariate analysis and to produce hierarchical classification trees showing cluster groups of cases that have the strongest similarities.

### 3.5 Brief description of the sample

All studied farms have a suckling herd, with 30 to 230 mothers, and three of them are mixed dairy-suckling (with small herd, 10 to 40 milked-cows) (table I). They use 50 to 600 ha of private owned or rented land. A large proportion (60%) has a herd of sheep for sale and/or home consumption, and some of them have other animal production (pork, laying hens). Labor force is

mainly family one (only 3 farms of our sample employ a permanent worker). 70% of livestock farmers and those who live in town (La Plata) travel daily to work on their farm.

**Table 1 – Structural description of farm sample**

| Herd number (min-max) | Farm area (min-max) | Productive orientation (number of farms in the sample) | Stocking rate (animal/ha) |
|---|---|---|---|
| 30 – 230 cows | 50 – 600ha | Weaned calf (3)<br>Aged weaned calf (4)<br>Young bull (3) | 0.6 – 1.3 |

Within the suckling herd, diverse production objectives can be observed: some farmers sell their claves at weaning (170-180 kg in general), others sell aged weaned calves (220 kg) fattened after weaning to be sold for finishing in other farms. Finally, some farmers fatten young bulf to sell them at a weight of 320 to 500 kg.

For their suckling herd, all breeders use natural grasslands called 'campo natural'[2] and many of them implement temporary pasture and annual forage crops for summer and winter periods such as sorghum, moha (*Setaria italica*), oats or corn.

## 4. Results

### 4.1 Brief description of variables used to describe the diversity of feeding systems

We have formalized 10 variables expressing the practices concerning flock and resources management, with 3 to 5 modalities for each variable represented as an axis opposing extreme practices. Our 10 variables concern: i) flock management (batches management, the breeding organization for cows, the age of heifers at first calving and the type of animals put for sale), ii) resources (way of producing forage resources during the campaign, seedling and use of pastures, use of 'campo natural', forage autonomy and role of stocks in the feeding system). One example of practices modalities for the variable "use of pastures" is given in figure 1.

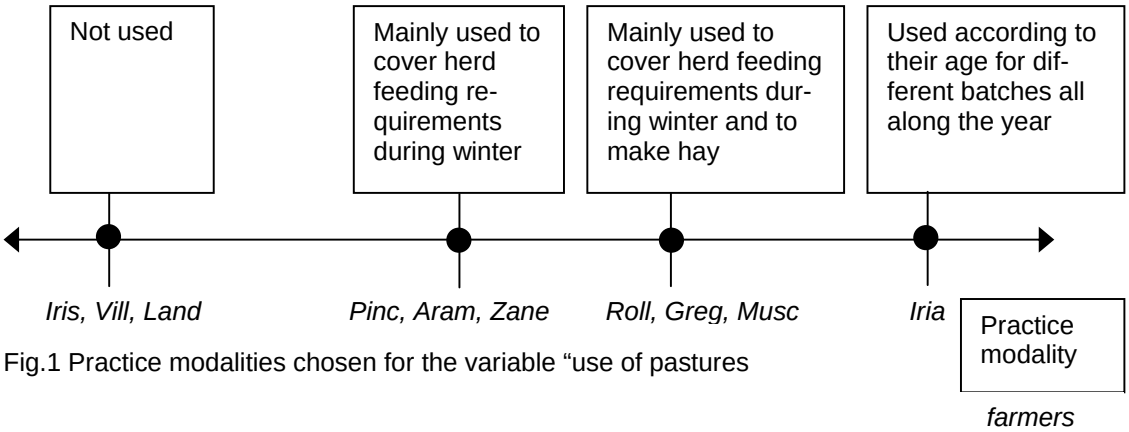


Fig.1 Practice modalities chosen for the variable "use of pastures

[2] The "campo natural" is a plurispecific plant community which is mostly made up of herbaceous species, but which can be also colonised by shrubby species. It is considered as "semi natural" because some species could have been sown by over-seeding or more rarely as stemming from a long term naturalization of temporary pastures.

### 4.2 Types of feeding strategies

These variables describing the diversity of feeding practices have then been crossed using Repgrid (figure 2), from which we abstracted four types of feeding strategies. We describe them hereafter by the common practices of farmers belonging to each type before examining how each type reacts to hazards and climatic events.

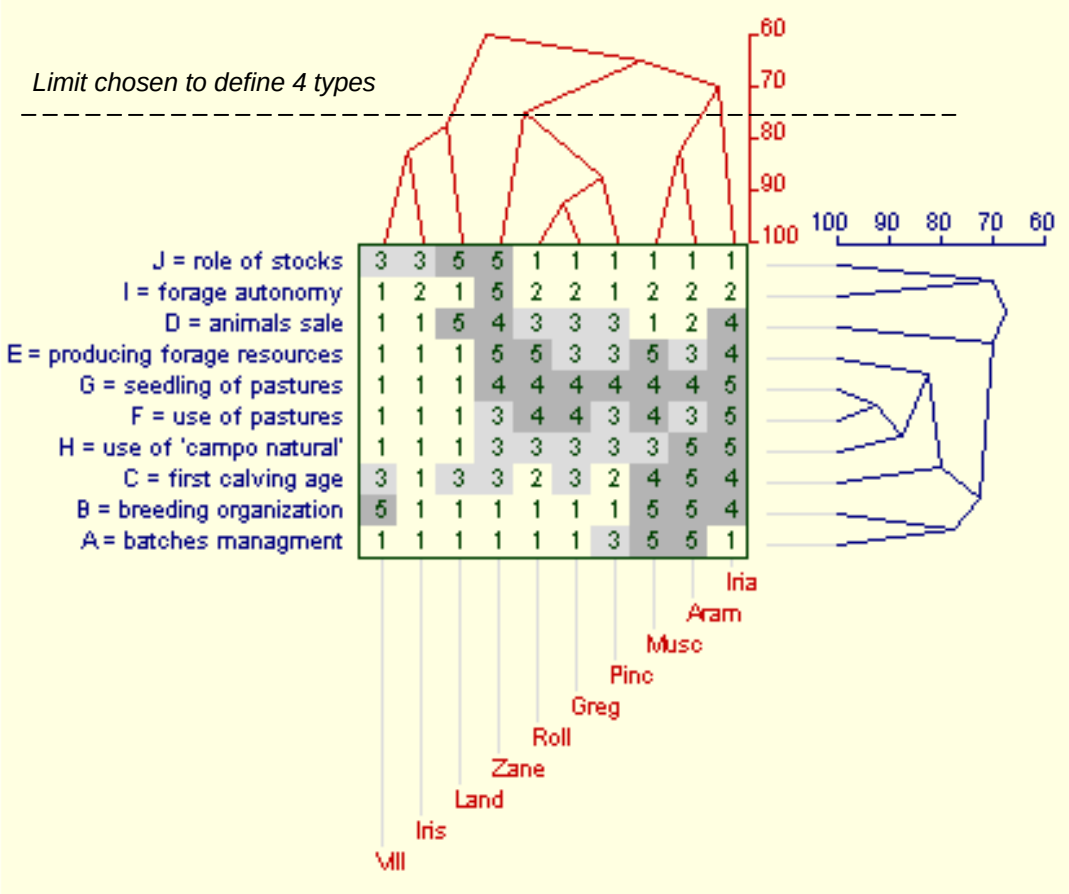


Fig. 2 Crossing analysis with Repgrid.

***Type 1 "Relying on 'campo natural' all along the year" (Land, Vill, Iris)***

This type of feeding system is grounded exclusively on resources drawn from the 'campo natural' with set batches of animals chosen in relation to animals' requirements and breeding mode. The system is therefore thrifty since it does not necessitate inputs to feed the animals.

This system might be strained because of the natural limit of the resources potential of the 'campo natural' which cannot be highly controlled. Nevertheless, diversity can be observed in the way in which farmers of this type manage this tension. One farmer (Land) defines a global stocking rate always slightly below the campo natural potential to cope with the seasonal and inter-annual variation of feed availability. Another one (Iris) adjusts her feeding practices to the seasonal variations of vegetation growth while stocking the resources surplus either in hay or in foggage.

***Type 2 "Producing aged weaned calves by intensifying and diversifying the production of resources" (Zan, Pinc, Roll, Greg)***
This system aims at improving and maintaining production at a high level regarding calves production related to the surface. This objective is ensured both by the diversification of resources and by the cultivation of highly productive resources. These resources are combined with the 'campo natural' in space and time within a set batching scheme. This feeding system is always strained to reach the production objectives, especially to produce winter resources. Long-term security is given by caring the development and maintenance of cows which is seen as a key to maintain the reproduction rate.

***Type 3 "Maintaining the family farm within a complex and autonomous system relying on subtle adjustments of feeding practices" (Musc, Aram)***
The main objective of this type of feeding system is to maintain the family farm with few inputs, by a complex combination of various pastures and batches within a relatively small farmland as well as the combination of diverse productions and off-farm incomes. The strong adjustment of forage resources and batches all along the year creates a permanent tension requiring a subtle steering with many adjustments and anticipation to prepare the next strained periods.

***Type 4 "Artificializing the feeding system with few cultivated resources to reach high production objectives" (Iria)***
This type of feeding system relies on a strong artificialization of resources production with the cultivation of few productive resources (mainly temporary pastures and maize) on good quality soils. It aims at high production objectives such as quick fattening of young bull with the help of a high mechanization, a strong manpower and a high capital. These resources are integrated within planned crop rotations, thus producing each year a relatively stabilized amount of resources putting the system out of reach of climatic hazards.

### 4.3 The feeding systems facing climate hazards
Having formalised our four types of feeding strategies, we are now able to examine how each type has reacted in front of the severe drought of 2008-2009. Our results then show that there is no direct relation between a feeding system type and the way farmers of this type adapt their system facing extreme climate events. Adaptation way is especially related to management modes specificity as the implementation of a fine steering of resources.

Within some types, we observed homogeneity of farmers' reactions facing drought of 2008-2009. For example, in order to save their cows which constitute their long-term capital, the farmers of type 2 all have weaned their calves earlier than usually and they have also bought some food to take care of the animals. The adaptation lever of type 3 has been similar, with the purchase of food and the earlier sale of animals to reduce the stocking rate. These farmers have put a particular focus on the maintenance of herd size. The farmer of type 4 has got through the drought without adapting his system since its strong artificialization releases the direct connection of the productive system from natural processes. Nevertheless, our results show that the adaptation ways chosen by farmers of type 1 have been various. This variation can be linked to the different ways in which farmers of this type manage the tension coming from the natural limit of the resources potential of the 'campo natural'. The farmer who defines a global stocking rate below the 'campo natural' potential (Land) does not adapt his feeding practices but has had to sell or lost many animals in 2009 (he decided to sell all the heifers and a large part of mothers, and many of them died). His management based on a fixed stocking rule has led him to reduce largely his herd that he still seeks to reconstitute. The extent to which this rule may jeopardize the farming system can

thus be questioned. On the contrary, the other two in adjusting their feeding practices to vegetation practices, either in modifying plot size to reduce temporary the stocking rate (Vill) or adjusting in time to vegetation variations growth has got through the drought without putting the system in a crisis situation. For Iris it can be demonstrated by the remaining good body condition of cows after the drought. Nevertheless, this situation is more risky for Vill as the ratio plot size/herd size is more strengthen.

## 5. Discussion and conclusion

Our analysis of feeding strategies highlights that systems' adaptation to climatic events is given either by the farm structure or chosen by decision rules on herd or resources state and may be implemented on various temporal extents (short / long term). In particular, the suckling herd plays a buffer role in the farming system. Some of them (mainly type 1) sell cows and thus jeopardize their herd capital at medium-term. Others prefer to anticipate difficult periods (by earlier weaning and sales of culled cows) and to adjust by purchasing food to keep the herd in order to avoid challenging their production organization. This role of the herd in flexibility is original in comparison with European farming systems (Cialdella and Dedieu, 2010). This is convergent with the conclusions of Levrouw et al (2007) in Uruguay who have illustrated that some flexibility can come from "disinvestment" practices in a crisis, for instance matching supply and demand for feed from the sale of animals in several states, which contrast with strategies identified in Europe. Moreover, the wide diversity of objectives and practices within the feeding systems which co-exist at the scale of the area can be related to the diversity of vegetation types and thus of forage resources. Creating such diversity or taking the best of the existing one is a central lever of flexibility in these systems. This diversity can exist within the 'campo natural' or can be created by pastures and forage crops. The importance of diversity for flexibility has already been stated in the literature (Darnhofer et al, 2010; Nozières et al, 2011) and we have investigated thoroughly how diversity creates adjustment possibilities.

One of the major findings of our work is that the many and various ways of adaptation are not strongly linked to the type of feeding systems. They depend more thoroughly on the type of steering rules which do not depend on intensification level. In that sense, the most artificialised systems are not the most fragile ones. In the same line, the systems which are expected to be the most agroecological ones (i.e. relying on the 'campo natural') are not the most resilient ones.

Finally, these adaptive capacities may be linked to the knowledge used by farmers to manage their feeding systems, and especially their knowledge about ecological processes and know-how to guide them. Some authors have put forward the link between adaptive capacities and farmer's knowledge and skills (Bilello et al, 2011). It thus questions their background in managing a farm and how they have built it (either at school or on the farm), together with their social network and the technical support which they can find in the area, that is the Agricultural Knowledge System (Röling, 1992) in which they are situated. One perspective to this work is thus to investigate the link between their career and training path and their management styles, together with the trajectory of their farms. The types of feeding systems which we have formalized with a technical viewpoint should then be crossed with more socio-economic perspectives, in relation to local history and farm capitalization.

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