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ORIGINAL PAPER

Participatory rural appraisal in smallholder dairy systems in Tunisia

J. Rekhis · F. Saaidane · M. Laamouri · K. Ben Hamida · W. Mabrouk · N. Slimane

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Abstract Participatory Rural Appraisal (PRA) was carried out by a multidisciplinary team on a total of 60 smallholder dairy farms in three different geographical areas of Tunisia. Farms with less than three cows were excluded. Those participating had between three and 10 cows. Average milk production ranged between 8 and 32 litres per cow per day. 70% or over of milk produced was sold off the farms. Average inter-calving intervals — measured from month of calving only — ranged from 12.9 months to 19. Age at first calving varied from two to nearly three years. Most work was done by the families. PRA revealed that the farmers in all three regions perceived unbalanced nutrition, which included availability of forages, to be the most important constraint, followed by poor reproductive efficiency. Reseeding with new species was instituted for grazing and hay. Farmers from the different regions were taken on exchange visits to see how these approaches worked. Training in reproductive management and milking hygiene was introduced. Seasonal ration formulation depending on local forage analysis was instituted. Two farms are participating in a programme of evaluation of olive oil extraction by-product as a ruminant feed. Partial budget analysis of these interventions will be carried out.

Keywords Dairy cattle · Nutrition · Participatory rural appraisal · Reproduction · Small farmer

Abbreviations

DM	Dry Matter
GIVLAIT	Groupement Interprofessionel de Viandes Rouges et de Lait
PRA	Participatory Rural Appraisal
UFL	Unité Fourragère Lait

Introduction

Milk production systems in Tunisia are highly dependent on the environment, the climate and the socio-economic status of farmers within a region. Milk production is largely based on smallholder family units (more than 70% of farmers have fewer than 10 dairy cattle), where milk production and income is usually low (Direction Générale des Productions Agricoles, [DGPA] 2002).

Tunisia is located in North Africa and is bordered by the Mediterranean Sea to the north and east. The country has 150,000 farmers, among its 10 million inhabitants, who own 552,000 head of dairy cattle (127,000 purebred and 425,000 local or crossbred)

J. Rekhis (✉) · W. Mabrouk · N. Slimane
Veterinary School,
2020 Sidi Thabet, Tunisia
e-mail: jrekhis@yahoo.fr

F. Saaidane · M. Laamouri · K. B. Hamida
Regional Veterinarians Sejnane (ODESYPANO),
Mahdia and El battane, Tunisia

and produced 864,000 tonnes of milk in 2004 The production average for the pure breeds is 5000 kg of milk/cow/year. However, only about half of the milk produced (483,000 tonnes in 2004) is marketed by the commercial dairy industry, while the rest is kept for home use, locally sold or processed. The calving interval is more than 400 days in some areas (Groupement Interprofessionel de Viandes Rouges et de Lait [GIVLAIT] 2005).

In order to overcome problems of low income, milk production and milk quality and high calving interval a multidisciplinary approach is required to identify the potential constraints - including animal rearing, milk marketing, and farmer expectations - and to establish the most effective subsequent technical interventions. Such an evaluation requires effective linkages between researchers, extension workers, and farmers. Among the existing methodologies, the Participatory Rural Appraisal (PRA) has been shown in many developing countries to be an excellent tool for retrieval of basal farming data and evaluating farmers' perceptions of their own problems (Devendra 2007). The PRA is a methodology for surveys where the researchers, the extension workers and the farmers interact together to identify and understand the problems encountered by the producer that restrict productivity and profitability, including the perceptions that the farmers themselves have.

The objective of this study was to implement the PRA methodology in the local dairy farming systems in Tunisia, and so propose activities to confront the problems, through on-farm research and changes in cattle management.

Materials and methods

Smallholder dairy farming in Tunisia comprises three main systems, described in Table 1. These different systems tend to be associated with different geographical regions, as they depend on climate and the amount of land owned by each farmer. The first system is largely found in the northwest of the country (NW), where rainfall tends to be highest. The other two are practiced in the northeast (NE), and east-central (EC) of southern Tunisia, respectively. Separate PRAs were held in each of these regions, in order to evaluate and compare the systems across geographic regions and to determine whether the same constraints had similar levels of importance in each area.

The goal of the PRA was to focus on dairy cattle production despite the fact that, for some farmers, milk was secondary in importance to other commodities such as sheep, chickens, rabbits, bees and fruits. Milk production was emphasized because dairy cattle provide a regular cash flow to farmers for day-to-day expenses as well as manure to fertilize crops, and because the PRA was organized as part of a Coordinated Research Project involving dairy farming sponsored by the International Atomic Energy Agency (Perera 2007).

A multidisciplinary team was formed for the application of the PRA methodology in each region. The teams were composed of two university teachers and two researchers in different livestock fields (animal husbandry, nutrition, reproduction and health) of the Veterinary School, Manouba University, three

Table 1 Characteristics of the dairy farming study sites in Tunisia for the application of the PRA methodology

Location	Nutrition base	Number of farms	Average number of dairy cows per farm (range)	Average Farm area in hectares (range)	Land type
North West (NW)	Forest and mountain grazing, concentrates	20	8 (5–10)	4.5 (1–10)	Mountain
North East (NE)	Cut and carry pasture forages, hay, straw in dry season, concentrates	20	6 (3–10)	3 (1–5)	Plain
East Central (EC)	All purchased; hay, straw, by-products, concentrates	20	5 (3–8)	2 (0–3)	Flat

regional veterinarians, three extension workers and one socio-economist. The veterinarians and the extension workers differed according to the region, but the remaining members participated in all PRAs. The veterinarians and extension workers were responsible for identifying the farmers to contribute to the PRA. Twenty farmers were chosen in each region. In general, the farmers selected were those that had a past history of good cooperation with the workers and had previously shown interest and enthusiasm in trying new ideas to help solve their own problems on the farm, where such new practices had been economically justified. Quite common in the EC area are farms with as few as a single adult cow (11% of the total farmers in the region, DGPA 2002). Those having less than three were not included in the PRA because at any time, such a farmer may sell his cow to have money for a family wedding or to solve a family financial problem.

The team prepared the guidelines for the PRA survey (Devendra 2007) and organized several village meetings with volunteer farmers prior to and during the actual PRA, in order to explain in more detail the objectives and methodology of the study. Also, during these meetings the team described to farmers and village leaders the ultimate benefits they may hope to obtain after the application of interventions for problems identified by the PRA. In addition to these primary objectives, the meetings had the purpose of collecting farm data concerning production, reproduction, health, management, and milk marketing.

The PRA consisted of three main types of field activities for data collection. The first of these activities was to gather general data from key formal institutions and organizations. Data collected included the number of farmers and cows, estimates of milk produced per cow per day (total quantity and quality recorded in some farms, in milk dealer notes or in collecting milk centres from individual calving interval data minus one week for colostrum), reproductive performance (inter-calving intervals recorded from data of month of calving only), artificial insemination (AI) network details, grazing/feeding strategies, local calendar for vaccination programmes and main diseases with detailed information about each disease.

In the second activity, the researchers performing the PRA travelled to each farm and gathered data first-hand through direct observation. This step of data collection included both visual inspections of the farm, its animals and facilities, and informal discussions with the farmers during the farm tours. These visits allowed the PRA team to have some indication of the general health of the cattle during lactation, including body condition scores; livestock housing systems - including access to feed and water, the rations and feeding strategies employed; the distribution of labour both on and off the farm and the definition of roles of different family members responsible for care of the livestock. In addition, some information about the prevalence of specific health disorders, such as mastitis, abortion, and parasitism, was collected.

The team considered a ration to be unbalanced when the farm used forages and raw materials without mineral and vitamin supplementation, when concentrate represented more than 70% of the ration dry matter due to unavailability of forages, when the ration was composed of only low quality forages such as straw because of the unavailability of concentrate for more than one week a year or when either milk fat or protein was less than 28 g per litre of milk. Poor reproductive performances were signalled when a farmer did not have one calf/cow/year.

The third activity consisted of formal interviews and discussions with of groups of farmers. One of the first procedures during these meetings was the completion of a questionnaire by the farmers in attendance. All of the members of the research team participated in the preparation of the questionnaire, contributing questions relevant to their specific fields of interest. The questionnaire used was the same for all three geographical regions. In addition, all team members were present during the first day of the survey and each was responsible for interviewing some of the farmers. During the subsequent days of the PRA meeting, other interviews were conducted primarily by the extension workers.

Interviews generated information about characteristics of the livestock populations (number and species of livestock per farm, breeds of livestock, whether a herd bull or artificial insemination was used, and rates of mortality); production data (quantities of milk produced and sold), characteristics of individual animals (age, sex, and body weight at calving, and reproductive history; labour (roles of different family members and if outside workers were employed); frequency of and reasons for calling veterinarians (body drawings were given to farmers

to indicate body areas with health problems); nutritional data (forage production or buying, identity and source of concentrates fed, by-products used, systems for feed storage); miscellaneous inputs and outputs; perceived opportunities for income improvement; availability and quality of services and constraints hindering productivity. The questionnaire was used as a guiding principle and helped to open discussion among farmers and team members. Most of the information collected regarding constraints was of a qualitative nature and, therefore, prioritization of the importance of the constraints identified was necessary.

To help in the prioritization process, the following questions were discussed about each constraint cited by the farmers:

- What is the main problem in the view of the farmers and the research team?
- Can it be solved and how in their collective view?
- A group of some of the farmers then participated in speculating whether the solution would improve milk production or reduce the cost of it, bearing in mind that the end target is to improve the income of the farmer in a simple and sustainable manner.

In addition, a team member reviewed every survey, listed the constraints for each farm, and scored the problems (e.g. number of farmers considering the same constraint). The main constraints were discussed and finally classified by team members according to their importance.

Results and discussion

Table 1 shows the basic characteristics of the farms in each of the three regions targeted by the PRA. Table 2 presents more detailed farm statistics. Most of the farms involved in the survey had fewer than 10 lactating cows. Some of the farmers held other jobs off the farm, but the prevalence of this depended upon the region (10% in the NW but 75% in the EC). Off-farm jobs included administration work in the local government, teaching, and general labour in manufacturing. Some of the farmers (25% in the EC and a single farmer in the NW) refused to allow their daughters to work off the farm, especially in factories with long hours and relatively poor payment. So, daughters were often responsible for looking after the cows in the EC.

Table 2 Regional means (and ranges) of the primary dairy herd characteristics recorded by the PRA in three regions of Tunisia

	North West	North East	East Central
Number of adult cows	8 (5–10)	6 (3–10)	5 (3–8)
Age distribution (months) of adult cows	40 (24–71)	43 (29–80)	42 (25–81)
% cows in milk	73 (51–91)	66 (40–81)	80 (61–93)
Milk Production Litre/cow/day	17.1 (9–30)	12.3 (8–25)	19.7 (10–32)
Lactation number	2 (1–5)	2 (1–5)	3 (1–5)
Calving interval (months)	13.6 (12–20)	14.7 (12–19)	13.4 (12–17)
Age at first calving (months)	27 (24–32)	33 (24–34)	27 (25–30)
% bred by AI	33 (0–100)	25 (0–100)	60 (0–100)
Annual mortality rate (%)	5	4	5
% of milk sold off the farm	70.1 (55–100)	73.2 (61–100)	80.0 (75–100)
Body Condition Score (1–5)	3 (2–4)	3 (2–4)	3.5 (2–4)
Family labour (%)	99	89	95

The majority of the milk produced on the farms involved in the PRA was sold off the farm (Table 2). This was greater than the national average of about 55% (GIVLAIT 2005). Most of the milk produced is sold to milk dealers in the NW and NE. In the EC, a milk cooperative is operating and the milk collecting centres picked up the farm milk twice a day.

Milk production per cow in the EC is much greater than in the NE (Table 2). This is probably because farmers tend to feed more concentrates of a higher quality purchased from the cooperative (18% crude protein and 1 UFL (Unité Fourragère Lait)) net energy content per kg Dry Matter (DM) for example against 12% crude protein and 0.85 UFL net energy (Veterinary School Laboratory results). In addition to there being lower milk production, feeding of this lower quality ration was associated with lower body condition score and decreased reproductive performance of the cattle, as expressed by longer calving interval (Table 2). The NE region had farms with the longest average calving interval and highest average age at first calving.

Poor nutrition was not the only factor that seemed to be affecting reproduction, however. Farmers said that the percentage of cows successfully bred by AI is low. More than two-thirds (14/20) of NW farmers and half of NE and EC farmers reported dissatisfaction with their local AI services (unskilled technicians, low semen quality, long distances and difficult roads between AI centres and some farms). Oestrus detection may be a problem as a change in cow behaviour noticed by the farmer's wife only during the day is usually the only method. 70% of farmers using AI did so only for the first insemination and then used natural service for all cows that did not conceive. For these reasons, the proportion of cattle bred by AI in the NW and NE was much smaller than in the EC (Table 2). In each village in the NW, a single farmer kept a bull to be used by the neighbours for breeding their cows as needed. Each bull is kept in service for three years. The standard price for breeding a cow in this system is 4 US$ per insemination. For comparison, a single breeding by AI costs 5 US$ in this NW region. In contrast, in the EC, the AI technician receives a lump sum of 25 US$ per pregnant cow from farmers included in the cooperative.

A summary of the problems and constraints faced by the farmers is shown in Table 3 for each of the three regions. The same problems were generally judged the most important in all three regions. For example, unbalanced ration was the most commonly indicated problem in all regions. Low reproductive performance was also very important in all regions, ranking second in the NW and EC and third in the NE. The regions had a different geographical background (Table 1). For this reason probably, perceptions about constraints for the NW differed more from the other two regions that the NE and EC did from each other. For example, milk quality and marketing and availability of concentrates were more important constraints in the NW, possibly due to the mountainous conditions and poor roads. With relatively poor availability of concentrates and more parasitic disease problems, low production was also considered a greater constraint in this region. One the other hand, the mountainous terrain in the NW seemingly had a moderating effect on the weather, as heat stress was considered much less of a problem than in the NE and EC.

Table 3 The percentage of 20 farmers in each of the three farming areas of Tunisia who identified specific constraints to milk production

Constraint	North West	North East	East Central
Unbalanced rations	81	70	72
Low reproductive performance	71	60	65
Low availability of forages	49	63	61
Milk quality and marketing	64	41	52
Heat stress in summer	9	32	50
Low milk production per cow	66	40	41
Parasitic diseases	34	23	28
Availability of concentrates	24	7	14
Unreliability of national prophylaxis programme	19	9	12

The PRA questionnaires showed that reasons underlying the different constraints of particular importance were the following:

- Unbalanced ration: Most farmers use the most readily available and cheapest feeds without considering their nutritional value. In some areas, grazing is conducted in existing degraded prairies (NW) and animals are supplemented with small quantities of concentrates of low quality (NE).
- Low reproductive performance: The main cause of this problem is probably female subfertility. Many of the cows remain in a state of anoestrus for months after calving because of poor nutrition (GIVLAIT 2005). In addition, calving interval exceeds 15 months in some farms because oestrus detection is poor, quality of semen is low or a bull is not available when the cow is in heat. Furthermore, checks for pregnancy are often not performed and, with poor heat detection, normally cycling cattle can remain unbred for months. For the farmers, poor reliability of the AI network and low experience of some AI technicians were also said to be a major factor affecting reproductive performance.
- Low availability of forage and concentrate: The use of irrigation for production of animal feedstuffs is very limited in Tunisia and, therefore, forage production is highly weather dependent. In dry seasons and dry years, prairies are overgrazed and stored forages become expensive; so the cost of energy coming from forages becomes higher than from concentrates. In addition, farmers often use low quality concentrate because good quality concentrates are not available or are much more

expensive. The problem becomes even more complicated in summer time as heat stress decreases the voluntary food intake. When food intake potential is high, cattle can compensate somewhat for low food quality by consuming higher quantities - if available and if offered.

- Milk production: Milk yield among the farms surveyed (Table 2) was low relative to European and North American averages and also lower than the local average (GIVLAIT 2005). In the NW, some farmers have high genetic potential Holstein cows imported from the south of France where the climate is similar, but production is much lower than in France, implying that the level of nutrition is poorer in Tunisia. In the spring, high production season, milk quality often decreases and milk is often refused by collecting centres. Reasons include a decrease in concentration of milk fat, commonly observed for cattle on comparatively lush pasture, and poorer keeping quality due to a lack of cool storage facilities.
- Health problems: The major health problem reported by regional veterinarians and found in some farm records was mastitis (38% of cows per annum) but parasitism was also relevant to a certain extent (12% of cows in NW and 8% in NE), particularly infection by *Theileria* from ticks in the summer season. Some farms in the PRA were not included in the national vaccination programme.

The results from this PRA should be more precise than results from previous local surveys of smallholder farms in Tunisia (GIVLAIT 2005), because it focussed specifically on the production of milk by dairy cattle, whereas other studies considered the problems of the farmers in general. Such studies were more exhaustive but identifying the most important constraints and resolving them would be more difficult. In contrast, our study allowed for the identification of particularly common constraints for which targeted interventions could be proposed to improve farmer income.

Interventions

Generally speaking, the major problems identified in this PRA were the same for the farms in the different areas (Table 3). The specificity of the problems also allowed for more precise evaluation of the effectiveness of the interventions.

For example, nutrition was considered the major problem in all areas. The precise problem differed from one area to another, however. In the NW, the primary constraint in nutrition was related to the area and quality of the prairies. In times of low availability of grazing, forages (local straw, hay bought in the market) and by-products can be supplemented with a suitable concentrate to produce a balanced ration. The prime intervention needed in the NW was to define the best time to harvest and store conserved forages and so obtain the best combination of quality and quantity. This should allow less dependence on purchased feeds. We have recommended the planting of sulla (*Hedysarum coronarium*), a bi-year legume, in October and le bersim (*Trifolium alexandrium*), an annual legume, in September for fresh intake and *Lolium perenne*, annual grass, in October for producing hay in late April or in the beginning of May when the plant has an optimal ratio leaf to stem . The grass is dried in the sun and placed in a covered store to prevent any problems with the bad weather.

By comparison, in the EC, the farmers are used to buying most of the forages they use. Therefore, their attention is directed at monitoring the quality of the hay purchased and the proportions of concentrate and hay in the ration. In particular, during the dry season, the forage price increases significantly. Farmers in this area often consider only the net energy value of the forage (sometimes by extension analyses or more usually they assume an energy content of 0.5 UFL/kg DM of average hay). On this basis, the forage can appear a much more expensive source of energy than concentrate. Little regard is given to the important and positive aspects of forage to rumen function and feed utilization. So more concentrates and smaller quantities forage or lower quality but cheaper forage are fed and production falls. Farmers will often respond by increasing the quantity of concentrates in the ration, which can cause rumen acidosis, depression of milk fat, low production and poor reproductive performance. Changing this mindset has proven to be difficult. Interventions on forage quality are much more easily accepted by farmers in the NW, where they harvest their own forages from their land and the main intervention involves planting and controlling the harvesting time. We have recommended the purchase of greener hay even if it is more expensive. One farmer has bought 1 tonne of *Vicia sativa* hay, costing 22% more but the analysis showed 15% crude

protein and 0.7 UFL/ kg DM. (INRA France system) So it is 40% better in nutritional value.

Compared to low nutrition value hay, the introduction of Sudan grass was recommended (Moule 1980) as a green forage in the summer. However irrigation is required and it was only possible in two farms.

As a consequence of the PRA findings, these interventions have been instituted:

- Exchange of visits between farmers in the EC and the NW, with the farmers helped by extension workers, to illustrate and discuss planting of appropriate new forage crops for grazing and conservation.
- Education meetings for farmers on milking hygiene - udder preparation, fore milk check, on oestrus detection - observation four times a day, noting of vulval and behaviour changes, and on data recording - keeping a diary, notebook or blackboard and recording all reproductive events such as calving, oestrus and insemination.
- Ration reformulation for each season - autumn, winter, spring and summer - with the change of climate and forage resources. A sample of the forage available for each new season was collected and analysed free of charge in the Veterinary Nutrition Laboratory. Using locally available ingredients, such as beans, barley grains and wheat hulls and mineral and vitamin supplements, a ration was formulated to provide the nutritional needs of maintenance with 1 kg of concentrate for every 2.25 litres of milk produced. (INRA 1987) Partial budgeting was used to check the economic viability of the approach.
- Evaluation of olive oil extraction by-product as a ruminant feed: Two farms in the EC have been using the remnants of the skin and flesh of olives after oil extraction as 15% of the concentrate. It is a raw material available from the middle of November for 4–5 months. Its nutritional value is similar to wheat straw (analysed in Veterinary laboratory) especially if there is residual fat in it but it is four times cheaper. Its problem is it cannot be stored and it must be eaten fresh to prevent the oxidation of residual fat which can be as high as 9%. of DM (Chabouni 1984).
- Reseeding practices for home grown forages: Five farms in the NW introduced a legume (*Hedysarum coronarium*) and new grass seed into the pasture. An assessment is planned of the effect by partial budgeting and by simple comparison with similar farms where the seed was not used. Silage-making was tried in one farm but it was expensive because of the low quantity produced and the necessity for renting a truck.
- Sudan grass was introduced on two farms as a green summer grazing in EC and in NW in irrigated areas.
- Progesterone testing to help early pregnancy diagnosis and early resolution of any reproductive problem: On two farms in the NW region, milk samples were collected at strategic times in the reproductive cycle of 11 cows and sent for analysis for progesterone content. The aim is to increase the understanding of those farmers of the reproductive cycle of their cows and to provide early negative pregnancy diagnosis.
- To improve AI results in the NW, the Office Sylvo-Pastoral du Nord Ouest (ODESYPANO) council for extension and agriculture development has appointed a new experienced technician. Farmers have to pay him a symbolic sum 1 US$ for each AI.

Conclusion

PRA proved to be a useful tool in the understanding of the management systems in each of the different regions and allowed the clear identification of the main farm constraints as perceived by the farmers. The farms surveyed can be considered to be representative of typical dairy farms in the different regions of Tunisia and thus the interventions in place can generally be applied across other farms in the same region.

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