The Impact of Socio-Economic Aspects on the Development and Outcome of Animal Recording Systems

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Preliminary considerations

Basically, an animal recording system is a process dedicated to the collection of information on animals involved in animal production units, and completed by its processing and by the interpretation and dissemination of the results in a perspective of decision making for chosing breeding animals in view of the further generations. It is usually achieved by mobilizing a complex and technological organization aiming to combine joint registration of birth and of measurements on the individual animals, procedures of writing and registration of the information, transfer and computer processing. In fact, it is also an association of various types of actors - farmers, recorders, technicians, researchers - each of them having a specific function in the process. Under this point of view, animal recording system is not only a technics, it can also be considered as a particular social network (Flamant, 1991).

However, it has to be clear for anybody, that animal recording system does not have a justification *per se*. It is only a tool the conception and the management of which having to be in close relation to the goal it contributes to pursue. In this paper, It is stress that animal recording system is not only of basic importance for any breeding programme but can be also "a lead technology" (Hammond, 1995) for all actions which aim at the improvement of the global productivity and efficiency of farm systems.

Animal recording systems were evolved in developed countries over several decades in high input animal production systems as the basic tool of pure breed genetic improvement programmes. They were the support of the development of high productive modern breeds which now spread out allover the world, mainly in cattle and pig species (Bougler, 1990). These recording systems usually involve a large number of animals and animal husbandry units. They need a costly organization associating on-farm recording to high level investments in performance testing and progeny test stations, and requiring the support of informatics systems, information networks and specialized analysis laboratories on milk components or on wool or meat quality traits. Efficient programmes were particularly achieved in dairy cattle

production in accompanying intensive production systems at the farm level. Their development was aided by the use of reproductive biotechnics as artificial insemination and embryo transfers, and they are based on the theoretical models built by research in the field of quantitative genetics. In these situations, the studies demonstrated that the realized genetic progress highly valorized in the long term the investment achieved (Poutous et Vissac, 1962).

Despite these successful results, there is need to examine more attentively the usefulness of animal recording systems and to precise their functions in medium-to-low input systems, more particularly in developing countries, with major needs to increase animal production and productivity in these low input, higher stress production environments. Several explanations can also be searched for their relatively rare use in these situations: difficulties to involve a large number of poor small farmers in a development project, low investment capacities of the government and few current means for functioning, weak technical level of the farmers, insufficient technical and scientific framework.

On the basis of programmes experimented in various situations, mainly reported in congresses on animal breeding and genetics improvement, this paper presents and discusses four principles which underly the interest and the implementation of animal recording systems in low-to-medium input systems, more particularly taking into consideration the case of developing countries:

1. despite its contribution to the development of breeding programmes, there are numerous factors limiting on-farm animal recording;
2. in contrast to its specialized role in the high input pure breed selection programmes, on-farm animal recording appears to be a multi-purpose tool for development and also a concrete and recognized means for establishing personal relations between the farmers and the officers;
3. the establishment and the organization of an animal recording system need progressive approach, with successive preliminary phases;
4. several types of strategies of animal recording systems for breeding purpose have to be distinguished, each of them having their interest and there limits.

These four principles provide basis for discussion on economical and organizational aspects of animal recording systems under three types of considerations:

1. practical implementation in relation to socio-economics and cultural\educational conditions;
2. cost and evaluation of economical efficiency of animal recording systems;
3. requirements of animal recording systems and human and economic conditions; final recommendations.

1. Factors limiting on-farm animal recording

The reproductiveness of the success of animal recording systems in high-input animal production systems has to be questioned in low-to-medium input production systems. In fact, this issue cannot be correctly iconsidered without reference to the various types of animal husbandry situations characterized by their social and economic dynamics able to be mobilised within a global development view. Animal recording system can be one of the tools assisting a specific project for development, and animal recording operations can meet constraints specific to every type of animal production systems concerned with.

1.1. Various animal production systems

The purpose here is not to give an exhaustive description of animal production systems at the world level and to discuss their respective way of evolution - an example of such an attempt can be found in the exhaustive survey and analysis carried out by Nardone (1996) in the exemplary case of Mediterranean cattle husbandry - but to propose simple keys for analysing the situation in respect to the interest and the constraints for carrying out animal recording operations. The basic asumption is that considering the level of input is not sufficient. We need to also take into account: the level of richness/poverty of the farmers, their degree of integration in the marketing chains, and their level of technical competences and of general education. These points will be mobilised in the following pages in order to inform the issue of the animal recording systems.

Low-to-medium input animal production systems are currently likened to "traditional" and "extensive" systems in contrast to "modern" and "intensive" systems. In fact, preliminary precautions have to be taken with these expressions: "traditional" does not obligatory means "extensive", and vice versa. Various types of extensive animal production systems have to be identified.

Extensive systems in developed countries are carried out in large farms in the framework of countries and regions with high living standard, low population densities and large land availability with low rent rate per hectare. The farmers are largely involved in the international market of wool or/and meat from sheep or/and from cattle, and usually have a good technical and educational level and are assisted by efficient extension services, with close relations to research and universities.

Animal production have large potentialities in developing countries which harbor the majority of the world animal population. For instance Meyn (1984) outlines that for cattle species, developing countries have got 65% of the world population, but only produce 30% of the total supply. Limiting factors for their development come from structural and financial aspects or from the traditional management systems and not only from environmental constraints strictly speaking. Here simply three types of situations are distinguished:

1) Large traditional extensive farming systems: they are carried out in mountainous, or steppe and even desert areas in nomadic or transhumance systems, less developed for their relation to market economy than for their social significance. Their management is strongly linked to the collective live of the societies. They require assistance for maintaining herd health and preventing them against the consequences of heavy droughts periods. They suffer from limitations to their deplacements, with strong tendencies towards sedentairising, and also willingness of young people to go out from this living style.Large extensive animal husbandry is also achieved in ranching systems, like in Latin America, where farmers with low technical and educacional level could be far from the extensive technical model of developed countries.
2) Small to medium poor farmers in countryside areas. they are not specialized units and output can involved as well milk, meat and wool as draught, manure, skins... They are associated to cereal and crop production in mixed farms (Guessous *et al.*, 1992). Local breeds are the usual germplasm but they are insufficiently well known. Market purpose of the farmers are mailny to supply the family income, but it can be mixed with social and cultural considerations linked to the tradition. The dynamics for development has to be organized and stimulated at the local level. But in any case as in Africa, new situations for animal production come from the interest for the development
3) New small specialized farming units: dairy farms were developed for last decades in most developing countries, dedicated to supply cities market with fresh milk. The level of input could be low to medium, as well as the technical level of the farmers. The germplasm is usually composed by crossbred animals from local cows or goats with cosmopolite breeds (Holstein, Saanen, Alpine). Farmers have an economic project and they are receptive of assistance in feeding, breeding, artificial insemination, veterinary... These systems can be linked to forage production in irrigated areas or only related to animal feeding purchases into out-soil systems even with low milk yields.

1.2. Limiting factors for animal recording systems in developing countries

In the extensive large farming systems in developed countries, the main limiting factor to on-farm animal recording comes from the usual management system - ranching - and the difficulty to have in these conditions a close and engaged relation with the animals. This hampers for instance the possibility for marking them at birth and for frequent registration of there performances (mainly their live weight) at monthly intervals even if there is interest from farmers with good technical level.

In the various situations observed in developing countries, outside the rare case of large artificial intensive dairy or fattening units which are carried out on the model of developed countries, several authors listed and commented limiting factors for on-farm animal recording, for instance:

- In the case of dairy buffaloes farms in Pakistan (Usmani, 1996), structural factors which limit the possibility of organizing performance recording systems appear to be: small herd size, low literacy rate of the farmers, lack of awareness of importance of records, lack of incentives for recording, lack of breeders associations.
- In tropical Latin America, with large ranching cattle and sheep conditions (Ordoñez, 1990; Vaccaro *et al.*, 1994), it is often asked if on-farm recording is justified in such difficult conditions as illiterate herdsmen, lack of technical personnel at the production area, great distances and deficiency of transportation and communications particularly during the rainy season.
- In north Ivory Coast, Poivey (1987) describes the difficulties for the practical recording operations on traditional cattle collective herds carried out in collective pens at the village level: difficulties for identification of the animals, disappearance of the animals, lack of weighing equipment of the cattle pens, doubt in age determination, problems in handling of the information and computer treatment...
- In south Saharan African countries, on the basis of the ILCA experience, Peters and Thorpe (1988) give an exhaustive description of the constraints to "livestock-on-farm-testing" (LOFT) coming from the characteristics of the animal production systems. The authors produce a comprehensive table which identifies 11 types of problems ([a]), and express for each of them issues for animal recording system and propose solutions. This table seems to be useful as a basis of the inventory of the problems to solve in every situation where it is aimed to initiate an animal recording system. From their analysis, it's evidently clear that frequent monitoring and feedback towards the animal owners, completed by only light technical and statistical means, are determining conditions for efficient on-farm animal recording system.

([a]) 1. representative sample of households and animals; 2. ownership of animals; 3. particular owner attitude; 4. animal mobility; 5. length of production cycle; 6. asynchronous production; 7. management variability; 8. communal grazing; 9. multiple output; 10. small herd/flock size; 11. single sire herd/flock

2. On-farm recording system: a multipurpose tool and a platform for development

2.1 Arguments for an on-farm recording system

Low-to-medium input farm systems are not usually well studied in developing countries. In so far there is a governmental objective for increasing productivity and income of small farmers, there is a basic need to better know the conditions of the management of their production systems, particularly in paying attention to the association between the feeding resources and the reproduction traits, the performances and the characteristics of the local animal material, the specific products of the units, and more generally the principles of their management and the social functions of animal husbandry at the village level.

Consequently, despite the limiting factors mentioned before, on-farm recording systems have a fundamental interest, considered as a multi-purpose tool and not only, in these low-to-medium production systems, with the unique objective of animal genetic improvement. Its means clearly that the analysis and assessment of the individual animal performances for breeding purposes are not the only way to pursue through animal performance recording.

Peters and Thorpe (1988) review the first animal recording systems achieved in developing countries during the years 70s and 80s, namely in south Saharan Africa, and regret that they only gave priority to breeding purposes and underestimated the interest of this tool as support for improving management, production efficiency, and health status of in-field animal production systems, in contrast to those achieved more recently under the framework of ILCA. For the last ten years, the literature notably provides a large agreement among the authors on "farmer-oriented" animal recording systems from a large field of experiences coming from Egypt (Abdel-Aziz, 1996), India (de Groot, 1996), tropical Latin America (Plasse, 1988), sub-Saharan Africa (Poivey *et al.*, 1986; Poivey, 1987; Peters and Thorpe, 1988). They can be summarized in considering that knowledge of the qualities of the animal material through on-farm performance recording can be a key for a larger knowledge and appraisal of the production units, and can provide an organized support for further developments.

Another consideration favorable to animal recording as a multi-purpose tool, concerns the issue of the cost, to be shared between the expected genetics progress by the breeding scheme and the support to farm monitoring. In other words, the investment for long term genetics improvement could be acceptable if the operations are also useful for decision-making concerning short-term herd/flock management (Ordoñez, 1990). It is also remarkable to observe the evolution towards this principle in on-farm animal recording systems carried out in developed countries for purebreed selection purpose, due to the need for a better economic valorization of the high costly information recorded on individual animals (for instance: Cournut and Rehben, 1988, on beef cattle and sheep in France; Ponzoni, 1988, in extensive Australian conditions). See also the remarks by *Nicoll et al.* (1986).

In the context of sub Saharan Africa, Peters and Thorpe (1988) outline that "performance testing is a progress-oriented, systematic process of collecting and analyzing data on economically important performance traits and production practices under defined conditions". They outline that the objectives of animal recording system have to include:

1. identification and quantification of non-genetic constraints to performance in order to improve husbandry, hygiene and feeding practices;
2. economic evaluation of the production process and different technical interventions;
3. characterization or evaluation of breed performance under defined production conditions;
4. and finally breed improvement.

It is interesting to compare this list of objectives with that proposed by Plasse (1988) in tropical Latin America extensive systems, and to observe the evidence of the convergent views:

1. the design and control of management, sanitary control, pasture, feeding, breeding and selection programmes as well as the evaluation of alternatives;
2. the estimation of the breeding value of males and females as a basic requirement for selection;
3. the economic evaluation of the production process.

Clearly, there is a change for the last 10 years in the consideration for on-farm animal recording system. In fact all the literature now available can be read and interpreted considering three main purposes for animal recording systems:

- observation and diagnostic of animal production in a given territory, testing and experiments;
- support for farm monitoring and organization of actions for development;
- basis for the organization of breeding programmes.

Consequently, animal recording has to be considered as a multipurpose tool and a platform for development which can be achieved into various forms related to various objectives in respect to the specific local situations of animal production systems.

2.2 Appropriateness of recording at the farm level

2.2.1 Principles and expressions

It is usually admitted that the development process is facilitated by organizing networks which should link the farmers involved at the local level and by establishing close confident relations between these organized farmers and the officers. Within this view, the recording systems at the farm level can be considered by the officers as an appropriate starting point - a concrete means for establishing relations between institutions and farmers. In fact, at this local level, the interest of the farmers is not firstly for increasing the national

food production neither reducing the state financial deficit, or even not the genetic improvement of the breed. These objectives are those of the responsible of the governments or of international institutions.

Several inquiries revealed first importance consideration given by the animal owners to health and diseases of their animals, to the reproductive activity of the sires and to their choice, and to the opportunity offered for marketing the products. Certainly, the first chance to be taken by the officers of recording systems is to pay attention to breeding animals - particularly to the sires - and to meet this interest of the farmers before to consider the "official" quantitative objectives. If this principle is admitted by the officers, it is clear that their initial efforts have to be put in order to know and to meet the subjects of interest for the farmers and animal keepers. There is no doubt that the farmers, or the animal owners, or the village herders, have their own criteria for the choice of sires - their own performance testing - and that in some situations, they don't need the measurements and the organization of a large scale coordinated programme (Plasse, 1988). In the situation of dairy cattle production with Friesian x Zebu crossses in Malawi, Kuettner and Wollny (1997) report the results of an inquiry through smallholder farmers about their claims to extension services for their enterprise: they put in first rank the high cost of supplementary feed and the poor artificial insemination service.

2.2.2. Theoretical basis

Conceptual basis of these attitudes and principles can be found since the beginning of the years 1990 in the successive International Symposium of Livestock Farming Systems (Gibon and Matheron, 1992; Gibon and Flamant, 1994; Dent et al, 1996; Sorensen, 1997). They promote systemic approach of animal production farming, taking into account the coherence of the existing goals of the individual farmers and of their families. Gibon et al (1996) conclude, from on-farm research-and-development programmes carried-out in various situations of animal husbandry in European countries, "the livestock farming system (LFS) to be a dual entity". They consider that LFS has a bidimensional aspect, at the same time as a biotechnical system in which animal material plays a biological function for transforming vegetal raw material to animal products, and as a farmer decision system in which the animal farmers and their family are central actors. (Figure 1).

According to this view, a livestock farm is a human activity system and the success of a development project has to begin by taking roots within own consistent goals of the farmers before applying top-down solutions from larger political aims. Gibon and Flamant (1994) and Vissac and Beranger (1994) gave arguments and described the evolution of the conceptions of animal production research, particularly in France, from a "top-down" technological progress which proves a remarkable efficiency

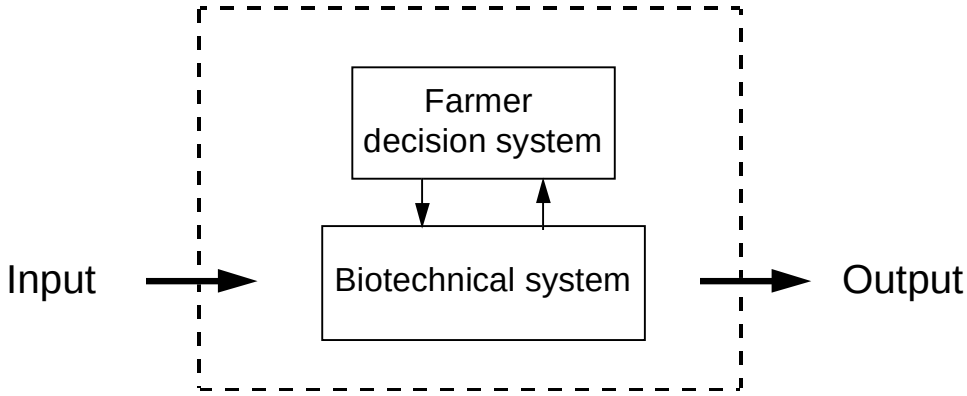

Figure 1: Common conceptual model of a livestock farm (Gibon et al.*, 1996).*

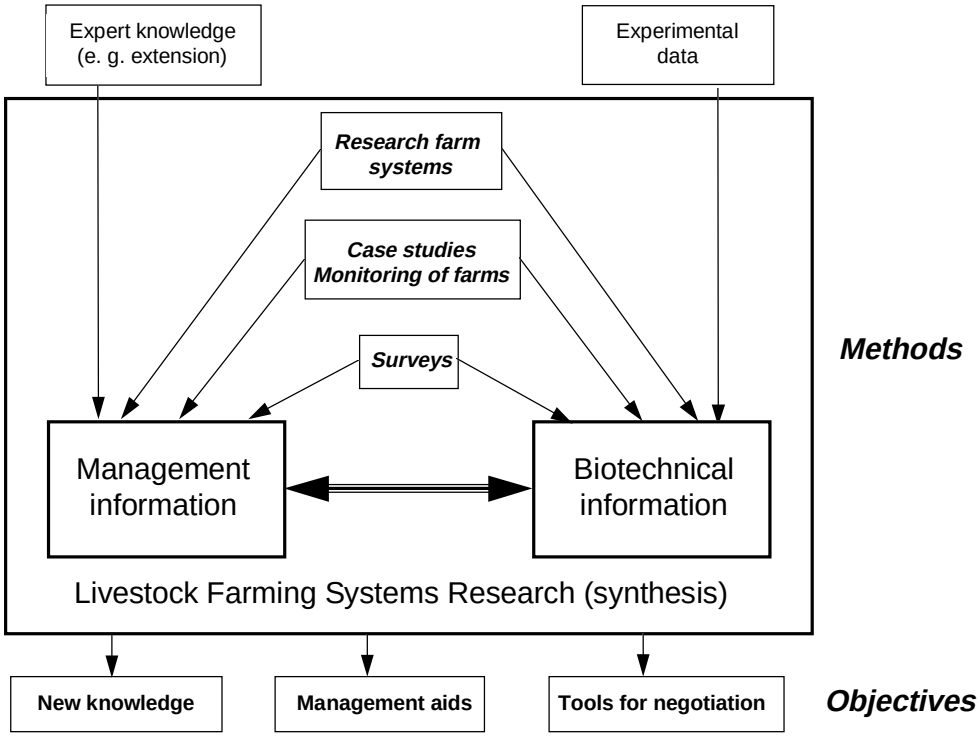

Figure 2: Objectives and methods of Livestock Farming Systems Research at the farm level (Gibon et al. *1996).*

for transforming the agricultural industry at the national global level, towards focal interest for the diversity of the animal production systems in a given local territory.

In this context, LFS research has been for the main objectives of gaining better understanding of the whole system at the farm level by collecting both biotechnical information and management information. Three types of operation are pursued by the researchers: case studies, farm monitoring, modeling (Figure 2). Herd/flock animal performances inform the components of the biotechnical system piloted by farmers when taking decision and as a response to farm management strategies. In other words, animal recording provides quantified basis of production, the level and quality of which being explained by the management and the condition of the system.

The suitability of this theoretical approach can be asked for developing countries. In fact, one has to outline that these concepts were primarly built in the context of European mountainous or Mediterranean regions "in backward development", in respect to the European economy, where the classical intensive way for development of animal production was not suitable. It is also interesting to note that this approach was considered as convergent with the issues observed by various French, German or British scientists working in African or Asian countries (Gibon and Matheron, 1992).

2.2.3 Adaptation of theoretical basis to functional and cultural traits

Even if "the common understanding of the dual entity of LFS" seems to be of first usefulness for studying animal production systems in developing countries, it does not mean direct application of the methodology without adaptation to achieve. It needs to consider particularities which are not relevant from biotechnical features but from the human and economic aspects of the animal husbandry and which differ from the basis on which the systemic concepts where built.

The first difficulty, outside European countries, could be the identification of the pertinent production unit considering the social role of animals which can be of higher importance than the commercial one. For instance, Moulin and Lhoste (1996), providing a good illustration of the usefulness of the systemic approach assisted by animal recording in the village herds\flocks in Sénégal, explain they needed to make the choice of recording and monitoring the "concession" herd/flock gathering the animals belonging to owners in the same family "concession". In fact, the batch of animals belonging to every individual owner was not a pertinent management level in these conditions. Poivey (1987), in Ivory Coast, has to face the same type of question regarding the suitable animal unit. He chose to organize animal recording on the basis of the village collective pens and not on an individual animal owners basis. These examples mean that the "farm-family system", structure clearly identified for instance in

French conditions where there is close linking between the production unit and the farmer and its family, is less readible in other cultural conditions whith active enlarged family and strong collective habits at the village level.

A second type of methodological questions to solve comes from the various functions of animal production. It has for consequences that the nature and significance of the traits to be recorded could not be the same in the traditional conditions of developing countries than in the farm units in Europe or North America. For instance, Moulin and Lhoste (1996) underline that in Sénégal small ruminants production contribute not only to the family income by marketing milk and young males, but has also a savings function mobilised for cereal purchases during the soldering season, participates to the needs for ceremonies and also contribute to the women personnal funds. The respective role of the men and women in the societies and in respect to animals of the various species has also to be taken in account and attentively examined in considering the responsability of the management of the animal production systems. In the Indian conditions, another example is given by Rushton and Ellis (1996) who report the function of cattle production systems in relation to cereal systems by producing castrated males for draught and manure, the milk production being mainly assumed by buffaloes and not by cows. It means that the productive functions of the same species can be differ from one country to another one.

2.3 Contents and processing of on-farm observations

2.3.1 Recorded traits

Convergence of interest appears between on-farm animal recording and global appraisal of livestock farming systems coming from the fact that the fundamental characteristics of on-farm animal recording system is to be achieved at the farm level, which also is the management unit of livestock. However, clarification is needed about the conditions of the usefulness of animal recording system for livestock farm management.

In the conditions where the first purpose of recording individual animals which composed production units, is the genetic improvement of the whole population, we can assume that the efficiency of the breeding scheme in the long term will have consequences on the improvement of the individual herds/flocks which are part of the population. In the short term, interests of the farmers involved in such breeding scheme are also met if animal recording provides help for selection within the herd/flock, mainly of the females by the way mother/daughter. These short term interests are also more immediatly satisfied if "accompanying technics" of the breeding programme - for instance: heat synchronizing, artificial insemination, early mating of the females... - are also "improving technics" for the management of the herd\flock and acceptable by the farmer (Flamant, 1991).

If considering first the interest for management of the global livestock farming system, recordings on individual animals do not provide sufficient information and have to be accompanied by recording traits and practices concerning the herd/flock considered in the whole, or a particular batch of

animals, like fattening animals, young females for breeding, mature animals at mating season, etc. In this respect, Gibon et al (1989), considering that animal production systems are management systems of biological cycles and technological systems of transformation of plants into animal products by animal material, propose in the condition of sheep and beef cattle farms in Pyrénées mountains (France), to complete the current animal recording systems achieved for sheep breeding purpose (registration of births and of individual weights). They recommend to pay attention to the various annual cycles which are components of and organize the production systems, by observing namely:

- the exploitation of the forage plots in the farm territory, at the origin of the feeeding resources of the herd/flock, by direct grazing or through various types of stored forages as hay or silage;
- the mating period and birth of the youngs animals, and their specific feeding regime and breeding management;
- the pathological events in the flock/herd;
- the economic aspects, by marketing, and main expenses and returns from animal production.

They promote the use and adaptation on the local animal material of body conditions scoring which provides information on the evolution of the state of the energy reserves of ewes (Dedieu *et al.*, 1994). They also outline the need of close talks and exchanges with the farmers in order to better know their systems and also better address the needs of the farmers (Hammond, 1995).

In the same line and in the African conditions, Peters and Thorpe (1988) point out the fact that the exigencies of monthly records for the estimation of the performances of individual animals are coherent with the need of frequent monitoring and efficient feedback by officers towards the farmers. As an illustration of the above considerations, Moulin and Lhoste (1996) provide a very interesting example of the use of recording system in sheep and goat production units in Sénégal. The method they used is that of "herd/flock follow-up" including: records of individual animal performances, demography of herds/flocks, productions of the herd\flocks, farming practices, and pathological events.

We can conclude that if it is recognized that the purpose of animal recording systems is not only the recording of performances but also that of events occurring in the herd or flock, of the feeding regime, the health status, the management practices... then there is there a consistent basis for method of monitoring the animal production systems including the use of animal performance recording.

2.3.2 Processing of on-farm observations

From the above considerations, it is clear that information coming from on-farm recording can be processed and interpreted within two types of considerations, in respect either considering individual animals and the population to which they belong, or the characteristics and the management of the production units.

In another part of this study, description and discussion are made about the calculation of indices from records on individual animals in the framework of an animal population. Our interest here is focused on the processing of information on the livestock production units.

Gibon (1994) provides an exhaustive review of methodologies used for establishing farms typologies on the basis of systems approach from in-field surveys. Typologies building means to obtain a comprehensive view of the farm diversity in respect to a limited number of groups which are considered as homogeneous for structural and technico-economic traits. From the collected data, automatic classification methods or even manual processing, are achieved in order to identify several farming "types". In-field applications are well illustrated by Rey and Fithzugh (1994) in the case of the ILCA's experience in south Saharan Africa.

Gibon (1994) also makes an inventory of various methods of "farm monitoring" or "continuous survey": frequency, recorded traits, choice and size of the farm sample. Examples are provided of methods which permit to graphically put into relation biotechnical characteristics of monitored herd\flock with practices of the farmers, and the seasonal variations of the herd\flock condition with the feeding resources and the breeding events. Epidemiological approaches can also been achieved in this same framework, combining the herd/flock characteristics, the animal performances and the sanitary events (Bernues at al, 1994; Lescourret *et al.*, 1994).

In further parts of this report, information will be given on the implementation of these methods in animal recording systems.

2.4 Animal recording system: an observation and diagnostic tool for development

From experiences achieved in various countries there seems to be a good agreement that animal recording systems are considered as an observation and diagnostic tool for development. We can consider that it is a logical consequence from its bidimensional aspect, outlined before, either in respect to animal resource, or in respect to the production units in which animals are managed.

The case of the experience carried out by Poivey in the Ivory Coast, either for sheep (Poivey *et al.*, 1986) or for cattle (Poivey, 1987), demonstrates the role of recording system operated as an observation system at the village level permitting to gather a great number of data, supplying results to be used as a basis of dialogue between the farmers, the technical officers and the scientists. More than individual animal performances, this platform opens the way to

approaches in the fields of animal management (feeding, reproduction control), agronomy and pastoralism, socio-economy. It also can be a support for analysing the attitudes and receptivity of the farmers faced to technical and economic evolutions. Poivey (1987) pushes further in that direction, considering that, from own experience in Ivory Coast villages, the first function of on-farm animal recording is to be a permanent observatory of the issues of animal production systems at the farm level. Consequently, he considers it needs to be an obligatory accompanying tool of any development programme in order to minimize the risks of unadequacy of the official objectives to the farmers and local realities, and to make a possible adaptation of the strategy of developemnt to the evolution of the production systems.

If we come back to the use of animal recording in respect to animal resources, it provides information for describing and assessing the local animal material at a regional level in order to develop animal production on the basis of the animal material used by the farmers and not exclusively by the introduction of exotic breeds (de Groot, 1996). It can be also associated with the evidence of the existing traditional networks of exchanges of sires between farms: "this sire come from?": farmer, locality... These existing and spontaneous networks of exchanges can serve as a basis for the consistence of a local breed, being in the mind that domestic animal breeds are social creations by the human societies (Flamant, 1991). It could be put in relation with the social system of compromise associating the members of the same family groups. There is a particular interest to detect such networks at the village and local level.

Confronting these various approaches enligthtens the opportunity, through the animal recording systems, to identify the issues of the animal production systems at the farm level in relation with the issues identified at another scale (regional development, local food security, marketing organisation): place of the animal production in the local economy and society, problems in the farm management, traits and potentialities of the local germplasm managed by the farmers. More precisely, in so far as animal recording system provides information derived from individual animals combined with information at the farm level, it offers the possibility of better understanding of the links between the animal production traits with territorial, meteorological, sociological, and economics local issues.

Moulin and Lhoste (1996) remark that this type of approach produces results dedicated to the institutions which have in charge the policy for animal production development at governmental and administrative levels:

- production of technical, health and socio-economics reference data on animal production in-farm;
- identification of the technical and socio-economic constraints for better control of their animal production systems by peasants;

- technical in-farm experiments in order to evaluate the practical ways for minimizing the constraints and making a cost-benefit evaluation.

For all the before reasons, an animal recording system, considered for its technical significance but also as a human and social basis for building development, can be used as a "platform" for various types of projects in the fields of extension service, marketing organization, on-farm demonstrations and experiments, breeding organization... Finally, various actions can benefit from the organization of an on-farm animal recording system:

- the monthly contact with farmers provides the possibility of grafting help and assistance to the farmers for animal health problems and feeding, then for the choice of the breeding animals;
- the concrete knowledge of the production systems makes effective the assessment of the possibilities to improve the input level of the animal production systems;
- the follow-up of a group of farmers can be a basis of the organization of relations between them involved in a development project: technical groups, collective marketing of the products, local animations by manifestations as the "ram days".

3. Need for progressive approach of an on-farm animal recording system

In this part, the purpose is to illustrate the possibilities of mobilizing concepts, methodology and various tools conceived and used by researchers for better knowledge of farming systems... in order to carry out effective and useful animal recording in difficult and adverse conditions. All the potential of actions opened by on-farm recording systems cannot be attained in a short time. There is a need for a progressive approach before considering the achievement of a new on-farm recording system. Principles of this progressive approach can be found in authors which aimed to carried out on-farm "participative researches".

In this respect, Gibon (1994) reports the successive steps defined by Tripp (1991):

1. Diagnosis: Review secondary data, informal and formal surveys.
2. Planning: Select priorities for research and design of on-farm experiments, in relation to target farmers and research priorities.
3. Experimentation: Conduct experiments in farmers's fields to formulate improved technologies under farmers' conditions.
4. Assessment: Farmer assessment; agronomic evaluation, statistical analysis, economic analysis.
5. Recommendation: Demonstrate improved technologies to farmers.

Other similar sequences of operations can be found in Landais (1986) on the basis of various programmes of research-development experimented on animal production systems in sub-Sahara Africa:

1. Available knowledges and preliminary in-field surveys.
2. First typologies and identification of the development issues, constraints and resources.

3. Provisional diagnostic; expression of research issues.
4. Choice of farms sample ; surveys, monitoring, experiments.
5. Processing and analysis of the data.
6. Diagnostic of the situation.

From these schemes, we can conclude that the successive phases have to be clearly identified: "in which phase have we achieved?" and "is it necessary to go to the further phase and which means are needed for that?"

A possible scenario for a progressive establishement of a new on-farm animal recording system could be as following fccording to the previous principles.

3.1 First phase: diagnostic survey

A first inquiry is needed in order to have a diagnostic survey for the knowledge of the diversity of the production systems at the local level. The collected information in-field can be organized in a document composed as follow, each of the items being relevant to a brief description and tables illustrating the various categories observed.

A first part of the document has to deal with to the expression of the official interest for the improvement of animal production systems.

Namely, the document has to recall what are the official developmental purposes and objectives in the territory considered, and to give justification as why animal recording is a pressing need for the inhabitants and the animal production systems in the concerned territory.

In the same manner, it is desired that people responsible for the project state what they consider as the main issues for animal production systems, for instance: need for association between resources from steppe area and resources from limited irrigated area or from cultivated areas, or solving the competition between extensive animal production and sedentary, or action in favor of the development of animal production in specialised crops areas, or supplying production of protein food for local or cities consumption, or lastly approvisioning national or export markets.

A second part of the document has to be deal with a description of the place and function of the animal production systems in the local economy and society, on the basis of socio-economic information (see 2.2.2). In this part, attention has also to be paid to the identification of the operational level of management and property of the animal material: individual farmer, family group, village community.

The third part of the document provides information and data from an in-field diagnostic survey:

- average size and variability of the flocks or herds: only some heads, several tens, hundreds, thousands;
- types and species of animals composing the production units;
- type of products and of their functions, association of the products to social life and cultural/religious manifestations, place of the market;
- components of the feeding systems: grazings and pastures, forage crops, cereals and other feeding complementation; first description of seasonal variations of the feeding resources;
- profile of the reproduction rates: strictly seasonal, partly seasonal, largely spread out along the year;
- estimated rate of reproduction: fertility, size of the litters, renewal rate, longevity;
- preliminary inventory of the main diseases and vulnerabilities in the animal production systems.

This survey can be performed by collecting information from available informants but combined with data collected during extensive visits on the field.

The duration of this first phase cannot be less than one complete year, in order to include the seasonal events.

3.2 Second phase: typology of the animal production systems and on-farm data collection

On the basis of the data collected with this first extensive survey, a first classification, or typology, can be built of the animal production systems in the region (see 2.3.2)

From this typology, one can achieve a choice of a sample of farms representative of the various pertinent types, being in the mind the specific goal of the local development. The objective of recording for genetic improvement should not precede, but preferably follow, this specific goal. It is clear that the personal receptivity of the farmers has a determinant role to play in this choice. In any case, it could be impossible to find receptive farmers for one or several of the identified types. If the criteria of receptivity of the farmers are really strongly determinant, it is very helpful to have the possibility to identify the types to which they can be referred.

A sample of 10 to 15 herds/flocks (individual or villages) followed-up at monthly intervals during one complete yearly cycle seems a maximum number for one officer when the purpose is to identify the pertinent traits to record (Gibon et al, 1989). This number will be able further to be enlarged till one herd/flock per day after this preliminary observations step, that it could mean approximately 25 animal units per month and per recorder.

Information recorded from this preliminary on-farm data collection are as following:

- age and social position of the farmer, family composition;

- structure of the units: size of the herd/flock; size, land use and spatial structure of the farm or of the grazing territory; characteristics of the land and of animal property;
- demography of the units: renewal rate and mortality; times for breeding, sale and slaughter; birth rate; estimated longevity;
- establishing of the feeding calendar of the herds/flocks, origin of the resources in the farm and environmental territory;
- description of the causes of mortality;
- origin of the sires and criteria used for their choice;
- variability of the performances (litter size, growth rate, mature size, milk production, wool) in respect to the conditions of production: responses of the animal production to the variability of the feeding systems.

3.3 Third phase: choice of the objectives

From the information gathered and analyzed in the first two phases, the organization of a recording system needs a clear definition of the objectives, global objectives in a strategy of development and specialized objectives for breeding animals and selection. This phase now needs clarification about methods for defining objectives either in respect to strictly breeding purpose or more largely for development purpose.

3.3.1 Breeding objectives

Theoretical approaches for the definition of breeding objectives are provided by the works of authors working in the technical and economic conditions achieved in good technical level farms. Ponzoni (1986) stresses the need to clearly distinguish the breeding objectives from the selection criteria. He considers that the breeding objectives are related to the economic interest of the farmers and they identify the traits the genetic improvement of which influencing the return. The selection criteria are the characters recorded and used for the assessment of the breeding animals within a genetic improvement scheme. Several available studies aim to give a comprehensive approach of the choice of the breeding objectives considering the fact that the genetic progress is operated in the long term, while the income of the farmer is submitted to immediate variation of the market. It provides a discussion which will be revisited when considering the methods of estimation of the economic efficiency of animal recording systems (6.3.1). At the present stage, we could simply retain the assumption of Pearson (1982) which considers that "weighing traits by their effects on profitability should provide the best genetic basis for improving long term profitability". However, if the question is a comprehensive one, the response needs deeper discussion considering that even in the favorable farming conditions for milk cattle production, in developed countries, the possibility to take into consideration "functional traits" as breeding goal, and not only productive traits as milk yield or growth rate, is now largely discussed. For instance at the European level, Groen et al (1996) make an extensive review about the economic weight of these "functional traits": health traits, fertility, calving ease, body weight,

feed intake, persistency, milking speed, longevity. They discuss the efficiency of their indirect versus direct selection in the usual situation where there is no direct information on the corresponding traits. It is not a marginal issue for the future development of animal production. It means that even in very favorable conditions, we can no more consider that breeding schemes can be conceived as if there were no limitations for quantitative output based on milk yield records (Groen, 1989). The general situation in the long term is with environmental and economic constraints related to a set of diversified animal traits.

In low-to-medium input systems, the constraints are closer and more immediately sensible that in high input systems, and the efficiency of animal breeding programme has to be questioned. Particularly, McDowell (1977) considers that under strong constraint conditions there are too high limitation for efforts in genetic improvement if the animal diet is not exceeding by one and half the maintenance requirements. It is interesting for our discussion about the various ways for animal recording systems, to report here the comments of Poivey (1987) who considers that the remark of McDowell can be used as an argument for insisting more on the interest of animal recording as a help to the improvement of livestock condition than at first for breeding schemes.

In respect to this question of the constraints of the production systems, the Philoetios group (Flamant and Morand-Fehr, 1989) proposed to make a deep analysis for identifying the various types of constraints and not only to envisage the degree of constraints in respect to the level of input. Examples of this approach are given in the case of Mediterranean sheep and goats, in combining the knowledge of the farming production systems in a given area and the data provided by on-farm animal recording systems. This type of qualitative approach can provide a justification for the existence of local breeds. The methods proposed in these difficult poor environments can be very profitable for the assessement of any local breed. Flamant (1997) and Gabiña (1997) provide in this respect exhaustive review of the present state and evolution of Mediterranean germplasm.

3.3.2 Objectives for local development

In contrast to the above discussion on the objectives of animal breeding and the original traits of the local animal resources, there is less available publications about the definition of objectives for local development using data from farm units. It is less easy to describe explicit methodology in order to clearly identify the objectives of a global strategy for development on the basis of the datas collected from a better knowledge of the production systems and of the characteristics of the local animal germplasm. This fact needs clarification, and we'll attempt to discuss how such a strategy could be built.

A first reason of the lack of publication could come from the fact that the great majority of the development projects are "top-down", with global objectives coming from macro-economics analysis on statistical basis. They

are achieved with the support of technical packages and improved breeds with quantitative objectives - increasing the volume of milk or meat production for instance - and ignoring the basic qualities of the local livestock.

A second reason is that the publications concerning the analysis of local development rarely give a description of how one passes from global national objectives to more precise objectives in a local given territory, or how in coming back the identification of specific local objectives can be taken in charge and support at the national level.

And thirdly, it is simple to make the remark that the approach by the breeding objectives of the local animal resources is more specialized and easier to model than the complexe issue of the local human and economic development.

However, the content of the publications of International Symposium on Livestock Farming Systems can provide some ways to go through according to various tools available for analyzing the specific case of animal production systems:

1. Farm typologies express the diversity of the existing production systems at the local level. From them, arguments can be expressed for carrying out diversified proposals for improvement adjusted to the diversity of the objectives of the individual farmers in contrast to a unique technical package to be applied.
2. From modeling, which provides description of the characteristics and constraints of the main production systems achieved in a given territory, one can deduced the function of the animal material and the possibles objectives for its improvement, but also the role played by each part of the territory and their possible contribution to a better efficiency of the feeding system.
3. Considering livestock farming systems in there local social and economic context, the system approach put the point on the possible role of animal production system in the coherence of the society and in the organization of market chains.
4. In a more specialized step, the organization of breeding strategy on local breeds with the participation of the farmers should lead to the organization of a human group taking in charge various aspects of the local development.

All these aspects can be considered as a contribution to the conception of a global plan for development carried out at the local level from it owns traits, constraints and potentialities.

4. Strategies of animal recording systems for breeding purpose

The literature clearly indicates two types of approaches for the breeding strategies and consequently the organization of animal recording systems in developing countries regarding the relation with the farmers. Bearing in the mind the factors limiting the effectiveness of the operations of on-farm recording systems in low-to-medium input systems, and considering the need for intensifying the production systems in order to meet the increasing demand for animal products from the urban consumers (de Groot, 1996), the first approach is based on precise and complete recording and breeding in controlled environment (in-station). In a second approach, the activities of animal recording systems founded on closer relations with the farmers or animal owners, and for keeping adaptation traits of the local animal germplasm, are strong argument to make desirable the strategy of on-farm animal recording system. In fact, there is a third strategy which combines on-farm recording and in-station recording.

4.1 Strategy of stations and closed nucleus

The difficulties for achieving the recording operations in-the-field, at the farm or village level, confronted to the necessity felt by the administration to organize the improvement of the animal material and of the management conditions, are apparently resolved by building central breeding farms and performance test stations. Stations can also be dedicated to experiments on improved breeds, breeding technics, intensive feeding, etc.

In the field of this strategy, we can find two types of situations:

- Firstly, as it is mainly the case for dairy cattle production, the purpose is to organize the spreading of improved and imported germplam by crossing with the local females, and with the support of extension services. Trevedi (1996) presents the Indian organization in this respect with stations and central breeding farms, along with frozen semen production centers for artificial insemination for crossing local cows with improved breeds. The disadvantage of this strategy is the low adaptive traits of the up-graded crossed animals to the current farming conditions and also the limitation of the number of farmers involved to those receptive to these technics. However, in the long term, this strategy can be in the origin of new dairy small farms around cities (see 1.1.) in so far market organization and support to the improvement of the farm management are achieved, as it is well illustrated by Eddebbarh (1996).
- Secondly, if considering the interest for fitness qualities of the local breeds, mainly their specific traits of adaptation to constraints as demonstrated in the case of the Mediterranean germplasm (see 3.3.1.), closed nucleus can also be established for the knowledge, appraisal and selection of the local animal material, in view of further spreading in farms selected and controled sires.

The apparent advantages of this strategy for animal recording are the possibility for complete procedure and the control of the successive breeding phases of a selection scheme. In fact, there are also large limits to this apparent efficient solution: improved management conditions of the stations are usually

far from those of the on-farm production systems, the breeding animals produced from the stations demonstrate low adaptation capacities to the conditions of the local herds or flocks, the selection efficiency is very low in closed nucleus with a reduced animal stock. Organization for grading-up schemes with intensive dairy imported germplasm from central stations may be ignorant of the consequences on the true genetic composition of on-farm livestock and of its relation with the farm management conditions. In fact, in developing countries, this strategy usually expresses the difficulty of the official framework to face the logics of the on-farm management of the farmers and to include it in a development process.

4.2 Strategy of on-farm recording

Chapter 2 exposed the interest of on-farm recording systems as a basic tool for development: a multipurpose tool, appropriateness of recording, a platform for development. In contrast to the closed nucleus strategy, strategy of on-farm recording considers: firstly the interest to work on the local animal material; secondly, that the public expenses for the salaries of officers are best valorized by addressing the effective needs of the farmers than by the unique maintenance of stations with artificial conditions. In the case of India for instance, de Groot (1996), explain the interest found in appointing part-time recorders chosen and trained in the villages, carrying out the close contact with the farmers and the local societies.

Many authors (Poivey *et al.*, 1986; Poivey, 1987; Peters and Thorpe, 1988; Plasse, 1988) also underline that even if the on-farm recording procedures are less complete than in-station one, and are achieved on only a few number of traits, with a loss of precision, the major interest comes from the opportunity for selection on a large population, and of keeping the characteristics of adaptation of the local animal resources to the constraints of the environment and of the production systems. Limitation to the level of genetics progress could come from the absence of artificial insemination or of recording mating for progeny testing. But Poivey et al (1986) and Poivey (1987) point out to the possibilities offered to carry out selection through dam-son way at the farm or village level and in a large population either on cattle or sheep.

4.3 Strategy combining on-farm recording and open nucleus recording

In the progression of on-farm recording and breeding systems, could appear the need to have the control of the young males detected in the private herds or flocks for better testing them. The individual selection of young males, primarily chosen from on-farm extensive recording, is completed in performance test central station with more complete recording on reproductive ability, own growth rate and conformation, wool characteristics... before coming back to the farmers of the best sires.

Another scheme, combining on-farm and station recording, comes from the condition of animal ranching systems in Australia and New Zealand. Private open nucleus flocks or herds are achieved by the farmers who

provide the best females chosen from a large number of animals by extensive and low cost on-farm recording (Turner and Parker, 1984). Originally, this scheme was conceived by groups of farmers unsatisfied with the sires they purchased in the traditional elite Merinos flocks, and they wanted to make a more efficient selection with scientifically based on recorded traits, but the difficulties came from the management conditions of the large extensive flocks. In fact the adopted solution of the open nucleus can also be included within an official breeding programme, under national or regional organization, with small to medium size of the herds or flocks which does not authorize efficient on-farm selection, as demonstrated in the case of the selection of the sheep Thimahdite breed in Morocco (Bouhamar and Bouix, 1991).

In these two types of situations, attention has to be paid to the management conditions of the testing station or of the nucleus herd/flock which have to be far from of that of the current farms. As mentioned by Poivey (1987), this danger can have several reasons, for instance the necessity of standardizing and improving the feeding system for better expression of the genetic variability with the risk of deteriorating the adaptation traits.

In fact, as assumed by Peters and Thorpe (1988) in African conditions, there are compatibility between on-farm animal recording considered as a platform for development and on-station testing in so far as it is possible to organize at the local or regional level an association between a network of farmers involved in on-farm recording and a station which gathers several tools: a flock or herd on which more complete recording is carried out in order to better know the local animal material in complement to traits recorded on a large population, an open breeding nucleus for testing and producing sires coming from the farms, and a support for specific demonstration and experiment in various field of interests (feeding, reproduction techniques, cereals and pastures, material, sanitary practices, etc) and estimation of their economic efficiency. In the case of grading-up schemes for dairy cattle production, examples are given of the usefullness of the association of on-farm animal recording with central breeding farms in order to monitor the evolution of the germplasm in relation to the evolution of the feeding and management conditions (de Groot, 1996).

Such schemes were also achieved in Mediterranean countries as an evolution of previous State regional stations, isolated from around animal husbandry systems and local breeds. In these conditions, Philoetios network provided reference methodology in order to identify the specific qualities of the local sheep and goat breeds in response to the constraints of the production systems (Flamant and Morand-Fehr, 1989) for meat or milk production.

5. Practical implementation of animal recording systems in relation to socio-economics and cultural-educational conditions

One can ask what it has to be considered as a complete on-farm recording system. In the case of beef cattle in Latin America, Plasse (1988) provides a list of the components of what he considers as desirable:

- "recording of the basis data on farm;
- listing of the data;
- coding of the data and preparing them for the computer input;
- processing of the data in the computer, listing and statistical analysis;
- making the list available to the producer at certain strategic dates according to the production cycle;
- interpreting the results (producer technician scientist);
- drawing conclusions and making decision (producer - technician - scientist)".

In the case of Ivory Coast, these successive steps are also identified in the establishing of recording systems on cattle and on sheep (Poivey, 1987 and Poivey *et al.*, 1986) . In a first approach, we'll consider this sequence of operations as a reference one, but preliminary conditions have to be filed and problems solved before to make operational an animal recording system: identification of the individual animal, age identification, operations of recording data, transportation facilities, computer treatment. Another remark is that the solutions are not only technical but are in relation with the human and economical issues at the local or national level.

5.1 Practical and technical aspects

5.1.1 Individual identification

For all the authors and the practionners, the individual identification of animals is considered as a basic condition for achieving animal recording system for breeding purpose. The assumed reasons are firstly the need for successive records on the same animals at regular time intervals, and also to register youngs at birth in relation to their mother. To insure this possibility, it is also recommended to registr all the animals of the same given flock/herd in order to avoid confusing situations and facilitate the correction of possible errors. One can remark that if the purpose is a global appraisal and monitoring of the production system, ther may be no need for individual identification of the animals, but for example the same mark on individual of the batch monitored. But if animal recording system is established for using for various purposes as a tool for further developmental actions, problem of individual identification has to be solved.

The usual system of marking consists of a plastic ear-tag on which a number is readable at distance, combined with a fixed and definitive tattooing. Several authors mentioned a lot of difficulties, even if there is acceptance by the animal owners: wearing away of the number on the ear tags, losses of the tags, tearing of the ear in the field conditions particularly in grazing and brush environment... It is also well known that the tattooing can face difficulties with black eared animals.

For the organizers of an animal recording system, other problems can occur coming from the lack of availability of the material and ink for marking at the national market, needing importation and even long administrative steps. In some cases, where herd/flock size is small, the solution was used to include the name attributed to each of his animals by the owners or the caretakers (see for instance the practical remarks of de Groot, 1996; in the case of goat herds in India).

In order to face the consequences of loosing the ear tags, Poivey *et al.* (1981) describe how they imagined a solution in changing the number of the ear-tag of individual animals but outline the need of permanent number for processing the information, using pretabulated lists established on computer for every monthly record in one given herd. This needs regular exchanges of information between the recording place and the computer center.

5.1.2 Age identification

The preliminary enquiry on the demography of the herds/flocks (see above) and the initiation of the inventory of the animals make useful a method for age attribution of the existing animals. Information from the animal owner or animal keeper can be useful, completed by using a dentition pattern adapted to the characteristics of the local livestock and productions systems as outline by Poivey *et al.* (1981).

5.1.3 Operations of recording data

Firstly, considering the need for frequent contacts between animal owners and technicians in a global project of development for advise and monitoring, it is clear that the recording operations have to be achieved by officers and not by the farmers themselves as it can be the case in large extensive farms of developed countries (Plasse, 1988).

Secondly, many practical problems occur for taking the information as it is the case for recording the live weight of the animals and for the transport and the use of weighing bridges. The equipment for sorting and containing animals, very useful for these operations of recording, are also useful for other purposes as antiparasite, sanitary and prophylactic treatments. In fact, it is recommended (Poivey *et al.*, 1981) to use methods which limit the need for material by using an indirect weight recording by body measures, as for instance chest girth, with prediction equations established on the local breeds themselves and adapted to their conditions of production.

5.1.4 Transportation facilities

The problems of the transportation is mentioned above in respect to the weighing material. More generally, transports can be a limiting factor in developing countries. Usually, the first demand from the officers is the frequent use of a vehicle to achieve engaged relations between the central office and the farmers. The appointment of local recorders, even at part-time, is a solution to limit the weight of this constraint and to optimize the use of the financial availability. De Groot (1996) gives other arguments favorable to this solution, considering the need for confidence and close relations between

the recorders and the farmers at the village level. That induces a need for training this local part-time recorders which can also contribute to other aspects of the development programme.

5.1.5 Computer processing of the data

It is obvious that all the recording system projects include the use of computer systems even in the situation of developing countries. At the present time, it seems difficult to conceive any recording scheme without including this technology which is basic for any large field of activities in the societies.

But clearly also, there is various types of using this obligatory mean. Minimum solution consists in using a central computer, in part-time with other purposes, on the basis of data processed manually at the farm level by the recorders. Poivey (1987) illustrates the interest of frequent feedback from the computer to the recorders in establishing pretabulated listings of animals to be recorded. But we need to outline the importance of frequent and reliable relations, even during the bad season, with the central computer. For instance, in the case of Ivory Coast, Poivey (1987) stresses the advantage of regular meetings with the chief town Abidjan where the central computer is located. It is not a generalized situation.

The description of a "pilot cattle information system", designed for small dairy farmers in Egypt (Abdel-Aziz, 1996) aims to create a data processing center at the Cairo University (College of Agriculture) mobilizing current computer material but also adaptating software specialized for animal on-farm recording created either in Canadian conditions or by ILCA.

A basic remark of many authors is also that the synthetic result be available for decision making at the strategic periods for the herd/flock. It is a condition of the credibility of the system for the farmers. Peters and Thorpe (1988) for instance, outline that "the lack of effective mechanisms for analysis and feedback of results and recommendations to farmers, researchers and extension agents, remains a major constraint on livestock development". (**)

The evolution of the computers towards portable microcomputers makes possible the direct computerisation of the information at the herd or flock level, which opens the possibilities for local immediate treatment. But as in the case reported just above by Abdel-Aziz (1996), it needs appropriate software adapted to the local treatment of the information including the various purposes of animal recording (management and breeding).

(**) Plasse (1988) consider in the conditions of beef cattle production systems in tropical Latin America that the "production data need to be available at the following stages of the production cycle: (1) after the end of the calving season; (2) after the last weaning; (3) after the last weighing post-weaning; (4) after pregancy checking; (5) at the time of selection between pregnacy checking and the beginning of the breeding season; (6) after the beginning of the breeding season."

Finally, in the most sophisticated recording systems, there is a remarkable evolution towards automation (Hammond, 1988; Bibé et al, 1997) which permits to avoid many errors in rewriting the data, and also which facilitates the relation between on-farm and off-farm information from analysis laboratories or from slaughter house, related to the same animal, in large breeding schemes. The cost of this equipment and the practical possibilities for their maintenance in difficult environmental and climatic conditions have to be submitted to preliminary evaluation. It can be out of the possible field, but acceptable for stations and nucleus in a further phase of development. As it is well argumented and described by Tomaszecski (1993) in the conditions of large high producing herds in the States, the ultimate step of this evolution is the current use of integrated information system at the farm level (or "total farm information management system": Hammond, 1988), by the farmers themselves, as a support to the herd management. Obviously, these systems need farmers with high technical level.

5.2 Human and educational aspects

Human and educational aspects were mentioned before in this report, when considering the factors limiting the possibility of achieving on-farm recording systems in developing countries (see 1). Low literacy rate of the farmers is frequently mentioned as one of its major obstacles, in so far as this tool is on written basis, taking roots in information as individual number of every animal, reading and transcription of quantities and measurements, lists of numbers, quantified results, etc. The languages used in the computer system and software, mainly English or French or any other European language, can be different from the local language used by the farmers. Partial solutions can be found to solve problems linked to the numbers, as it was mentioned before, in so far softwares can now taken into account the true name attributed by the farmer to a given animal, even if the data processing consider only numbers. Nevertheless, the officers involved in animal recording systems have to be competent in the technical language but also familiar in the local language of the farmers and in confidence with them. It is an important point to take into consideration within the training programme of the officers and recorders.

However, it is a too short a view to only consider cultural aspects of traditional societies in developing countries as a matter of resistance to the diffusion of the technical progress. Several additional reflections can be expressed which provide elements for a deeper understanding of the relations between the local farming societies where livestock are playing a major cultural role and animal recording systems considered as a support for the introducion of technics from industrialized countries and cities.

Firstly, it is obvious that operations of animal recording systems have to be carried out according to mimimun educational conditions and that means that all the farmers cannot be concerned with. It means to select only a part of them. This can be considered as a limitation of the efficiency of recording

systems. This remark is of importance and needs special consideration. In fact, one has to outline that despite it is a multipurpose tool, animal recording system is not dedicated to be generalized to all the farmers for it is not a farming technics providing per se a better efficiency and improvement of animal production systems as it is the case of feeding, health control, reproductive technics.... It is before all a tool for better diagnostic of the true situation of animal husbandry in a given area, for better knowledge of the possible ways of evolution of the farmers and better adressing their needs for development, and for demonstration of better organization at the local level. We also have to remind that in the case where animal recording systems are to support breeding programmes, only a part of the farmers are involved in it and produce the improved animals for others farmers. So, it does not matter if animal recording system is limited to some farmers, in so far as other categories of farmers could indirectly benefit from the recording process through a better address of the extension actions.

At a second degree, attention has to be paid to situations where only a part of the farmers is primarly concerned with progress adapted to on-farm situations. Sociologists observed that this gap can provide preeminent social role to people playing the card of the technical development in traditional societies which are moving toward development and integration in a logics of production for marketing. It means that the introduction of technical progress in local societies can encounter at the same time resistance and interest. If the proposed changes mean to destroy the existing systems or are outside the cultural references of the people, they will be rejected. But they are also able to meet interest if they are considered by the farmers as an acceptable way of evolution of the existing systems. From the point of view of development, the goal is to identify technics and evolutions which can be accepted by a large number of farmers, and it is a basic goal for animal recording systems.

Thirdly, humility attitude has to be respected. The possible ways of evolution of in-field animal production systems are not so easy to identify in so far, as it was mentioned before, all animal production systems in developing countries are not firstly dedicated to market production, but can have other functions in relation with religious and social events or have a saving role in order to face future uncertainty (see 2.2.3). More generally, we have to consider the social consequences of the introduction of new farming technics in animal production systems closely related to the societies as it is the case in transhumane and nomadic large extensive systems. The success could mean the disappearance of these specific human societies, and as a matter of fact also a break in the ecosystems balance of fragile environments.

Finally, in respect to the role of recording system in the assessment and selection of local germplasm, we cannot be aware about the issue of its property. This question has to be carefully discussed considering the

respective role of the farmers in breeding original germplasm for several generations in specific context of constraints, resources and objectives, and of the support of the national foundation and organization for assisting them, in front to possible international interests. This discussion can be initiated taking into consideration the evolution of the human challenge about keeping biodiversity at the world level (Hammond and Leicht, 1997; Hodges, 1997).

6. Cost and evaluation of animal recording systems

For any group or organization involved in an animal recording programme, or planing to build a project including it, a first elementary question surges: "How much are the costs?" and a second one: "Is it possible to diminish the cost by simplifying the recording system?" And finally: "What is economic interest for an animal recording system?"

As an illustration of the weight of these questions, it can be mentioned here the facts reported by Turner and Parker (1984), about the cost of an animal recording system directly taken in charge by farmers involved in New Zealand Group Breeding Schemes. Some participating farmers "naively" discovered that the management and the recording and breeding operations of the open nucleus flock, common to the group, has to be paid by them, and that the sires coming from this sytem can cost as highly and even more than those they previously purchased from elite farmers. In these circumstances, some farmers left the scheme with the consequent failure of some Group Breeding Schemes as remarked by the authors.

6.1 What are the costs of an on-farm animal recording system?

This approach needs basically to make an inventory of the material means necessary to carry out an animal recording system.

6.1.1 Components of the cost

An exhaustive list of the types of components involved in an animal recording system is proposed in Annexe 1. The table can be filled at the level of a functional unit size for carrying out the recording system, for instance at a regional level, or within a farmers organization, or at a national public institution. The example (Annexe 2) is given here from the situation of the sheep recording system carried out in Morocco by Association Nationale Ovine et Caprine (ANOC) in marginal areas (Ait Bihi and Boujenane, 1997). Such a table could be also used for providing a financial estimates to state or private institutions which would initiate an animal recording system. It could also provide a basis for a comparative evaluation of the cost between the existing systems if needed.

If the breeding programme also involves testing station, or open nucleus herd/flock, or frozen semen and artificial insemination center, the cost includes initial investment plus maintenance and functionning operations, in which the reembursing and interests of the capital for investment could be included.

6.1.2 Factors of variation of the cost of the components

The global cost could largely vary in respect to the respective cost of the components which are variable among the various countries, in respect to the living costs rate, to the relative amount of the appointements and also to the cost of material which needs importations from developed countries which, as vehicles and computers, or even specific material for animal recording as ear-tags or weighing machines.

Bearing in mind the role of the computer processing in the organization of animal recording systems (see 5.1 and 5.5), differences between countries can also come from the current facilities or not to have close relation with active informatics (computer, software, and human expertise).

The type of recording system (see 4.) is also a factor of variation of the cost of an animal recording system. Particularly, for a given animal recording system, all the topics of the Annex 1 may not be necessary. Comparisons can be easily made of the cost of the various strategies of animal recording and breeding. For one side, we can consider what is called the "minimum animal recording system" and on the other side, we have the most complete and sophisticated systems associating testing station and artificial insemination to on-farm recording.

6.1.3 Indices for comparisons

Indices can be obtained from the global cost (gC) calculated from the list of the Annex 1:

* the cost per individual recorded animal (iC)

This index can be obtained by dividing the global cost (gC) of a given animal recording system by the number of recorded animals (nRA), bearing in mind that the meaning of this index is only valuable when the recording system has passed through the preliminary period and is carried out in routine period.

$$iC = gC / nRA$$

* the individual cost expressed in respect to the commercial value (cV) of the animal

$$R1 = (iC / cV) X 100$$

This percentage measures the financial effort for animal recording in respect to the economic value of the recorded animal.

* then in respect to the value of the all products: meat, milk, wool

$$R2 = (iC / p) X 100$$

p = price of meat kg. or price of milk litre, or price wool kg, depending of the recorded trait considered as the main one.

This percentage (R2) has a particular value in permitting comparison between systems at the international level, without taking into consideration currency exchange rates. For instance, we could express the cost of individual recording in equivalent of weight of meat, or litter

of milk... The value expressed in reference to milk, meat, or wool quantity can also be used for measuring the relative contributions of the various partners to the global cost: farmers, commercial company, regional authority, state...

But we have to pay attention to the fact that this index is mainly adapted to situations with specialized and intensive animal production systems - for milk or for meat or for wool. In contrast, in the developing countries, the basic situation is that of multipurpose production systems: meat + milk + draught and labor (and wool and hair). In this situation, the global value of return from one animal could be difficult to appraise in monetary terms. We can only retain here from these remarks that the ratio cost/production value, expressed in unity of milk, or meat, or wool production can provide an index for comparison without the direct influence of the currency fluctuations between countries.

These indices were calculated in reference to the Moroccan example in sheep recording (Annex 2). The average cost per recorded ewe (iC) is estimated at 9 DH per head. It represents approximately 0.6 to 0.9% of the commercial value per ewe (R1), or 2.0 to 2.6% of the commercial value per lamb (R1'), or still the value of 160 to 180 g of lamb meat (R2). This type of evaluation permits to estimate the investment rate set by the animal recording system to be put into relation with the expected progress (see 6.3.). In the Moroccan case, it is remarkable that the two largest sources of expenses are linked to vehicle (depreciation, fuel and management: 25%) and to appointments and traveling expenses (45%) due to the large distances to cover in the countryside, the both representing 70% of the global cost. Certainly, it is an usual pattern for expenses of animal recording systems in any situation in developing countries with large distances and extensive conditions. It is hoped that this type of evaluation be achieved in various national situations.

6.2 How to diminish the cost by simplifying the animal recording procedures

6.2.1 Choice of record frequency

a) Principles: a fundamental principle is on the basis of the recording system organizations for breeding purpose: *how to obtain a non-biased estimate of the whole production or performance of an animal without daily measurements?* Its means to make the choice of records frequency. In this respect, for instance monthly recording in dairy animal or still measurements of the live weight of the lambs every 3 weeks, can be considered as current and acceptable procedures.

However, the pressure for increasing the simplification of the recording procedure has two roots:

- to search for cheaper procedures with the same objective and information production;
- In fact it means to make more with less money;
- to obtain better adjustment of the recorded traits to the objectives.

This last consideration opens the way to a come-back to the objectives pursued by the respective actors having interest for animal recording system: individual farmers, farmers organization, technical and economic framework of the production systems, or official authorities (regional, national...). This discussion on the objectives can be complex if considering that are not only the breeding objectives on individual animals concerned but more largely development purpose and strategy of engaged contacts with the farmers are considered.(see 3.3)

b) Modalities: in fact, the choice of the frequency and of the recorded traits have to be always a compromise between the expected precision of the assessment and the cost. Particularly, one can search to have less charges for the appointments, and its means that every officer is able to record more animals, more herds or flocks... during one month or one year.

The lower cost can be also obtain in a better share of the fixed investments (as rent of housing, price of vehicles, computer systems, etc) among a greater number of animals when the recording system attain the routine phase. If the recording procedures are managed by officers, it will be of interest to evaluate the reasonable number of farms that can be monthly followed by each of them. It is clear that this number is related to the frequency of the records carried out at the farm level. In fact, it can be chosen that for development purpose, there is a need for monthly contacts between farmers and recorders.

6.2.2 Issues of simplified procedures

Whatever the result of this optimization, several research studies are available in the literature which support the interest in and the possibilities of more simplified procedures.

The example of dairy animals is interesting to discuss even if it is achieved in intensive dairy sheep dedicated to the Roquefort cheese in France. The basic idea was that it was not necessary to collect the two daily milkings. Alternate evening/morning monthly records are sufficient and more efficient than an complete record per two months, evening and morning. Better efficiency of the estimation of the daily yield is obtained, if the record of one milking, evening or morning, is completed by the knowledge of the total milk production of the herd obtained in the two daily milkings, evening + morning, in the bulk. The same procedure can be follow for the estimation of the milk composition. In Lacaune dairy sheep this proposal (Flamant and Poutous, 1970) was made at first in order to increase the efficiency of the pure breed selection scheme, but it generalized achievement in the recorded flocks demonstrated also the value of the knowledge of the bulk yield for management help and the global efficiency of the flock production. (***)

In fact, in these efficient breeding schemes, the organizers and framework of an animal recording system have to pay attention to the fact that the introduction of simplified procedures in a routine system can be considered, by the farmers for instance, as inefficient. This aspect has to be taken into consideration and needs explanation. It has its place in the training programme for the officers and the farmers, if necessary with the participation of scientists who can provide objective arguments, for example demonstrating that it is efficient to record the milk yield of more dairy daughters cows per sire bull with less individual precision in order to improve the estimation of the breeding value of the sires. In developing countries, the authors usually favorable to on-farm recording system consider desirable to have less precise recorded traits, but on larger number of animals for breeding purpose and on a larger number of farmers for development purpose. This fact also needs explanation and training from scientists towards politician and financers. It is clear that these simplifications are more and more easier to achieve with the assistance of computer facilities.

A good optimization of the animal recording system could also include the participation of the farmers to the recording operations: the birth registration in a specific booklet is clearly relevant to the farmer, and can also include observations on the conditions of the birth, on the mother and the young animal. The farmer can take charge of the milk recording in so far as the recording system is considered more as a help to the management of the herd than an official one for genetic indexing purpose. But it is clear that this choice cannot be made in situation with low literacy and technical level of the farmers.

6.2.3 Money for station or for on-farm recording?

Beside the simplification of the recording measurements and the issue of the frequency, other source of expense has to be considered: the need or not for creating testing stations or open nucleus herds/flocks. To make complete instruction of this critical point, it is recommended to refer to the conclusions

(***) For the estimation of the growth rate in sheep production for instance, preliminary French studies argumented for a 3 weeks frequency, in order to estimate the daily growth individual rate from 10 to 30 days which expresses the maternal milk ability, and then from 30 to 90 days which expresses the growth potential of the individual lamb. This registrations are completed by the birth declaration made by the farmer: date of birth, number of born lambs. The evolution was processed in regard of the too high cost of the procedure in regard to the need of increasing the number of flocks and animals recorded. Firstly in admitting that the 30-70 days growth rate was sufficient for estimating the individual growth potential, that means a reduction of one passage in the flock during the lambing period. Secondly, in considering that the need for a precise evaluation of the lamb growth rate is more needed in meat breeds but less important than the estimate of the maternal productivity in a large number of breeds. Consequently, the recording procedure can be limited to the birth declaration, with the number of born lambs, then with weight control at larger frequency, with two records per lambs between the birth and the slaughter or selection for breeding animal. (Bodin *et al.*, 1995)

of Croston *et al.* (1980) who consider that, even if testing stations authorize more complete and accurate records, this advantage is limited by the capital expense it needs. This issue has to be carefully examined in developing countries with low level of available investment, in contrast to the political attractiveness of such realization, larger than the organization of only on-farm recording. And if capital should be available, calculation has to be made about the interest of the use of this financial facilities for extension of on-farm recording system to new farmers.

6.3 Estimation of economic efficiency and appraisal of the interest of animal recording systems

6.3.1 Methods for estimating the economic efficiency of recording systems for breeding purposes

Animal recording systems which are active since a long term can be submitted to an evaluation of their economic efficiency, considering the estimated overall cost and the response obtained. An approach of the estimated overall cost can be at first performed by describing the successive steps of the evolution of the recording and breeding system: number of animals and herds/flocks involved, evaluation of the genetic progress. For the new systems, it is useful to get from the organizers an expense\income estimation of the recording operations, as suggested by James (1986), taking into account the successive years, the planed enlargement of the number of the farmers concerned, and the expected rate of progress for the production. For instance, Callow *et al.* (1986) demonstrated that the new "Sheeplan" scheme they designed was not only technologically more efficient but also will provide financial benefit to the New Zealand sheep industry. This type of estimation is useful for providing arguments for the people or institutions which have to pay to cover part of the whole cost of the recording and breeding system.

Question is asked about the estimation of returns from the expected genetic progress in the long term, from 10 to 20 years after starting the breeding programme. In this situation a first issue concerns the possible changing of the market conditions with heavy consequences on the economic situation for the farmers, that could modify the interest of the chosen objectives in the origin of the programme. The response to this embarrassing question could be the choice for criteria which can be considered as of permanent interest, for instance: adaptation to constraints of the environment, resistance to diseases, mothering ability. But it is well known that these functional traits are difficult to select for and that they could be in a negative genetic correlation with productive traits as milk yield, growth rate, of immediate economic interest for the farmer (Groen *et al.*, 1996). Flamant *et al.* (1995) also propose to pay more attention to the diversity of the animal resources in respect to the possibilities it offers for rapidly changing of the herd/flock genotype in response to new economic interests. Illustration is given of the interest of local breeds in the case of rural areas in the Mediterranean where the orientation toward tourist activities in relation with specific quality products or leisure and landscape could be more interesting for the farmer than the only milk or meat production with specialized breeds. In these conditions, conservation of

the biodiversity and acceptance of the usefulness of non specialized breeds are of importance to face these rapid changes and evolutions (Flamant, 1997).

Another question to discuss is related to the method of estimation of the economic efficiency of one given breeding programme, in respect to returns and expenses. James (1986) examines the significance of two types of combinations between returns (R) and costs (C): the profit equation P = R - C or the ratios Q = C/R or Q = R/C. The profit equation seems better when considering the evaluation in the short term (10 years) and the ratios are better for estimations in the long term (25 years). But the consideration of the long term stimulated research on the interest of the "discounted cash flows procedure", used by Poutous and Vissac (1962) on dairy cattle and by Hill (1971) on beef cattle. James (1986) and Ponzoni (1986) consider that despite the better precision and theoretical interest of this last method, the results are similar to the comparison cost vs. income year per year.

These estimates can also be practically used for chosing the best breeding objective considering the need for better optimization of the expense (Pearson, 1982). But we have also to have in mind that coming back to the situations of low input systems in developing countries, the genetic progress of the performances of individual animals cannot be obtained outside a global goal concerning the improvement of the efficiency and productivity of the whole production system (Poivey, 1987).

6.3.2 Examples of financial efficiency of breeding programmes

All the examples deeply studied on breeding programmes carried out in developed countries, as those by Poutous and Vissac (1962) on the on-farm progeny-testing of dairy bulls in France with artificial insemination or by Hill (1971) on a project of beef cattle testing station, prove their high economic efficiency in the long term.

It is interesting to outline that de Groot (1996) arrives at the same conclusion in India with an on-farm performance recording programme on local goats, with high technical means, and considers that taking into account the initial investments and the current yearly expenses and the expected genetic gain in milk yield and body growth, the first net benefit year is reached on the 10th year.

However, the effectiveness of such results have to be submitted to critical view in low-to-medium input systems, where the first limiting factor could be the investment availability. In this situation, it is not sufficient to demonstrate the long term economic profitability of a breeding programme. It is necessary to adapt the choice of the breeding and recording procedure to the financial possibilities in the short term resulting from arbitration of the public governemental funds, in respect to other needs for development of the society and of the economy.

6.3.3. Efficiency of animal recording system with goal of global development

Considering the use of animal recording not only for breeding purpose but for global development progress, the conclusions reported before need to be reoriented for the efficiency of the animal recording system has not to be appreciated independently of the global programme.

In this type of situation, animal recording is only one of the tools used in support to development programme. Consequently, the relation cost\benefit cannot be estimated by isolating the animal recording system from the whole context. The evaluation has to take into account the interest of a bottom-up strategy in contrast to a top-down strategy. Particularly, considering animal recording system as a privileged tool in order to better inform responsible of the development about in-field situation of animal production systems, ways of evolution acceptable for them and their effective evolution within a global projetc of development, we cannot estimate the result in only the recorded farms but in the whole project better adressed with the support of the data coming from the recording system. It is particularly true during the first step of establishment of the recording systems.

If further developments of recording systems are carried out toward breeding scheme, we have also to consider that there is no total independence between the efficiency of a breeding scheme on local breed and global development. Lessons coming from the observation of the evolution of well organized breeding scheme achieved in France in dairy sheep, (Flamant, 1991) show that the long term genetic objectives where supported by short term objectives in intensifying the production systems, considering the fact that the accompanying techniques for breeding purpose in the long term where also immediately favorable for the profitability of the systems. In these situations, we observe that animal recording system could not be only an observatory of the evolutions but also a motor for. It was also observed that in the most achieved breeding programmes on local breeds, the network of the various actors contributing to the recording and testing operations, can be the basis of a social organization taking in charge the objectives and the means of local development projects. This remark has to be linked with the reflexions achieved about the human aspects of animal recording systems (see 5.2).

7. Requirements and conditions of implementation of animal recording systems. Final recommendations

7.1 Basic requirements

From the various experiences of animal recording systems carried out in India, de Groot (1996) observes that there is a need for:
1. a clear definition of recording purposes;
2. a good institutional environment and backup;
3. a long-term perspective in planning and also for generating financial and human resources to ensure the continuation of the activities.

De Groot (1996) also defines the conditions required for a sustained success: (i) relative independent administrative status of the organization, (ii) continuous financial support from Government, (iii) vision and capacity of the staff.

The choice of the objectives for animal recording system is very needed in respect to finally 3 possible functions:
- animal recording system as observatory and diagnostic of the in-field situation;
- animal recording system as a platform for monitoring management improvement and a "lead technology" for development;
- animal recording system as a basis for breeding programme, on-farm or on-station.

There are relations between these three types of objectives which are not independent. Figure 3 illustrates these relations, and also the possible progression from one objective to one another.

As a system of collecting information, animal recording can be used as a platform for development and can have in this context various functions:
1. for observation and diagnostic purpose, animal recording has a specific contribution in the appraisal of livestock farming systems, in complementary with other types of information at the herd/flock level, combined with information on the local context;
2. as mean of entry at the farm level, animal recording system has a catalytic effect in supporting development programmes, farmers being considered as central actors for any technical action;
3. if breeding programme is considered as an objective for development, animal recording system provide basic information to achieve it.

7.2 "Minimum" animal recording system

Considering the generally low financial capacity of the State in developing countries, it appears very useful to describe the "minimun" standard of animal recording system to achieve, having in the mind its multipurpose function, and particularly the capacity of such technology to induce in the short term phenotypic progress before long term genetics progress, or to be an accompanying tool for developmental strategy.

Under this principle, animal recording system has to be adapted at the same time to the goal of increasing the productivity of the animal production systems but with reasonable financial expenses and requirements adapted

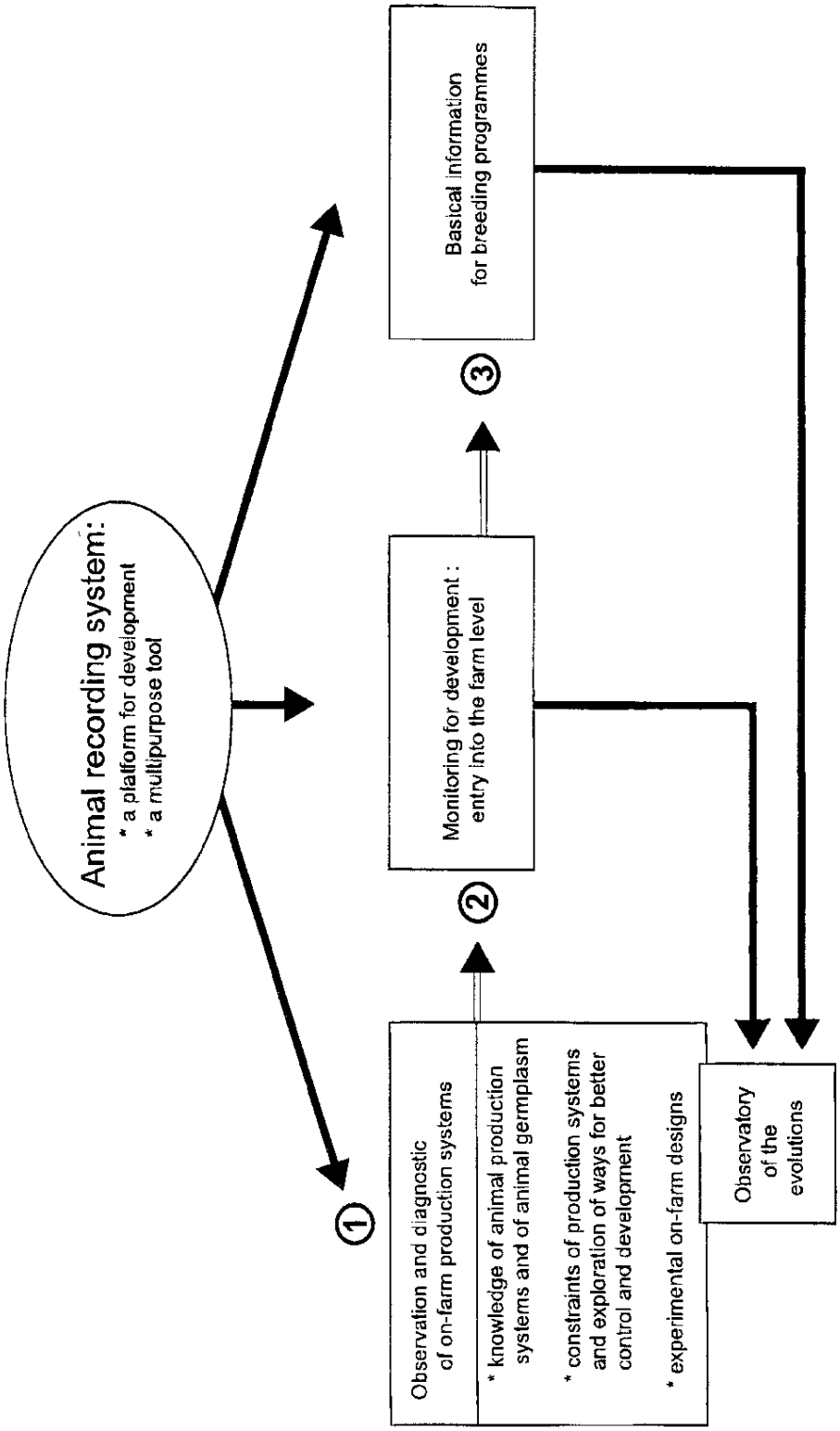

Figure 3. Animal recording system: multipurpose tool, various functions and progressive ways of implimentation.

to the conditions of the national economy and to the possible supports coming from international organizations. It is stressed that this desirable "minimum" can include various components, the nature of which depending a lot on the particularities of the local production systems, respectively: the nature of the animal products (milk, meat, wool, energy by draught and obviously mixed of all the possible products), the biological characteristics of the species (cattle, sheep, goats, horses and others), the type of the production systems (pastoral or intensive, sedentary or transhumant or nomad) and also the place of animals in the social organization (village keepers, religious aspects, social prestige...). So it is difficult to describe here a precise "minimum" animal recording system precisely adapted to every of these conditions. This is the job of any organization, which has the willingness to engage in such endeavor, to design this minimum in the context of its specific animal production systems.

However, it is possible to underline some principles from conclusion of the before chapters. They are summarized as follow:

1. on-farm recording on a sample of 10-15 to 20-25 units, representative of the diversity of the situations observed in a given local breed and territory (almost one thousand animals in the total);
2. individual marking of the animals, but individual names can be used in some situations and even the description of the color pattern in diversified cattle no standardised populations;
3. monthly recording, without assistance in material providing difficult to transport (weighing machines for cattle for instance), that means metric measurements;
4. possible local use of micro computers for immediate registration of the data and checking of the number of the animals;
5. adoption of standardized form and software at national level;
6. production of regular lists of results;
7. training programmes for officers, recorders and farmers.

These seven points have to be investigated and discussed at the local and national level, in respect to the characteristics of the project, and namely to the expression of the official interest for the developement of animal recording system (see 3.1).

In the situation where there is an existing station, it is useful to organize in priority an on-farm recording scheme around the station and linked to it, in order to make closer the activities of the station and the reality of the animal production systems. It is particularly interesting in the case of dairy herds engaged in crossing schemes from central station or artificial insemination center with European or North American breeds (see 4.1 and 4.3).

The creation of a station cannot be envisaged at the local level only after the phases of on-farm diagnostic and in accompanying monitoring management improvements, for demonstration and test of solutions, if the objectives and the role of this station for development purpose are well identified and discussed.

Finally, a ram/bull center can be imagined in a further step, in so far as breeding objectives and adaptation traits are clearly identified from the knowledge of the livestock farming systems.

7.3 Role of the State and of national organization

State and national organization have a specific role to play for achieving animal recording systems. Examples can be given of self-organized recording systems by the interested farmers as in New Zealand and Australia (Cf. Group Breeding Schemes. see chapter 4), but the need for continuous effort and long term perspective mentioned before cannot be meet without a public engagement.

Authors outline that it is only at a national level that it is possible to conceive, organize and manage an information system which provides the framework for any local action in the field of animal recording and farm monitoring. Such a system could be now more easily achieved through computer and software facilities, and in adaptating monitoring programmes designed by research as illustrated for instance by de Freitas et al (1997) in the case of Brazilian dairy herds.

The needed actions and obligatory contribution from State can be listed as following:

1. basic need for research in order to built methodology for on-farm observation, models for decision making, models for animal breeding, and in adaptating efficient solutions evolved in other conditions;
2. organization of information and processing network for animal recording, including computer center, standardization of forms used by officers and farmers, and building of software adapted to the situation of livestock farming systems;
3. creation of specific institutions and stimulation of collective organization taking in charge animal recording systems, assistance to the farmers and training programmes for technical framework, officers and recorders;
4. financial support in view of long term benefit.

7.4 Main snags to pay attention

In final, considerations can be made about the main snags to avoid in the achievement of animal recording systems.

As a matter of fact, this report highlights convergence of interests involving animal recording systems, and valorizes the usefulness of this multi-purpose tool. However the reality can be also a clash between various types of interests from the various actors involved with various and divergent objectives. It is why we also need to identify here and discuss possible sources of misunderstanding between various actors involved in the social system established by carrying out animal recording systems.

It is firstly possible to describe a "black scenario" in which the computer and the information network begins the finality of the animal recording system. The animal recording system is above all dedicated to supply the computer system. This situation is founded in the constraints of the management of the whole data network in which the computer center is the most technically sophisticated and so it only defines the rules to be followed by the other actors in the recording systems whic may be unaware of the constraints and needs of the other actors of the network.

In a second "black scenario", recording system is firstly designed for breeding purpose from traits of individual animals and does not accept to include and to process information at the herd/flock level. The origin can be technical, related for instance to the availability of software adapted to this purpose.

Other criticisms can also expressed towards a "blind" use of animal recording system:

- There could be limited confidence in the interest of animal recording system, from people closely involved in local development process in so far as they give priority to the need of understanding the management and decision system of the farmers, or in firstly diffusing basic techniques for the improvement of animal production systems and consider unuseful the knowledge of the variability of the individual animal performances.
- In contrast to the former remark, prejudices have also been taken against limits of the use of quantified data. It could have for consequences orientations towards exclusively improvement of the level of the strictly recorded traits. We have to pay attention to the fact that the improvement of the productivity of individual animals is not the unique way for higher livestock productivity and income at the farm level.

In the practical achievement of a given animal recording system, possible conflicts can also occur between top-down strategy from national decision-makers and bottom-up strategy privileging poor small farmers.

And finally, human issues have to be discussed in respect to questions about the consequences of introduction of new technics on the future of traditions and local societies.

The above "crititicisms" are mentioned not for objective to provide negative opinion about animal recording systems. Their purpose is to enlighten the challenges of good implementation of animal recording systems into a more

global and social organization of the development. It is expected here that the tool which is an animal recording system will not begin the unique objective but will remain only a tool. This important issue has to be taken into account in the training programme of people involved in animal recording systems.

8. Conclusion

This report is concerned with the largest number of farming animals over the world (approximately the 2/3 world population), kept in developing countries, but of which the contribution to the global world production is relatively low (only 1/3 of the meat and milk world production). It means that till now animal husbandry was unsufficiently taken in charge by development procedures adapted to the specific conditions of the majority of the world. Extensive range systems are not able to meet the increasing needs of humanity for animal protein, but the intensive model, evolved in developed countries, cannot be carried out in conditions where public and private financial means are not available. In these conditions the largest ranges of future progress have to be prospected in low-to-medium animal production systems in so far as the means used and the objectives defined be founded on the knowledge of the specific qualities of the local animal germplasm and on the identification of the ways of evolution of the farming systems acceptable by the present populations and societies involved in animal production systems.

It is why despite difficulties and limiting factors for carrying out animal recording systems in the context of most developing countries, this report stresses the need for voluntary on-farm procedures, even associating poor small farmers. Theoretical basis for this approach are now available, considering that animal production system is “a dual entity”, as well a biotechnical system as a decision making and management system.

Examples from the available litterature aim to cover a large range of situations for animal production:

- new specialised animal production systems in small to medium herds mainly dedicated for milk production in the surroundings of the cities (periurban systems), and linked to the milk marketing towards the close consumers; or new animal production systems associated to the need of draught animals for the development of cropping systems;
- traditional mixed farming systems in small to medium herd/flock for largely diversified production in village conditions;
- large extensive farming systems in range land conditions - ranching systems or nomadism and transhumance.

Litterature and experiences are convergent to consider now the possibility to carry out animal recording systems for multipurpose development use, associating records on individual animals to information from the herd/flock management and from the farming system within its social and economic local environment.

Computer systems and software are also now available and have to be considered as no bypassing means, for processing diversified and complexe information in direction of various goals:

- present state and diagnostic of the local on-farm situation and of its possible way of evolution;
- basis for experiments;
- help for various types of development and assistance actions: feeding, veterinary, breeding, organisation of marketing...

It should however be dangerous to see animal recording system as a new miraculous stick, suitable for rapid turning in advantage difficult situations of populations in the countryside. It was firstly illustrated in this report the need for progressive approach and for the respect of successive steps in order to success. Its potential interest does not justify the possibility to be unaware of possible snags coming from the difficulties to manage a complexe human network associating various competences and interests which could also be proved their capacity to clash.

Finally, a lot of experiences through the world proved the effectiveness of on-farm animal recording so long as there is search for adapted objectives and procedures to the local context, continuity of financial official supports, good level competences of the technical framework. Probably, the first important interest of animal recording system is the possibility to have a better knowledge of the true conditions for animal production at the farm level. Animal recording system carried out in a small but well choose sample of herd/flocks could be of first utility in order to better adress the need of a larger population concerned with the same goals, constraints and resources, and receptive to the same way for evolution. Nevertheless, this efficiency in the long term does not permit to avoid a serious local or/and national consideration and questions about the way chosen for the evolution of the farmers and village societies in relation to the technical and economic changes. The original association between traditions and modernity is under the hands of the responsible of the development programmes as well as in those of the farmers and their families and villages.

9. References

Abdel-Aziz A.S., 1996. Pilot cattle information system in Egypt. In "Performance recording of animals - State of art, 1996", 30th Biennial Session of ICAR, The Netherlands, June 23-28. EAAP Publication N° 87, 183-188, Wageningen Pers.

Ait Bihi N. & Boujenane I., 1997. Contrôle de performances des ovins en milieu difficile: Cas du Maroc. In Gabiña D. & Bodin L. (Editors) "Data collection and definition of objectives in sheep and goat breeding programmes: new prospects", Meeting FAO-CIHEAM Network of Cooperative Research on Sheep and Goats, Toulouse, 9-11 March. Options Méditerranéennes, 67- 72.

Bernues A., Manrique E. & Maza M.T., 1994. How to delimit and use the concept of an ecosanitary system in farming. In Gibon A. & Flamant J.C. "The study of livestock farming systems in a research and development framework", Second International Symposium on Livestock Farming Systems. EAAP Publication N° 63, 162-166.

Bibe B., Barillet F. & Poivey J.P., 1997. Apports de l'automatisation dans les programmes d'amélioration génétique des petits ruminants. In Gabiña D. & Bodin L. (Editors) "Data collection and definition of objectives in sheep and goat breeding programmes: new prospects", Meeting FAO-CIHEAM Network of Cooperative Research on Sheep and Goats, Toulouse, 9-11 March. Options Méditerranéennes, Série A, N° 33, 35-41.

Bodin L., Francois D. & Poivey J.P., 1995. Simplification of recording programme for lamb growth rate. Standardisation and homogeneisation, organisation of sheep breeding in France. FAO-CIHEAM Cooperative research Network on animal resources in sheep and goats. Tunis, 26-29 March, pp. 10 .

Bouhamar B. & Bouix J., 1991. Problématique de la conception d'un programme de sélection: le cas de la race Thimahdite au Maroc. Confrontation internationale de races ovines rustiques. Salon International de l'Agriculture, Paris, pp. 7 .

Bougler J., 1990. Les schémas de sélection des bovins laitiers dans les conditions du milieu sud-méditerranéen. In "Amélioration génétique des bovins sous climat sud-méditerranéen", Symposium, Tunis, 21-23 novembre 1989. EAAP Publication N° 47, 147-155.

Callow C.F., Clarke J.N. & Rae A.L., 1986. Further development of sheep recording in New Zealand. Proceedings of the New Zealand Society of Animal Production, 46, 117-120.

Cournut J. & Rehben, E., 1988. Situation et perspectives des contrôles de performances en ferme appliquées aux bovins allaitants et aux ovins viande en France. In 3rd World Congress on Sheep and Beef Cattle Breeding, Paris, Vol. 1, 259-273.

Croston D., Danell O, Elsen J.M., Flamant J.C., Hanrahan J.P., Jakubec V., Nitter G. & Trodhal S., 1980. A review of sheep recording and evaluation of breeding animals in European countries: a group report. Livestock Production Science, 7; 373-392.

Dedieu B., Gibon A. & Roux M., 1994. Notations d'état corporel et diagnostic des systèmes d'élevage ovin. In: Gibon A. & Flamant, J.C., "The study of livestock farming systems in a research and development framework", EAAP Publication N° 63, 342-346. Wagening Pers.

Dent J.B., McGregor M.J. & Sibbald A.R. (Editors), 1996. Livestock farming systems: research, development socio-economics and the land manager. Third International Symposium on Livestock Farming Systems. EAAP Publication N° 79, pp. 360.

Eddebbarh A., 1996. Systèmes intensifs de bovins laitiers dans le sud de la Méditerranée: évolution actuelle et évolution possible. In Flamant J.C., Boyazoglu J. & Nardone A. "Cattle in the Mediterranean area", EAAP Publication N° 86, 27-37.

Flamant J.C., 1991. Considering the social aspects of sheep breeding programmes. In Maijala K. "Genetic resources of pig, sheep and goat", World Animal Science, B8, 379-390.

Flamant J.C., Gibon A. & Casabianca F., 1995. Ajustement des populations animales aux évolutions économiques et sociales: un essai sur les capacités de flexibilité du matériel animal. In Flamant J.C., Portugal A.V., Costa J.P., Nunes J.P. & Boyazoglu J. "Animal production and rural tourism in Mediterranean regions. EAAP Publication N° 74, 15-24, Wageningen Pers.

Flamant J.C., 1997. Les ressources génétiques animales en région méditerranéenne. Leur caractérisation en relation avec les systèmes d'élevage et les enjeux socio-économiques. In Matassino D., Boyazoglu J. & Cappuccio A. "International Symposium on Mediterranean animal germplasm and future human challenges", EAAP Publication N° 85, 45-54.

Flamant J.C. & Morand-Fehr P., 1989. L'évaluation des ovins et caprins méditerranéens. Symposium "Philoetios", Fonte-Boa (Portugal), 23-25 sept. 1987, Rapport EUR 11893,. Commission des Communautés Européennes, Luxembourg, pp. 578.

Flamant J.C. & Poutous M., 1970. Aspects quantitatifs de la production laitière des brebis. VII - Précision d'un contrôle alterné (AT) et d'un contrôle laitier d'alternance quelconque corrigé pour les écarts moyens entre les performances du soir et du matin. Annales de Génétique et de Sélection Animale, 2, 65-73.

de Freitas M.A.R., Guilhermino M.M., Zambianchi A.R. & Grossi S.F., 1997. Monitoring Brazilian dairy herds: past, present and future. 48th EAAP Annual Meeting, Vienna, 25-28 August. Book of Abstracts N° 3, pp. 286.

Gabiña D., 1997. Current state of Mediterranean small ruminant germplasm and its characterization. In Matassino D., Boyazoglu J. & Cappuccio A. "International Symposium on Mediterranean animal germplasm and future human challenges", EAAP Publication N° 85, 147-168.

Gibon A. & Flamant J.C. (Editors), 1994. The study of livestock farming systems in a research and development framework. Second International Symposium on Livestock Farming Systems. Zaragoza, Spain, Sept. 11-12, 1992. EAAP Publication N° 63, pp. 449.

Gibon A. & Flamant J.C., 1994. Conclusion of the Symposium. In GIBON A. and FLAMANT J.C. "The study of livestock farming systems in a research and development framework", Second International Symposium on Livestock Farming Systems. EAAP Publication N° 63, 425-433.

Gibon A. & Matheron G. (Editors), 1992. Approche globale des systèmes d'élevage et étude leurs niveaux d'organisation. Concepts, méthodes et résultats. Premier Symposium International sur les Systèmes d'élevage en ferme. Office des Publications des Communautés Européennes, Luxembourg. Pub. EUR 14479, pp. 578.

Gibon A., Roux M., Vallerand F. & Flamant J.C., 1989. Eléments conceptuels et méthodologiques pour l'approche des exploitations d'élevage: quelques exemples français. 40th EAAP Annual Meeting, 27-31 August, Dublin, pp. 11.

Gibon A., 1994. Dispositifs pour l'étude des systèmes d'élevage en ferme. In Gibon A. & Flamant J.C., "The study of livestock farming systems in a research and development framework", EAAP Publication N° 63, 410-422.

Gibon, A., Rubino R., Sibbald A., Sorensen J.T., Flamant J.C., Lhoste Ph. & Revilla R., 1996. A review of current approaches to livestock farming systems in Europe: towards a common understanding. In Dent J.B., McGregor M.J. & Sibbald A., "Livestock farming systems: research, development socio-economics and the land manager", EAAP Publication N°79, 7-19. Wageningen Pers.

Groen A. F., Steine T., Colleau J.J., Pedersen J., Pribyl J. & Reinsch N., 1996. Economic values in dairy cattle breeding, with special reference to functional traits. Report of an EAAP Working Group. 47th EAAP Annual Meeting, Lillehammer (Norway), August.

Groen A.F., 1989. Economic values in cattle breeding. II. Influence of production circumstances in situations with output limitations. Livestock Production Sciences, 22, 17-30.

de Groot B., 1996. Experiences on animal recording in bilateral collaboration projects for livestock development in India. In "Performance recording of animals - State of art, 1996", 30th Biennial Session of ICAR, The Netherlands, June 23-28. EAAP Publication N° 87, 49-59.

Guessous F., Kabbali A. & Narjisse H., 1992. Livestock in the Mediterranean cereal production systems. EEAP Publication N° 49, Pudoc, Wageningen, pp. 249.

Hammond K., 1988. Automating farm performance testing. In 3rd World Congress on Sheep and Beef Cattle Breeding, Paris, Vol. 1, 303-317.

Hammond K., 1995. Small holder milk recording for developing countries. In "Milk and beef recording: State of art, 1994". 29th Biennial Session of the International Committee for Animal Recording, Canada. EAAP Publication N° 75, 363-369.

Hammond K. & Leitch H.W., 1997. FAO's global programme for the management of farm animal genetic resources. In Matassino D., Boyazoglu J. & Cappuccio A. "International Symposium on Mediterranean animal germplasm and future human challenges", EAAP Publication N° 85, 25-36.

Hill W.G., 1971. Investment appraisal for national breeding programmes. Animal Production, 13, 37-50.

Hodges J., 1997. Convention on biological diversity: implication for conservation of farm animal biodiversity. In Matassino D., Boyazoglu J., Cappuccio A. "International Symposium on Mediterranean animal germplasm and future human challenges", EAAP Publication N° 85, 5-14.

James J.W., 1986. Economic evaluation of breeding objectives in sheep and goats - General considerations. In 3rd World Congress on Genetics Applied to Livestock Production. Lincoln, Nebraska, USA, July 16-22. Vol 9, 470-478.

Kuettner K & Wollny C.B.A., 1997. Reproduction and productivity of Friesian x Malawi Zebu crosses in smallholder dairy farming in Northern Malawi. 48th EAAP Annual Meeting, Vienna, 25-28 August. Book of Abstracts N° 3, 209.

Landais E. (Ed.), 1986. Méthodes pour la recherche sur les systèmes d'élevage en Afrique intertropicale. Etudes et Synthèses de l'IEMVT, Maisons-Alfort, France, N° 20.

Lescourret F., Dorr N. & Faye B., 1994. Conception et intérêts d'une base de données dans un système d'information à visée de recherche exploratoire: un exemple en épidémiologie animale. In Gibon A. & Flamant J.C. "The study of livestock farming systems in a research and development framework", Second International Symposium on Livestock Farming Systems. EAAP Publication N° 63, 207-211.

McDowell R.E., 1977. Steps necessary in effective planning and evaluation of genetic improvement of tropical livestock. Colloque sur l'élevage bovin en zone tropicale humide. Bouaké (Côte d'Ivoire), 18-22 Avril.

Meyn K., 1984. Requirements and constraints for cattle breeding programmes in developing countries. 2nd World Congress on Sheep and Beef Cattle Breeding, Pretoria (South Africa), 16-19 April, pp. 12.

Moulin C.H. & Lhoste P., 1996. Fondements d'une approche systémique de l'élevage en régions chaudes: cas des petits ruminants au Sénégal. In Dent J.B., McGregor M.J. & Sibbald A., "Livestock farming systems: research, development socio-economics and the land manager". Third International Symposium on Livestock Farming Systems. EAAP Publication N° 79, 143-151.

Nardone A., 1996. Analysis of cattle production systems in the Mediterranean area. In Flamant J.C., Boyazoglu J. & Nardone A. "Cattle in the Mediterranean area", EAAP Publication N° 86, 5-26.

Nicoll G.B., Bodin L. & Jonmundson J.V., 1986. Evaluation of inter-flock genetic improvement programs for sheep and goats. In 3rd World Congress on Genetics Applied to Livestock Production. Lincoln, Nebraska, USA, July 16-22. Vol 9, 619-636.

Ordoñez J.A., 1990. Breeding beef cattle in Latin American tropics. In Proc. 4th World Congress on Genetics Applied to Livestock Production. Edinburgh, UK, 23-27 July. Vol. 15, 254-260.

Pearson R.E., 1982. Economic aspects of the choice of a breeding objective. In Proceeding 2nd World Congress on Genetics Applied to Livestock Production, Madrid 4-8 oct., Vol. VI, 50-57.

Peters K.J. & Thorpe W., 1988. Current status and trends in on-farm performance testing of cattle and sheep in Africa. 3rd World Congress on Sheep and Beef Cattle Breeding, Paris, Vol. 1, 275-301.

Plasse D., 1988. On-farm performance testing of beef cattle in tropical Latin America. 3rd World Congress on Sheep and Beef Cattle Breeding, Paris, Vol. 1, 319-330.

Poivey J.P., 1987. Development of breeding methods in the tropics with limited availability of in-the-field recording systems. Worl Review of Animal Production, 23, 83-92.

Poivey J.P., Charray J. & Humbert J.M., 1986. Research on sheep in Ivoiry Coast. Study and improvement of the Djallonké breed. World Review of Animal Production, 22, 77-82.

Poivey J.P., Seitz J.L. & Landais E., 1981. Finalités et aspects méthodologiques d'un système informatisé de suivi individuel des animaux dans les élevages bovins villageois du Nord de la Côte-d'Ivoire. Rev. Elev. Méd. Vét. Pays trop., 34, 199-210.

Ponzoni R.W., 1986. Economic evaluation of breeding objectives in sheep and goats - Summary and commentary. In 3rd World Congress on Genetics Applied to Livestock Production. Lincoln, Nebraska, USA, July 16-22. Vol 9, 465- 469.

Ponzoni R.W., 1988. On-farm performance recording service for beef cattle and sheep in Australia - Organisation and trends. In "Proceedings 3rd World Congress Sheep and Beef Cattle", Paris, 19-23 june 1988, Vol. 1, 239-258.

Poutous M. & Vissac B., 1962. Recherche théorique des conditions de rentabilité maximum de l'épreuve de descendance des taureaux d'insémination artificielle. Annales de Zootechnie, 11, 233-256.

Rey B. & Fitzhugh H.K., 1994. Systems approach to livestock development oriented research: ILCA's experience. In Gibon A. & Flamant, "The study of livestock farming systems in a research and development framework", EAAP Publication N° 63, 120-129.

Rushton J. & Ellis P.R., 1996. The changing role of cattle in the mixed farming systems around Bangalore, India. In "Livestock farming systems: research, development socio-economics and the land manager". Third International Symposium on Livestock Farming Systems. EAAP Publication N° 79, 91-102.

Sorensen J.T. (Chief Editor), 1997. Proceedings of the 4th International Livestock Farming Systems Symposium, Fouloum (Danemark), 22-23 August 1996. "More than Food Production". EAAP PUblication, Wageningen Pers (to be published).

Tomaszewski M. A., 1993. Record-keeping systems and control of data flow and information retrieval to manage large high producing herds. Journal of Dairy Science, 76, 3188-3194.

Trevedi K. R., 1996. Milk recording and genetic evaluation of cattle and buffaloes in India. In "Performance recording of animals", 30th Biennal Session of ICAR, The Netherlands, June 23-28 1996. EAAP Publication N° 87, 33-39. Wageningen Pers.

Tripp R. (Ed.), 1991. Planned change in farming systems: progress in on-farm research. John Wilheys and sons Ltd, Chicester, England.

Turner R.W. & Parker A.G.H., 1984. New Zealand group breeding schemes. In 2nd World Congress on Sheep and Beef Cattle Breeding, Pretoria, 16-19 April. Vol.1, pp. 7.

Usmani R.H., 1996. Factors limiting regular recording of lactation performance of dairy buffaloes in Pakistan. In "Performance recording of animals", 30th Biennal Session of ICAR, The Netherlands, June 23-28 1996. EAAP Publication N° 87, 321 - 324. Wageningen Pers.

Vaccaro L., Vaccaro R., Verde O., Meijias H., Perez A., Rios L. & Romero E., 1994. An improvement program for tropical dual purpose cattle. In Proc. 5th World Congress on Genetics Applied to Livestock Production, Guelph, Ontario, Canad, August 7-12. Vol. 20, 313-318.

Vissac B., Beranger C., 1994. An holistic approach to livestock farming systems: theoretical and methodological aspects. In Gibon A. & Flamant J.C. "The study of livestock farming systems in a research and development framework". EAAP Publication N° 63, 5-17.

Annexe 1

Material components of an animal recording system

1. marks of the individual animals: ear-tags, ink...

2. instruments for recording:
    - milk recording tubes
    - weighing systems
    - for young small ruminants
    - for mature small ruminants
    - for calves
    - for mature beef cattle
    - meter for metric measurement
    - automatic registration system
    - contention system and of sorting of the animals

3. pre-printed documents
    - birth daily registration booklet at the farm level,
    - printed forms for officers

4. informatics
    - individual computer
    - farmers
    - officers
    - central computer system and software

5. paper for editing the results, post, and divers

6. vehicles, fuel and maintenance

7. staff and employees:
    - appointments
    - travelling expenses

Annexe 2

Example of the cost of sheep recording system in Morocco (Association Nationale Ovine et Caprine - ANOC).

Cost in Moroccan Dirham (DH) (1 US$ = 9.53 DH)

1. animal identification (ear-tags and tattooing)	16.000 DH
2. instruments for recording (dynamic balance, 50 and 100 kg.)	3.000 DH
3. pre-printed documents for manual data acquisition	7.000 DH
4. Informatics: computer (annual sinking)	6.000 DH
5. Listing, Post, divers	10.000 DH
6. Vehicles	
- annual sinking	18.000 DH
- fuel and maintenance	19.200 DH
7. Staff and employees	
- appointments and traveling expenses of recorders	30.000 DH
- employee for computer data acquisition	15.000 DH
- appointment of the responsible of recording system (*)	20.000 DH
Total	**144.200 DH**

(*) 20% of its monthly time

Calculation of indices (see 6.1.3.)

- gC (global cost) = 144.200 DH
- nRA (number of Recorded Animals : 16.000 ewes (140 flocks)
  iC = gC/nRA = 9 DH
- cv (commercial value per ewe) = 1.000 to 1.500 DH
  R1 = (iC/cV) x 100 = 0,6 to 0,9 %
- cv (commercial value per lamb) = 600 to 800 DH
  R1' = (iC/cV) x 100 = 2,0 to 2,6 %