
CHARACTERIZATION OF SMALL SCALE DAIRY FARMS IN THE SOUTH-EAST OF MEXICO

*Tropical and
Subtropical
Agroecosystems*

[CARACTERIZACIÓN DE GRANJAS LECHERAS DE PEQUEÑA ESCALA EN EL SURESTE DE MÉXICO]

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SUMMARY

Mexico is one of the main importer of milk for human consumption in Latin America. The cattle systems located in the tropical regions of the country represent an alternative in order to reduce the milk imports. The structure of the production systems varies in accordance with the available resources in each locality, thus the description of their characteristics and particular problems that the owners face presents a basic step in order to propitiate their development and contribute effectively to achieve national self-sufficiency in dairy production. The present paper is part of a broader cattle systems characterization study developed in the South East of Mexico and describes the farms physical resources, animal management and performance, and farms' economic performance after two years farm's monitoring period, and discuss some of the economic, market and technical constraints that farmers face.

Key words: tropics, cattle production systems, characterization.

RESUMEN

Mexico es uno de los principales importadores de leche para consumo humano en Latin América. Los sistemas productores de leche localizados en las regiones tropicales del país representan una alternativa para reducir la importación de leche. La estructura de los sistemas de producción varía de acuerdo con los recursos disponibles in cada localidad, así, la descripción de sus características y de los problemas particulares que los productores enfrentan, representa el primer paso para la identificación de opciones de desarrollo y contribuir efectivamente para alcanzar la auto-suficiencia en productos lácteos. El presente documento es parte de un estudio de caracterización más amplio llevado a cabo en el Sureste de México y describe los recursos físicos de los ranchos, las condiciones de manejo y comportamiento animal, así como el análisis económico de los ranchos, a través de un monitoreo realizado por dos años consecutivos; además discute algunas de las limitantes económicas, de mercado y técnicas que los productores enfrentan.

Palabras clave: trópico, sistemas ganaderos productores de leche, caracterización

INTRODUCTION

Mexico faces an ever-increasing deficit of milk for domestic human consumption making it necessary to import large quantities of milk and milk products at an ever-increasing cost (Alonso, 1996). Milk powder and cheese imports between 1991-1994 increased 40.60% and 37.91% on average per annum during the period, respectively (Alonso, 1996; Gomez, Lopez, Gonzalez and Carmona, 1996).

Muñoz (1990) claimed that the tropics offer a broad potential for achieving national self-sufficiency in dairy production, but development of the traditional cattle systems (other than specialised dairy systems) is required to achieve this objective.

Specialised dairy systems are located mainly in the temperate areas of the country, contributing 56 % of the total milk production. Cattle systems oriented to milk production in the lowlands tropics (0-1000 m.a.s.l.; Sere and Vaccaro, 1985) are characterized by seasonal milk production (Muñoz, 1990), contributing 40-44% of the total milk production (Muñoz and Odermatt, 1992). This type of mixed traditional cattle production system are known as Dual-Purpose cattle systems along Latin America (Sere and Vaccaro, 1985) where the characteristics of the productive structure are a reflection of the production resources available (Sarmiento, Quijandria, Gonzalez, Hart, Solano, de Patta, Borel, Perez and Pinzon, 1983; Berry, 1985).

Due to the variety of farm production resources according to the current circumstances (e.i. physical,

animal and economic resources, and market prices of inputs and outputs) and the farmer's objectives to production, a wide range of DP cattle production systems can be identified (Wadsworth, 1995). Under these circumstances, system's characterization represents a basic step to identify particular needs and constraints for development.

The following is part of a broader DP cattle systems characterization study in the South East of Mexico. This paper describes the DP farms physical resources, animal management and performance; and discuss some of the economic, market and technical constraints that farmers face.

MATERIAL AND METHODS

Location of the study

The study was undertaken from January, 1991, to December, 1992, in the State of Yucatan, Mexico. Yucatan lies geographically between 19° 29' and 21° 37' North and 90° 25' West (see Fig. 1). The climate of the region is classified as subhumid tropics (AwO) with the main rainfall from June to September and annual average rainfall of 1,100 mm. Annual average temperature is 28° C and relative humidity around 78%. The soil varies from 0 to 25 cm in depth with 20% limestone and 60% stones (Duch, 1988). In relation to the topography, the state of Yucatan is a plain and lightly rippled in all-around the territory.

Description of the research process

The methodology employed in the study was adapted from the farming systems methodology as described by Shaner, Philipp and Schmehl (1982).

Sites and farm selection

The State of Yucatan is traditionally divided into three different economic zones: Central (CZ), East (EZ) and South (SZ). Local government use this classification as basis for planning. The same zones were used as working zones for the present study.

Participating farms were selected through a random lottery based on a list of the farmers delivering milk at the initial time of the study in each collection center located in the ES and SZ, until to identify 20% of the total farmers for participation in the research process. Participating farms in the CZ represents the total number of DP farms located there; then no selection in fact was done.

Data collection and analysis

The basic methodology was monitoring of each farm on a monthly basis. A range of methods were used for data

collection. These included questionnaires, direct measurement, observation and informal interviews. Animal feeding scheme and inventory, farm outputs and inputs, diseases and some of the farming activities were registered following a structured questionnaire. While information from direct observation of mastitis diagnosis and grazing paddocks pasture cover, evaluation of the calves rearing method and individual milk offtake were registered on a recording sheet at each monthly visit for all milking cows on each particular farm. Reproductive performance (births, abortions, mating and services) was recorded using individual cards, from which reproductive parameters were calculated (eg. calving interval). In this way lactation events, like initial and finishing milking date, were also registered.

Informal interviews following a semi-structured questionnaire were conducted to obtain information on farm's historical background and farmers objectives to production.

Several databases were constructed (i.e., monthly animal feeding scheme, monthly animal inventory) using the PANACEA (PanLivestock, 1989) software. Data were analyzed using descriptive statistics mainly.

The following equations were utilized to estimate animal performance variables:

- a) Length of dry period (LDP)
LDP= (actual parturition date – previous lactation last milking date)
- b) Lactation length (LL)
LL= (last milking date – first milking day of actual lactation)
- c) Lactation milk yield (LMY)
LMY= (DMO1 + DMO2 +DMO x)
where:
DMO1= Daily milk offtake in the first milking day of actual lactation
DMO2= Daily milk offtake in the second milking day of actual lactation
DMOx= Daily milk offtake in the last milking day of actual lactation
- d) Calving interval (CI)
CI= (Parturition date 2 (actual) – parturition date 1 (previous))

Calving, herd mortality and replacement rate were estimated as described below:

- a) Calving rate (CR) = Average proportion between 1991 and 1992 of the recorded calving events, estimated from the monthly average number of adult females along each year.

- b) Herd mortality rate (MR)= Average proportion between 1991 and 1992 of the recorded mortality events, estimated from the monthly average number of total animals in the herd along each year.
- c) Annual cows culled (ACCR)/replacement rate= Average proportion between 1991 and 1992 of the recorded culled/replacement events, estimated from the monthly average number of adult females along each year.

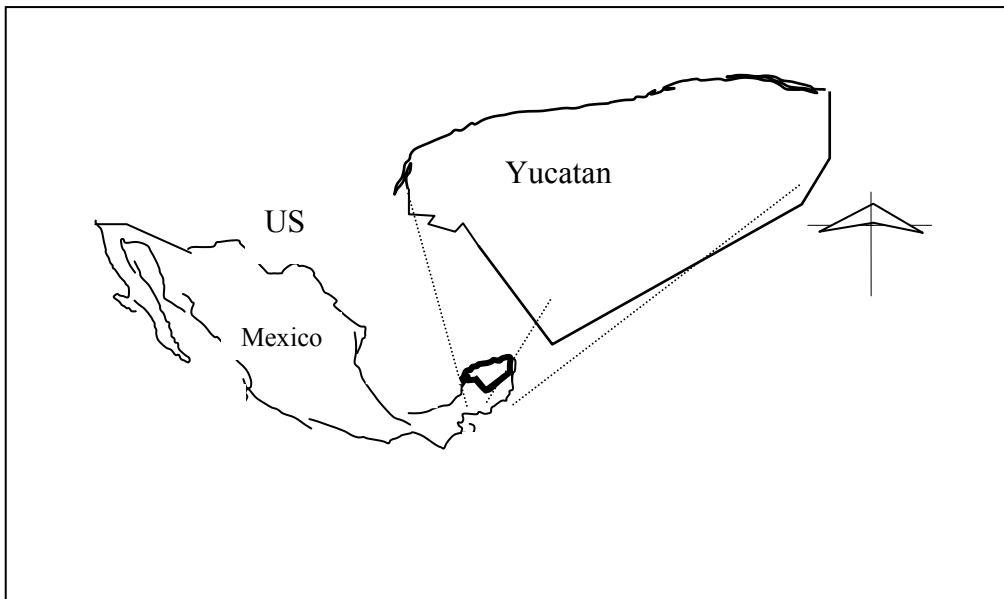


Figure 1. Location of the area of study

Estimation of farm economic performance

A structured questionnaire was monthly used to collect financial data contained 60 categories of farms' operating costs and income.

Data has been analysed by farm on an annual basis. The starting date of analysed period varied between surveyed zones according to the period when most complete and reliable information from the farms was obtained. These periods per zone were adjusted so as to be the closest possible in order to facilitate comparisons.

The approach used to evaluate farm economic performance follows the methodology for cost-benefit analysis described by Barnard and Nix (1988), whereby the key costs and sources of income are selected that most clearly describe the farmer's current economic situation on basis of farming activities only.

Gross margin (GM) per farm is used as indicator to evaluate farm economic performance. Gross margin in

the present case is defined in two ways: a) as total income in cash (milk and beef sales) less total operating costs, named as GM in cash subsequently, and b) as total income in cash and plus or minus the changes between the initial and final valuation of the animal inventory total operating costs, named here total gross margin (TGM) in order to differentiate it from GM.

Gross margin is separated in to GM and TGM as described above with the objective of analysing two different situations: a) the current cash income received by the farmer and his family, and b) to evaluate if the cash income is derived from animal stock sales or from actual farming activities.

No fixed costs, such as depreciation of infrastructure and equipment, nor rent for land, nor cow's replacement cost, were included in the analysis. The reasons for this were:

a) when depreciation, rent for land, replacement cost are inputted at market prices in the economic analysis of DP farms, frequently the result gives negative values and produce sub-estimates of the farm success,

b) in some cases farm infrastructure had already been discounted with the use or obtained as part of government support without any cost to the farmer; or, as in most cases, corrals and milking parlours were simple and built using farm natural resources, and equipment was very scarce,

c) added to this, it was the intention to estimate the farm economic performance following the farmers' logic in the identification of the most relevant costs attached to farm activities, whereby by the cited fixed costs were never taken into account.

Estimation of operating costs

Feed costs: included concentrates, minerals, by-products (i.e. poultry litter, malt, molasses), each costed monthly at the respective market price.

Labour costs: Labour costs per farm were calculated as the product of the number of full time workers at the time of the monthly visit multiplied by the basic daily salary paid. Family labour (the farmer and his sons) was excluded from the labour cost and analysed after GM over operating costs was estimated.

Family labour benefit is assessed using the ratio between GM and the amount of man-days spent by the farmer's family. This was estimated counting the number of days that the farmer and sons worked on the farm during the year. The ratio GM/man-day family labour assumes that the farm earnings were distributed equitably.

Maintenance of grazing area: Hired labour, contracts and appliances required to provide maintenance to the grazing areas were allocated under this heading. Main activities are related to fencing repairs, grass sowing, and, in East and South zones, the cutting and burning of paddocks.

Fuel and lubricants: These included the monthly fuel and lubricants expenses for farming activities, and transportation and/or produce commercialisation.

Other costs: Cost of medicines and vaccines for worming and tick control, and other small expenses were accounted for under this heading.

Estimation of Income from milk and beef: Income from milk was calculated as monthly yield per farm multiplied by the farm gate price at each visit. Income from beef was calculated from the monthly animal sales

(calves, heifers, culled cows) at the respective sale price per kg or per head.

Estimation of the change of valuation of the animal inventory: Initial and final herd valuations were carried out using mean livestock prices during the accounting period. Animal purchases were subtracted from the balance between the initial and final animal inventory in order to evaluate the changes due to production (Avila, Salinas, Chavez, Quiel, Soto, Li Pun, de La Torre and Pezo, 1983).

RESULTS

Farms' evolution and land use

Table 1 shown descriptive statistics of farm size and land use per zone. All the surveyed farms in the Central Zone (CZ) had 10 ha. The farms had a uniform size because they were initiated during a government programme in 1987. The farmers had originally owned farms inside Merida, the capital city of the State of Yucatan, but as the city grew, the farms were surrounded by houses. People's disagreement and contamination problems due to excrement disposal led to the Government's decision to relocate the farms out of the city.

Farmers in the East (EZ) and South Zone (SZ) were initially working in crop production, mainly maize and beans. All farmers had started the farm with their own resources, progressively accumulating capital to begin cattle production. Although beef was the main cattle product, new markets for milk led to the development of DP cattle production systems.

Farms in the CZ were on low quality litosol soils. The main land use was the production of Taiwan grass (*P. purpureum* cr. Taiwan), as forage, and African Star grass (*Cynodon* spp.) for grazing.

Farms in the East Zone (EZ) and South Zone were located on a complex of rendzin, cambisol and luvisol soils. Guinea grass (*P. maximun*) occupied the highest proportion of the grazing area in both zones. Small areas of African Star grass (*Cynodon* spp.) were sown mainly to graze calves. Taiwan grass (*P. purpureum* cr. Taiwan) was the main source of cut-and-carry forage in both cases; additionally, some farms in the SZ had sugar cane (*Saccharum officinarum*) as source of forage also. A small area of land for crops was found in two farms in the EZ only.

Table 1. Descriptive statistics of farm size and land use per zone

	Zone								
	Central			East			South		
	n	Mean \pm sd	range	n	Mean \pm sd	range	n	Mean \pm sd	range
Farm size	10	10.0 \pm 0.0	0.0	10	62.7 \pm 7.5	30.0-120.0	5	52.4 \pm 24.3	20.0-80.0
Land use:									
Scrubland	4	1.9 \pm 2.9	0.0-7.0	6	9.6 \pm 11.9	0.0-33.5	4	25.2 \pm 27.6	2.0-60.0
Cut and carry forage	5	3.7 \pm 1.5	2.0-5.5	8	1.45 \pm 0.5	0.5-2.0	2	6.5 \pm 2.1	5.0-8.0
Grazing area	5	4.4 \pm 2.1	1.0-7.0	10	50.9 \pm 18.6	25.0-85.0	5	23.2 \pm 13.9	8.0-45
Crops (maize, beans)	--	--	--	2	0.8 \pm 1.68	0.0-4.0	--	--	--

Animal inventory and stocking rate

Average herd size in the CZ was 21 ± 12 , ranked from 15 to 93 animals. The smaller herds had less cultivated land for pastures and more scrubland area than largest herds. 3.4 LU/ha was the global average stocking rate (SR). Largest herds were found in the EZ and SZ (35 ± 22 and 30 ± 4 average herd size, respectively). Global average SR in the EZ was 0.94 LU/ha and 1.03 LU/ha for the SZ.

The proportions of the animal categories did not show much variation across the monitoring period in all the zones, suggesting that farmers were adjusting stock numbers continuously. Weaned male calves had the lowest values because they were sold as soon as possible after weaning. Young females were kept as replacement when possible.

Animal management

Table 2 describes the proportion of cow genotypes and the general animal feeding schemes and, calf and milking management.

The main animal genotypes were crosses between *Bos indicus* (BI) and *Bos taurus* (BT) cattle. Brahman, Nelore and Indobrasil BI breeds, and Brown Swiss, Holstein, Jersey and Simmental BT breeds were the most frequently found. Several animal genotypes, including pure breeds, were found according to different breed combinations. Genetic groups were classed as BI, BIxBT and BTxBT, the last group also included some BT breeds. Proportion of the genetic groups into the herd varied between zones, being most frequently found in the CZ the use of milking cows with high level of BT genes (see Table 2). BI cows were most commonly used for milking in farms located in the SZ than farms located in the other zones. Specific crossbreeding plans did not exist anywhere.

Animal feeding in the CZ was based on grazing and cut-and-carry forage, while in the EZ and SZ was based on grazing only. Both pasture and scrubland areas were used for grazing anywhere.

In the CZ, supplementary animal feeding was an important part of the total diet for all the animal categories. It was mainly based on concentrates and agroindustrial by-products. Farmers made a combination of concentrates and by-products to supplement the animals. Amount of supplements combined in the total diet depend on the cost of each supplement and its seasonal availability. Supplementary animal feeding was not commonly found in farms located in the EZ and SZ.

Milking cows were supplemented as a priority followed by suckling cows. Farms in the EZ where steers were fattened had this animal category as second priority for feed supplementation.

Taiwan grass utilisation stopped during the rains due to pasture availability in grazing areas (grassland and scrubland). Taiwan grass was an important source of forage during the dry season (December to June). However not all the farmers had the opportunity to do this because it depended upon the area sown. No forage conservation was.

It was a common practice to milk the cows once a day. Only one farm in the CZ was found milking the cows twice a day. Cows were milked by hand.

There were a number of combinations of calf/cow handling to stimulate milk let down. The milking routine might start allowing cow-calf visual contact only, or allowing the calf to suckle some or all of the teats for few minutes before milking. If milk let-down ceased during milking but the milker suspect that more milk could be obtained, the calf was allowed to suckle again for few minutes to re-stimulate milk let-down. After milking, the cow and calf were left together, often in a corral with no feed for between 2 to 6 hours, prior to being separated and taken to their respective paddocks where they remained until the next day. Often farmers left the calf one unmilked quarter, specially during the first 2-3 months post-calving. After that cows were milked out completely and calves were allowed to suckle residual milk only.

The same milking/calf-suckling management pattern was found across zones, with variations on milking/suckling time per day and along lactation according to the farmer's decision based on a

combination of several animal characteristics (calving number, season, calf sex and/or genotype, cow's genotype). In the SZ cows were milked every two days.

Table 2. Animal genotypes and management on DP farms by zone

	Central zone	East zone	South zone
Average herd size*	21 ± 12	35 ± 22	30 ± 4
Proportion of milking cows genotypes:			
BT	72.67	2.97	6.0
BTxBI	26.74	89.43	71.0
BI	0.59	7.60	23.0
Feeding management	Basal diet on purchased supplements and cut-and-carry forages and grazing as complement. Concentrates are priority used to feed milking cows.	Grazing of Guinea grass. Occasional use of feed supplements (dry season) and use of cut- and-carry forages when available. Milking cows are the priority for supplementation and growing steers when fattening to slaughter is also an objective of production	Grazing of Guinea grass. Very occasional use of feed supplements
Milking/calves rearing management	By hand once a day. Occasionally twice a day. Four teats fully milked. Residual milk for the calves. Milk offtake period was around 10 m milking the cows continuously until the end of lactation when calves were also weaned.	By hand once a day. 3-4 teats no fully milked. Residual milk for calves. Milk offtake period was around 7-8 m milking the cow continuously during this period. Some calves could continue suckling for a time after milk offtake period stops.	By hand once a day. 2-3 teats no fully milked. Residual milk for calves. Rotation of lactating cows for milking every two days. Some calves could continue suckling for a time after milk offtake period stops. Milk offtake period was less than 5 m with shifting periods of milking for some cows. Calves could continue suckling for a time after milk offtake period stops.

* Adult cows only

Animal performance

Table 3 shows some of the productive parameters. It was impossible to establish an animal performance recording scheme on farms located in the SZ owing to lack of farmer collaboration in this respect.

Services and communication

Table 4 shown services and communications available to farms in the CZ, EZ and SZ. DP farms in the central zone were located close to an urban centre, where the main customers were "raw milk" consumers. Although milk collection centres were available, the milk price paid was low in relation to farm operating costs.

Domestic milk sales were important, to obtain better milk prices and to support farm operating costs. Farmers spent much of their time selling milk, as it was extremely important for farm income. Hence, very little time was available for other farm activities, for example, those related to land cultivation.

Farmers in the east and south zone sold milk to the collection centers or to local cheese processing plants. Owing to the reduced alternatives for milk commercialisation, farmers were always exposed to the milk price and payment conditions of the buyers. In fact, low milk prices and delayed payments were some of the main problems that these farmers faced during the monitoring period.

Table 3. Productive parameters of DP farms located in the central, east and south zone of Yucatan (means \pm sd)

Productive parameter	n	Zone				
		Central	n	East	n	South
Lactation length (days)	208	330 \pm 106	288	187 \pm 96	ne	Ne
Length of dry period (days)	208	79 \pm 42	288	148 \pm 87	ne	Ne
Lactation milk yield (l)	208	1917 \pm 964	288	1016 \pm 625	ne	Ne
Daily milk offtake/cow (l)	1920	6.58 \pm 3.0	1684	5.68 \pm 2.31	493	3.07 \pm 1.7
Calving Interval (days)	208	426 \pm 81	288	383 \pm 64	ne	Ne
Calving rate (%)	--	83.82	--	74	--	Ne
Herd mortality rate (%)	--	0.64	--	0.89	--	1.25
Annual cows culled rate (%)	--	7.06	--	21.36	--	Ne
Annual replacement rate (%)	--	14.13	--	19.45	--	Ne

ne= Not estimated because data were unavailable

Table 4. Availability of services and communications in the Central, East and South Zone

	Central zone	East zone	South zone
-Electricity	Available	Not available	Not available
-Roads	Good	Good	Good
-Tech.Assist.	Absent	Absent	Absent
- Farm outputs marketing:			
Milk	Domestic selling	Collection centers and local milk processing plants	Collection centers
Beef	At farm gate	Village market	At farm gate

Farms' economic performance

Table 5 shows means of each operating cost for farms in the central, east and south zone. Farms in the central zone incurred 62.3 % of the total operating cost in feed inputs. There are two reasons for this: a) herds relied less on pasture-based systems, b) farmers fed milking cows with more concentrate feed with the objective of producing more milk/cow/day. In the east and south zone expenses related to maintenance of grazing areas were the main farm operating cost.

Fuel and lubricant consumption in the central and east zone were the next most important operating cost followed by fixed labour. In the south zone this was

reversed. In the central zone fuel and lubricant expenses included those used for milk commercialisation which was done house to house, and in the east zone this cost included farmer transportation and the movement of water pumps and irrigation systems. Farmers in the South zone used motorcycles by preference and only one had an irrigation system.

Farmers in the central zone had much greater opportunities to purchase and select animal feed supplements and at better prices than farmers in the east and south zone who were subjected to the feed inputs availability in the village and at prices determined by the middlemen.

Table 5. Operating costs and income from milk and animals sales in the central, east and south zone (means and sd).

	Central zone	East zone	South zone
Operating Costs:			
Feeds	21599 ± 12743	6389 ± 7852	225 ± 347
Paddock maintenance	847 ± 638	13253 ± 6241	3988 ± 4239
Fuel and lubricants	6177 ± 3499	4225 ± 2969	1006 ± 1226
Fixed labour	2310 ± 330	1338 ± 1708	2620 ± 2628
Other costs	3734 ± 2818	6434 ± 4257	1886 ± 684
Income from:			
Milk sales	17793 ± 4708	13833 ± 14457	5207 ± 4359
Animal sales	14463 ± 9925	67685 ± 74964	12994 ± 7726

Note: all values are in Mexican Pesos (MP); Sterling pound exchange rate: 1 Sterling pound per 5 MP.

Farmers in the central zone sold raw milk directly to consumers with the intention of obtaining a better price. Average sale price between farms during the accounting period was around 1.4 MP/lit. Farmers spent a lot of time selling milk door to door.

In the east zone farmers had several milk marketing channels; the local collection point of the government's cheese processing factory, and a small cheese processing and a milk pasteurising factory both located in the village near the farms. In the south zone milk was only sold to the government's cheese processing factory collection point located in the village. No other options were available. The selling of milk to consumers was not practised in either east or south zones and the average milk price during the accounting period was 0.85 MP/l for both zones.

Animal sales were by preference through middlemen in all the zones. Although in the east zone a good infrastructure for beef marketing existed, DP farmers had limited access to this service, being dominated by the beef producers association which developed it. Table 6 shows the proportion of income from the sale of milk and cattle in the respective zones.

The contribution of cattle and milk sales to farm income in the central zone are almost similar. Whereas cattle sales were the main source of income in the east and south zones.

Average beef:milk price ratio varied according to animal category. Taking the sale price of weaned male calves per kg liveweight as the basis, the estimated beef:milk ratio in the central zone was around 2.5:1, compared to 4.1:1 in the east and south zones.

Table 6. Proportion of the farm income from milk and cattle sales in the central, east and south zone

Zone	Proportion (%):	
	Milk	Cattle
Central	55.16	44.83
East	16.96	83.03
South	25.13	74.86

Comparison of GM between zones

GM by farm and zone is shown in Table 7. Wide variation in GM existed between farms within zone. Although fixed labour was an important operating cost for the farm economy, all cases show the importance of family labour used for farm activities. In most cases it was the farmers' sons or sons-in-law who worked on the farm.

The average minimum legal wage during the study period was around 12.5 MP. Farmers paid their workers 15.0 MP per day on average in all the zones. As it can be seen in Table 7 (column 1/3), the distribution of cash earned per day worked by the family, only 3 farmers in the central zone and 7 in the east zone earned above the minimum daily wage and none of the farmers in the south zone earned the minimum daily salary.

The economic situation became worse for some farms when GM was analysed including positive or negative changes in the valuation of the animal inventory (Total GM; see Table 7, Column 2/3). Farms in the central zone

stayed without relevant changes. In most of the cases in the east zone a reduction in the TGM from GM value was seen. Following the analysis on the basis of the minimum daily salary as described above, only 3 farmers in this zone earned above the minimum daily salary and

one of them had negative earnings. Furthermore, only one case was found of an increment between GM to TGM, meaning that the valuation of animal inventory in DP farms in the east zone in general decreased.

Table 7. GM in cash and Total GM of DP cattle farms: analysis of family earning distribution in three zones of Yucatan

Zone	GM in cash ¹	Total GM ²	Family labour (man day)	1/3	2/3
Central	22535 ± 18887	23617 ± 22759	986 ± 176	20.96 ± 12.57	21.92 ± 16.23
East	49659 ± 75547	11182 ± 19951	1175 ± 266	39.81 ± 52.97	8.88 ± 14.74
South	8467 ± 10977	Ne	1193 ± 421	8.7 ± 7.21	ne

Note: all values are in MP. 1) GM estimated from cash expenses-income; 2) GM estimated from cash expenses-income +/- valuation of the initial-final animal inventory balance; 3) Man-day of family labour. ne= no estimated; Total GM in the South Zone was not estimated because annual animal inventory data was incomplete.

DISCUSSION

Farm characterisation suggests that DP production systems were managed different between zones. Differences in soils, farm/herd size, herd genotype composition, water resources, products/inputs marketing channels and farmers' background were important determinants in the orientation of land use, animal management and farmer production objectives between zones.

Farms' evolution and land use

Farmers appear to have adapted the production structure and stated objectives according to the particular circumstances in each zone.

Thus, farmers in the CZ had production systems based on the use of purchased feeds and were most oriented to milk production, whilst farmers in the EZ and SZ were oriented to milk/beef production based on grazing with little use of supplements. Farmers in the SZ placed more emphasis on beef production than those in the EZ. Plasse (1992) categorised similar DP systems based on the importance of farm outputs for Venezuelan DP farms.

Although farmers in the CZ had the possibility to produce grass/forage on-farm, looking for feed self-sufficiency, they put little emphasis on this. Several overlapping reasons for this can be deduced. The first is related to farmers' objective of production. Focused on milk yield, the farmers' believed that their 'old' production systems were 'intensive dairy systems'. High milk yield per cow was the main objective to achieve farm profitability. This objective remained important, and they were aware that it was not possible to achieve

on basis of a forage diet only. Secondly, traditionally farmers purchased all the feeding inputs required. Production systems have evolved without the integration of any kind of crop/forage on-farm production. Thirdly, to some farmers the farm had secondary economic importance (more than 50% of the farmers had another business with greater relative economic importance), hence these farmers were not interested in spending money to develop farm feed resources, and being at the same time, an important limiting factor for promoting farm development.

DP farms in the EZ had evolved from the traditional '*milpa*' system (itinerant maize) to become cattle systems. Owing to the decline in maize/beans prices, an intense government cattle programme was developed in this zone during the 1960s. The present DP farmers were previously involved in beef production having changed land-use gradually from the '*milpa*' system to grass production. They have been involved in DP systems now for more than 20 years.

A similar situation occurred with farmers in the SZ. They moved from crop production (sugar cane and horticulture, mainly) to cattle systems (originally orientated to beef production) much more suddenly than farmers in the EZ. Cattle systems have been orientated more towards milk production since around the mid 1980s, when a State Government Milk Development Programme started.

Thus, farmers in the CZ and EZ had more technical knowledge of managing cattle production than farmers in the SZ. However, farmers in the EZ and SZ had much more experience in land cultivation than farmers in the CZ. These are distinctive features which contribute to an

understanding of the differences in DP farms between zones. They are also important to keep in mind when suggestions for farm improvements are made.

Animal management

Animal management practices reflected farmers' production objectives, the animal genotypes and the resources available in the different zones.

Milking cows rotational offtake (eg. milking every other day) was a special characteristic of some farms in the SZ, whereas all the milking cows were milked daily in the other zones. This was an example of the DP systems' adaptation to particular conditions of production. There were several overlapping reasons to explain this particular situation. One of these reasons was related to the feeding resources available. Farms in the SZ had less feeding resources than other zones. Another reason was the predominance of BI or high percentage BI crossbred cows in the herd which had reduced daily milk offtake. Hence, farmers preferred to milk the cows every other day, thus dedicating more of the milk to the calves.

Milking manipulation (i.e. varying the number of teats milked per day across the lactation, according to season or cow's age) was also used by the farmers on an everyday basis to obtain better cow and suckling calf performance.

Suckling calf growth was an important productive issue to all farmers. But, in relation to feeding, due to economic constraints, priority was given to cow's (milking cows especially), and nutrition in terms of frequency of supplementary feeding across the year.

Animal performance

The performance of crossbreds under commercial farm management conditions has rarely been reported. The few papers identified in this respect will be cited here to get an idea of the relative situation of surveyed farms.

Milk yield, lactation length and dry period

Daily milk offtake (DMO) varied widely between zones and between farms within zone. Although feeding regimes and the predominance of BT cows in the CZ favoured DMO, the average here was not much greater than in the EZ.

Villegas and Roman (1986) shown an average of 5.74 l DMO for commercial herds with diverse cow genotypes located in Veracruz, Mexico, where animal feeding was based on grazing of Guinea grass (*P. maximum*) and African Star grass (*C. plectostachyus*) mainly and some supplementation with concentrates.

Roman and Roman (1981) report 4.5 l DMO estimated from a commercial farm located in Veracruz, Mexico, where cattle with diverse genotypes were kept, grazing Guinea grass (*P. maximum*) without supplementation. De Alba and Kennedy (1994) report an average of 4.01 l DMO under grazing conditions in the south of Tamaulipas, Mexico. These average DMO values are below those found in the EZ where the cattle were kept under similar conditions, and above the average DMO found in the south zone.

Portugal, Garza, de Leon and Molina (1981) report that average DMO of BTxBI crossbred cattle grazing on Pangola grass (*Digitaria decumbens*) associated with *Leucaena* (*Leucaena* spp.) was 8.04 l and 7.33 l grazing Pangola grass only. Hence DMO can be increased by improving the quality of a forage based diet.

Lactation milk yield (LMY) also showed large variation between zones and between farms within zone. Several non-genetic factors affect the LMY; year, season, cow's age, number of milkings per day, number of teats milked and calf rearing system and supplementary feeding (Verde, Vaccaro and Vaccaro, 1992). In the present case LMY was affected by the farmers' decision on lactation length (LL). LL was decided on a per cow basis. Longest lactations were found in farms in the central zone, where cow fertility problems and farmers' need to produce milk and avoid the loss of any cow lactation day were important factors. Cows with delayed re-conception were milked longest. In the EZ, LL was not prolonged more than 8 months, the average being around 7 months. LL coincided with calf weaning. Similar management was found in farms in the SZ.

Farmers in the CZ tried to maintain the length of cow's dry period (LDP) at 2 months to provide a sufficient resting period. Longest LDPs in the EZ were due to foreshortened lactations. No comparable information on these parameters was found in the literature.

Calving interval

Estimated calving interval in central zone (426 ± 81) was found to be lower than values reported by Villegas and Roman (1986) (481 days) where calvings occurred during the dry season, by Roman, Hernandez and Castillo (1983) (461 days) and by Wilkins, Pereyra, Ali and Agola (1979) (480 days) where F1 HOxCreole cattle were kept on grazing based systems without supplementation. Similar values were reported by Roman and Roman (1981) for crossbred animals kept on commercial farms (419 days).

The CI average value found in the EZ (383 ± 64 days) was similar to that shown by Villegas and Roman (1986) when calvings occurred during the rainy season (392 days).

All CI cited above were estimated from cows rearing their own calf with exception of those reported by Roman *et al* (1983).

Estimated CI from both central and east zones reveal good animal performance according to that reported in the literature. However, observed animal performance must be treated with caution as the data from both zones come from only one year. Villegas and Roman (1986) show strong influence of year of calving on CI.

More cow fertility problems were reported in the CZ than in the EZ. However, the highest calving rate in the CZ could be attributed to better farmer care (Wilkins *et al*, 1979). Nevertheless, estimated values from both zones were higher in relation to those reported as representative of DP cattle systems in Latin America (60-65% annual fertility rate) (Vaccaro, Vaccaro and Verde, 1992).

Mortality rate

Herd mortality was low across zones. Most data on mortality rate reported in the literature refers to specialised dairy systems and they are not comparable with the findings here. However, Wilkins *et al*, (1979), report 18.8% and 5.3% mortality rates for crossbred calves and adult cattle from farms of similar characteristics to those described here.

Farms' economic performance

DP farms had very low earnings, limiting the possibilities for investment to improve farm economic performance. This, plus the lack of available credit, meant that farmers followed different strategies of adjustments to production practices to maintain their enterprises. In the central zone farmers searched for more and better paying customers in order to offset the cost of their animal feed inputs. While in the east zone farmers often made borrowings between friends or relatives, or had part time jobs to complement the family income.

Beef:milk price ratios discouraged milk production and affected farm economy. Many farmers did not have the resources to react in the short term to changes and to adopt a new production structure with new objectives to obtain a better income, for example fattening their own male calves.

The economic situation faced by the farmers became most worrying when the number of family members and workers depending of the farming activity was examined. Farm financial status was always an important topic for discussion with farmers through the monitoring period. Their opinion was that daily cash flow was more important to the farm economy than higher returns on capital, although part of the animal

stock had to be sold to achieve it. This was particularly the way in which farmers in the east and south zone acquired cash for their own family and farm workers relatives, because they depended directly from the farm income principally.

Pasture areas were generally overgrazed due the need to maintain stocking rate (SR). In some cases farmers refused to sell animals and adjust the SR to within the farm capacity because animals represented the most important part of the working capital and savings for use during crisis situations.

Lowest economic indicators were found in the south zone. This could give an idea of the degree of DP farm development in south zone in comparison to the other zones.

However, the structure of production of the DP farms in the east and south zone could be most responsive to changes in the beef:milk price ratio, adjusting the balance of production (more beef less milk, or vice versa) in comparison with farms in the central zone. The advantage in the East and South zones is the grazing-based production systems, whereas farms in the central zone had high dependency upon purchased feed inputs.

Common constraints across zones

Although DP cattle systems showed differences between zones, they face some similar production problems/constraints. One such is feed availability during the dry season (from the middle of November to mid June). Some farmers in the CZ had areas of Taiwan grass under irrigation, but always encountered a forage shortage mid-dry season. To solve the situation farmers bought in feed.

Farmers in the CZ had most opportunity to purchase feeding inputs at better prices due to their vicinity to the state capital. The situation for farmers in the east and south zone was less fortunate. The majority of them did not have cut-and-carry forage and during the dry season grazing availability was reduced significantly. They also had less opportunity to look for and select better feed prices. They were subjected to the prices that the middlemen imposed.

Another constraint across zones was related to the supply of crossbred animals for breeding, especially sires. Farmers from time to time looked for breeding bulls with appropriate genotypes to maintain a beef:milk cattle system. The lack of breeding bulls in the region caused prices to rise and farmers often were unable to afford a favoured bull and had to accept a bull of a less desirable genotype.

Milk marketing security was another common constraint that farmers faced. As described above farmers in the CZ

looked on a daily basis for customers to pay better prices for milk. Farmers in the east and south zone were both dependent on the price and frequency of payments of the milk processing plant to whom they sold milk.

In contrast to farmers in the central and south zone, farmers in the EZ had better infrastructure for beef marketing. Although the infrastructure was built up to service beef cattle producers, DP farmers had access to the service. Hence, DP farmers had the opportunity to sell their animals at current market prices. Farmers in the other zones were always subject to animal sale conditions set by the middlemen.

Soil fertility on farms in the CZ was a major limiting factor plus farmers' lack knowledge of land cultivation. Water availability was not a limiting factor but economic support to properly manage irrigation systems was required.

Farms in the EZ had greater possibilities. Soil fertility was still low but better than in the CZ. Water was plentiful, but irrigation systems were required to improve forage production during the dry season. Electricity was not available hence the equipment had to be petrol driven.

Soils with good fertility were found in the SZ but here water was a limiting resource owing to the depth (70 m or more) at which it was found.

CONCLUSIONS

The DP production systems studied displayed different characteristics between farms and zones. Physical (soil, water resources) and socio-economic determinants combined with the particular farm's evolution, farmers' attitude to production, knowledge and his farming objectives, influence the development of these characteristics.

Despite the differences found, DP farmers also faced some similar problems/constraints to production. Milk market insecurity, low prices paid for milk produced locally, and price increments in farm inputs (feeding, sundries), were the most important external constraints to production. On-farm problems highlighted were the reduced availability of feed resources during the dry season, especially in production systems based on grazing, and, the limited availability of animal genotypes suitable to maintain a DP herd.

The farmers' attitude to production and his farming objectives mediated the influence of the environmental determinants on animal performance (e.g. variation in the number of teats milked according to season, rotation of lactating cows for milking).

Research and development programmes in animal production supported by Mexican institutions have generally suffered a lack of continuity. Decision makers view immediate rather than long-term circumstances. Additionally, when development programmes had been implemented, it is commonly found that the plan and objectives are designed without consideration of the variability of resources (physical and human resources) between farms. Due to the implications on the programmes success, decision makers must take into account farm's characteristics between zones into the planning programme.

DP farms had very low earnings, limiting the possibilities for investment to improve farm economic performance or to react in the short time to input-output marketing changes. In order to achieve farm economic improvement some adjustments could be made at the farm level (eg., identification of the 'best' proportion of beef/milk annual farm output for monitored farms in the east and south zones) and at the animal level (eg., identification of supplementary feeding strategies to achieve better returns on daily milk offtake for monitored farms in the central zone), using a minimum investment.

REFERENCES

- Alonso, P.F. 1996. Dinamica y nueva estructura de las importaciones en el sistema leche. Memorias del XX Congreso Nacional de Buiatria. Acapulco, Mexico. pp. 435-439.
- Avila, M., Salinas, H., Chavez, C., Quiel J., Soto Y., Li Pun, H.H., De La Torre, M. and Pezo, D. 1983. Diseño de sistemas alternativos de Producción Bovina de leche para el area de Turrialba, Cartago, Costa Rica. In Informe de la 3ra. Reunión de trabajo sobre Sistemas de Producción Animal Tropical Turrialba, Costa Rica (ed. M.E. Ruiz and H.H. Li Pun.), pp. 80-108.
- Barnard C.S. and Nix J.S. 1988. Farm planning and control. Second edition, Cambridge University Press, U.K. 435 p.
- Berry, S. 1985. Small scale dairying. In: Milk Production in Developing Countries. Proceeding of the Conference held in Edinburgh, Centre for Tropical Veterinary Medicine (ed. A.J. Smith), pp. 437- 458.
- de Alba, J. and Kennedy, B.W. 1994. Genetic parameters of purebred and crossbred milking criollos in tropical Mexico. *Animal Production* 58:159-165.
- Duch, G. J. 1988. La conformacion territorial del Estado de Yucatan: los componentes del medio fisico. Universidad Autonoma Chapingo, Centro Regional de la Peninsula de Yucatan. Mexico, 427 p.

- Gomez, O.R., Lopez, B.B., Gonzalez, L.G. and Carmona, M.M. 1996. Comparacion de las tendencias en el incremento de las variables poblacion, produccion e importacion de leche de vaca en polvo de 1950 a 2010 en Mexico. Memorias XX Congreso Nacional de Buiatria. Acapulco, Mexico. pp. 423-429.
- Muñoz, R.M. 1990. Limites y Potencialidades del Sistema de la Leche en Mexico. Comercio Exterior 40:886-893.
- Muñoz, R.M. and Odermatt, B. 1992. El sistema leche de Mexico en el Tratado Trilateral de Libre Comercio. In La agricultura mexicana frente al Tratado Trilateral de Libre Comercio. Universidad Autonoma de Chapingo. Chapingo, Mexico. pp. 189-212.
- Nicholson C. F. 1995. Mexico's dairy sector in the 1990's a descriptive analysis. College of Agriculture and Life Science, Cornell University. Ithaca, NY. Mimeograph, 62 p.
- Plasse, D. 1992. Presente y futuro de la produccion bovina en Venezuela. In Ganaderia Mestiza de Doble Proposito. (ed. Gonzalez, S.C.). Ediciones Astro Dat. Maracaibo, Venezuela.
- Portugal, G.A., Garza, T.L., de Leon G.R. and Molina Z. I. 1981. Avances de la investigacion en produccion de leche en pastoreo en el tropico de Mexico. Tecnica Pecuaria en Mexico. 7:52-60.
- Roman, P.H., Hernandez, L.J. and Castillo, R.H. 1983. Comportamiento reproductivo de ganado bovino lechero en clima tropical. 1. Caracteristicas reproductivas de vacas Holstein y Suizo Pardo. Tecnica Pecuaria en Mexico 45:21-30.
- Roman, P.H. and Roman, P.C. 1981. Produccion de leche en sistema extensivo tradicional en clima tropical. Tecnica Pecuaria en Mexico 40:7-15.
- Sarmiento, M., Quijandria, B., Gonzalez, S., Hart, R., Solano, R., de Patta, P.V., Borel, R., Perez, E. and Pinzon, B. 1983. Diseno de sistemas alternativos de produccion bovina de Doble Proposito para el area de Bugaba, Chiriqui, Panama. In Informe de la 3ra. Reunion de trabajo sobre Sistemas de Produccion Animal Tropical, Turrialba, Costa Rica (ed. M.E. Ruiz and H.H. Li Pun.), pp. 26-47.
- Sere, C. and Vaccaro, L. 1985. Milk Production From Dual-Purpose Systems in Tropical Latinoamerica. In Milk Production in Developing Countries. Proceeding of the Conference held in Edinburgh, Centre for Tropical Veterinary Medicine (ed. A.J. Smith), pp. 459-475.
- Sere, C. 1989. Socioeconomia de la produccion bovina de Doble Proposito. In Panorama de la ganaderia de Doble Proposito en la America Tropical. Memorias del seminario sobre ganaderia de Doble Proposito Bogota. (ed. L. Arango-Nieto, A. Charry and R. Vera), pp. 13-27
- Shaner, W.W., Philipp, P.F. and Schmehl, W.R. 1982. Farming Systems Research and Development: Guidelines for Developing Countries. Westview Press, Boulder, Colorado, 414 p.
- Vaccaro L., Vaccaro, R. and Verde, O. 1992. Estudios del comportamiento productivo de distintos grupos raciales en sistemas de Doble Proposito, fuera de la region zuliana. In Ganaderia Mestiza de Doble Proposito. (ed. Gonzalez, S.C.). Ediciones Astro Dat. Maracaibo, Venezuela.
- Verde, O., Vaccaro, L. and Vaccaro, R. 1992. Caracteres a considerar en un programa de seleccion en ganado de Doble Proposito. In Ganaderia Mestiza de Doble Proposito. (ed. Gonzalez S.C.). Ediciones Astro Dat. Maracaibo, Venezuela.
- Villegas, C.M. and Roman, P.H. 1986. Produccion de leche durante el proceso de formacion de un rancho de Doble Proposito en el Tropico. Tecnica Pecuaria en Mexico 51:51-61.
- Wadsworth J. 1995. Dual Purpose Cattle Production: a systems overview. Proceedings of an International Workshop, IFS (International Foundation for Science)/FMVZ-UADY, Merida, Mexico. (ed. S. Anderson and J. Wadsworth.). pp. 2-27.
- Wilkins, J.V., Pereyra, G., Ali, A. and Agola, S. 1979. Milk production in the tropical lowlands of Bolivia. World Animal Review. 32:25-32.

Submitted 7 June, 2002 - Accepted 22 August 2002