Experiences with Performance Recording of Dairy Cattle in Brazil

F.E. Madalena

Department of Animal Science, School of Veterinary Sciences, Federal University of Minas Gerais, Cx. P. 567, 30161-970 Belo Horizonte-MG, Brazil

1. Introduction

In their book "Modern Developments in Animal Breeding", Lerner and Donald (1966) identified four categories into which the many purposes of recording may be condensed:

- Selective breeding.
- Management.
- Research.
- Publicity.

Some or all of these purposes may be the basis of a recording system, although they may also conflict among themselves. For example, recording the better cows in the herd may serve publicity of an elite farm selling seedstock, since the average herd yield will appear better than it really is, but such data would not be useful for genetic improvement purposes (Henderson, 1983). Thus, clear specification of the purposes of a recording scheme is important to design it according to the desired end.

Recognising the purpose of recording is also important to establish who should pay for it. In principle, it may accepted that those who benefit from the recording should bear the expenses involved.

The objective of this paper is to describe some experiences with performance recording of dairy cattle in Brazil, which might perhaps also be of interest to other developing countries.

2. Dairy production

Milk production is one of the main agricultural economic activities in Brazil. The number of milked cows and milk produced are shown in table 1. It may be seen that dairy production is concentrated in the South/Southeast Regions.

One striking characteristic of the Brazilian dairy industry is the tremendous variation in production systems simultaneously coexisting in the country. This is due in part to the wide geographic variation, to differences in development, both between and within regions, and also to differences in income/education between farmers, even in the same region. In the South

Table 1. Herd strength and annual milk production in Brazil (1991)[1].

Region[2]	Number of cattle ('000)	Number of milked cows ('000)	Milk production ('000 kg/yr.)	Milk per person (kg/yr.)	Yield per cow (kg/yr.)
South	24 827	2 890	3 389 354	153	1 173
Southeast	35 742	7 902	6 990 638	112	885
Center-west	36 116	3 458	1 840 341	196	532
Northeast	22 391	3 917	2 174 500	51	555
North	8 966	1 797	684 354	67	381
Brazil, total	128 042	19 964	15 079 187	98	755

[1] Source: Zoccal, 1994

[2] States grouped into regions as follows: South: Rio Grande do Sul, Santa Catarina, Paraná; Southeast: São Paulo, Minas Gerais, Rio de Janeiro, Espirito Santo; Center-west: Mato Grosso, Mato Grosso do Sul, Goiás; N ortheast: Bahia, Sergipe, Alagoas, Pernambuco, Paraiba, Rio Grande do Norte, Ceara, Maranhão, Piaui; North: Pará, Acre, Amapá, Amazonas, Rondonia, Roraima

Region, comprising the States located south of the Tropic of Capricorn, dairying is based on temperate pasture species and on *Bos taurus* breeds, mainly Holstein-Friesian, while in the rest of the country tropical pastures are used and dairy cattle are mainly *Bos taurus* x *Bos indicus* crosses. The Southeast Region includes the larger urban concentration, which attracted dairy production, in areas 400 to 1 200 m over sea level. It has been estimated that milk production in Brazil increased by 45% in the period 1980 to 1993, while the number of milked cows increased by 18% (SEBRAE, 1996).

A trend of migration of dairy farming is apparent, from expensive lands in the state of São Paulo, where crops such as sugar cane and oranges are more profitable, to cheaper lands, in the same state and farther away, in Minas Gerais and Goias, in more tropical areas formerly devoted to beef ranching. In the period 1985 to 1992, the annual rate of increase in milk production in those two states has been 4.3 and 4.8 %, respectively, while the rate of increase in São Paulo was 2.1% (SEBRAE/FAEMG, 1996).

3. Marketing and consumption of dairy products

As shown in table 1, milk availability per capita is low. The annual imports of dried milk, cheese and butter (1990 figures) were, respectively, 23, 22 and 9 thousand metric tons. Because of the low income of a large sector of the population, liquid milk and dairy products have a high income elasticity (Madalena, 1986). Thus, the drastic reduction in inflation rates after 1994 has caused an important increase in consumption of dairy products, because it effectively increased purchasing power of that sector.

Some 55 percent of the milk produced is marketed through dairy plants subjected to federal sanitary inspection. Half of this is sold as liquid pasteurised milk and the rest is processed mainly into dried milk (25%) and cheese (20%) (Zoccal, 1994). Three milk qualities. A, B and C, are defined by federal regulations. However, these are based on farming criteria, such as health practises, machine or manual milking and milking parlour facilities, rather than on milk bacterial counts. In 1992, the percentages of liquid milk sold as types C, B, A, sterilised and re-hydrated were, respectively, 79, 10, 5, 5 and 1 (Zoccal, 1994). A major factor in the recent evolution of the Brazilian dairy industry has been the rapid growth of the consumption of ultra-high temperature (UHT) sterilised milk, which increased at a rate of 25% per year between 1988 and 1993 and continues growing. This milk, being offered in tetrapak boxes, is very convenient for distribution through supermarkets. One should bear in mind that some 80% of the human population of Brazil lives in urban centres. The A and B types have not been able to compete, and in fact the number of B-type dairy farmers has decreased at a rate of 5% per year in the recent years. The increase in consumption of UHT sterilised milk has contributed to accelerate the migration to more tropical regions described above.

An analysis by SEBRAE (1996) notes four other major factors that had an impact on dairy production in recent years. Milk prices, at all industry levels, which were formerly fixed by the government, are now freed. The GATT agreements reducing milk subsidies made imports less competitive, particularly from Europe, attracting local investments in dairy plants. Economic competition influenced concentration of milk processing in fewer plants; in 1994, forty two percent of the milk was processed by six firms, three co-operatives and three private, including two large international groups. Finally, the establishment of the MERCOSUL free trade agreement favoured imports from Argentina and Uruguay, where cost of production is low, thus posing a strong challenge to Brazilian dairy farmers to adopt production systems that effectively utilise the natural resources available to them.

4. Farming practices

Description of dairy farming practices is complicated by the wide variation noted above, Elite farms with very high production levels and modern technology exist, but these are a minority, and low input/low production systems predominate, including, in some regions, the milking of only part of the herd, during the rainy (favourable) season,

Some characteristics of dairy farms in Minas Gerais are shown in table 2. Manual milking, with the calf at the foot of the cow is the commonest practice. However, it should not be taken for granted that machine milking without the presence of the calf is universally more convenient (Madalena, 1993). Better techniques are used in the larger herds which obtain higher milk yield per cow (Table 2).

Table 2. Characteristics of dairy herds in Minas Gerais stratified by milk volume produced.[1,2]

	Daily milk production, litres per day				
	<25	25 to 49.9	50 to 99.9	≥100	Total
Number of farms surveyed[3]	104	78	50	59	291
"Beef cattle" farms[4] (%)	1.0	2.6	10.0	11.9	5.2
Area (ha.)	25.2	49.9	50.0	174.8	67.4
Number of cows in milk	5.3	10.3	14.4	36.1	14.6
Number of dry cows	4.6	7.4	9.3	24.0	10.1
Daily milk production, rainy season (l.)	24.6	50.4	98.9	327.1	106.0
Daily milk production, dry season, (l.)	13.9	31.6	64.6	250.1	75.6
Daily milk yield per lactating cow, (l.)	3.7	4.5	6.5	8.2	5.3
Cows milked once a day[5] (%)	94.6	95.0	69.6	33.2	78.3
Manual milking with calf stimulus (%)	99.0	97.4	96.0	81.4	94.5
Artificial insemination (AI) only (%)	1.0	2.6	0.0	8.5	2.8
AI and/or hand mating	4.2	19.5	18.0	50.8	20.6
Natural mating only	95.8	80.5	82.0	49.2	79.4
Herd European "blood fraction"[6] (%)					
<1/4	75.0	52.3	53.2	27.6	55.6
1/4 to 3/4	24.0	46.1	39.5	50.3	37.9
>3/4	1.0	1.6	7.3	22.1	6.5

Source [1] Source: Madalena *et al*. (1997).

[2] Means and percentages refer to farms in stratum, unless otherwise specified.

[3] Slight variations in the number of farms for each item answered in survey.

[4] Only part of the herd milked.

[5] Of total cows in stratum.

[6] Means of percentages in each individual farm.

5. Official pedigree and milk recording

Official pedigree and milk recording in Brazil are the responsibility of the Ministry of Agriculture, Provisioning and Agrarian Reform (MAARA), but this is only formal, because this responsibility is delegated to the breeders associations. The main organisations for milk recording have been the Holstein-Friesian Breeders Association in several states, the Brazilian Zebu Breeders Association, at a national level, which records Zebu herds, and the Brazilian Breeders Association, recording all breeds. In recent years it has become possible for those associations to sub-delegate milk recording to official institutions or to regional groups of breeders\institutions.

The associations handle the milk record files to the National Dairy Cattle Research Centre of the Federal Research Organisation (EMBRAPA). The Centre, located in the city of Juiz de Fora, Minas Gerais, organises the "National Milk Records File", which is used for genetic evaluations. published as sire summaries. The Centre conducts its own research and also makes available the data to universities and other centres for research purposes. The data used for the 1995 sire summaries are described in table 3.

Traditionally, milk recording has been performed by centrally located recorders travelling long distances to the farms, but in recent years local recorders are being employed. There is no supervisor scheme. Milking in the presence of the recorder officer is required on the afternoon before the recording day to guarantee the recording time period. Thus, the recorder has to sleep in the farm and the farmer has to be advised of the visit in advance. On farm fat testing by the Gerber method is still used, but there

Table 3. Numbers of herds, cows and lactations in the National Milk Records database.[1]

	Hol[2]	Jer	Bs	Gir	Guz	Nel	Mes	Total
Herds	1 863	144	87	196	28	11	26	2 355
Cows	117 235	2 339	2 329	141 41	1 000	1 091	2 199	140 334
Lactations	205 204	3 685	4 213	36 128	2 075	2 315	4 061	257 681
Utilised for sire summaries[3]								
Milk yield	176 399	3 302	3 554	17 116	1 361	1 682	3 222	206 636
Fat	147 824	2 703	1 506	10 413	359	1 333	2 409	166 547
Milk, kg[4]	5 859	3 717	4 193	2 568	2 423	1 594	2 120	-
Fat, %[4]	3 64	5 03	4 01	4 86	5 03	5 12	4 02	-
Sires	772	27	26	131	7	13	68	1 044

[1]Source: MAARA (1995).
[2]Hol = Holstein-Friesian; Jer = Jersey; Bs = Brown Swiss; Guz = Guzerá; Nel = Nelore; Mes = Mestiço (*Bos taurus x B. indicus* hybrids).
[3]Data edited out for calving before 1980, short lactations, age outside 20 m to 18 yr. or missing birth/calving dates, sire, bred or upgrading generation.
[4]Lactation mature equivalent averages.

is a transition towards lab testing. Farmers are usually charged on a per cow basis, and the farmer may record as few cows as he chooses from the herd. These practices stem from the fact that the main purpose of recording is official certification of individual production, which in Brazil has an important economic value. Milk and fat yields are calculated from monthly records by the test interval method.

Official milk recording used to be subsidised by the Federal Government but nowadays it is no more so, the costs being met by the farmers.

6. Milk recording in the state of Paraná

Milk recording in the sub-tropical state of Paraná is outstanding both for the number of herds as for the technical operations. Official recording for all cattle breeds, buffaloes and goats is conducted by the Paraná Holstein-Friesian Breeders Association in co-operation with the Federal University of Paraná. Ribas (1996) described the operations. The programme grew from 88 cows in three herds in 1966 to 17,176 in 385 herds in 1995. There are 32 recorders and one supervisor, (who however does not re-record). Recording is done on two normal milkings per day. Fat, protein and lactose testing and somatic cell counting are performed at a central laboratory, using Bentley electronic equipment. Data are processed electronically to produce reports for herd management and also for certification of yield of individual animals. Average milk yield in 1995 was 24.1 kg per test day, with 3.39% fat and 3.11% protein and 596 000 cells per ml. Paraná is the only state where protein in milk is paid to the farmer. The Dutch colony in that state has had an important influence in all aspects of dairy farming.

7. Other experiences on milk recording

A milk recording programme is run as an extension activity of the School of Agriculture ESALQ in the state of São Paulo. Milk recording, fat, protein and lactose testing and somatic cell counting are offered using Bentley equipment, plus conventional reports on herd and individual cow performance. Computer software was developed for this programme, including an on-farm input section. Only operational costs are charged, which run at about US$ 1.6 per cow per month for the whole package, although farmers may choose only some modules. Official certification adds some US$ 0.6 to the cost. There are currently 130 farms in the programme, with more than 12 000 cows, averaging 21 litres of milk per test day (Prof. Paulo F. Machado, ESALQ, personal communication). A similar programme is run by the Institute of Animal Science of the Secretary of Agriculture of São Paulo state, also for extension/research/development reasons. Data are processed using the Daisy software. Farmers are offered several modules, the most commonly used being those producing individual and herd summaries for yield, reproduction and health, Only operational costs are charged, of US$ 1.4 per cow per month up to

100 cows. In the period 1989 to 1996 14 000 lactations of 6 500 cows in 52 herds were recorded. Average 305 d yield in Holstein-Friesian and hybrid herds was, respectively, 5 885 and 4 519 kg (Freitas *et al*., 1997).

The MAARA initiated in 1993 a programme of technical assistance combined with farm monitoring based on the Monty-Panacea software, based on co-operative or other organisations. with (usually) monthly visits of their own or hired technicians. Typically, the cost, 2% of the farm milk receipts, is mainly borne by the co-operative. The scheme has engaged 65 co-operatives up to now (A.D. Almeida and T.L. Machado Jr., personal communication).

In the early dairy cattle crossbreeding and selection field experiments conducted by EMBRAPA/FAO/UNDP (Madalena, 1989), a total of 104 farms were involved, in an area larger than 1 000 000 km^2 in the Southeast Region. Milk recording was carried out by local personnel of several institutions in various sub-centres. One full time EMBRAPA technician centrally located plus two part-time technicians located at sub-centres supervised the recording. Extension agents were extremely effective in helping with the execution details. Milk samples were collected in containers with 0.1% w/v $K_2Cr_2O_3$ and sent to the National Dairy Cattle Centre for protein and fat testing (using Foss Electric Milkotester and ProMilk equipment). Samples were usually sent by bus, taking one to three days to arrive. However, poor organisation in processing the samples resulted in some 2% of them being analysed up to 28 d after collection. In a study of 13 189 samples, Ferreira *et al*. (1995) showed that fat content remained constant for 6.5 days and then declined at a linear rate of 0.0147 percents units/day, while protein content remained constant for 11 days, then declining by 0.0062 % units/day, except in the hotter sub-areas, where corresponding values were 7 days and 0.0178 % units/day. Although on the whole the operations worked well for their research purposes, de-centralisation, forming nucleus to collect records and milk samples in smaller areas, would be less costly in terms of transport and communications for routine recording. On the other hand, centralisation of milk component testing proved feasible. The main constraint to efficient operation was poor organisation common in public administration, which makes it difficult to have things done correctly and in due time. This problem exists in many countries and should by no means be overlooked, as erosion in the quality of detailed execution may bring down an otherwise well designed programme.

8. Animal breeding

Modern genetic evaluation methods are slowly taking the place of show ring and milk yield contests in Brazil. A study on factors affecting Holstein imported semen prices showed that 69% of the variation in prices was accounted for by relationship with famous bulls, while progeny testing information explained only an extra 10% (Madalena *et al*., 1985). However, a more recent study indicated the semen prices of Milking Gir are

influenced only by data on progeny testing for milk yield, (Madalena *et al*., 1996). A similar evolution is starting in beef cattle breeding, which counts with more than ten modern selection programmes advertising EPDs for liveweight. The Brazilian Society of Animal Breeding (SBMA) was created in 1996 to bring together academic staff, breeders and companies.

It is estimated that only 5% of all cows in Brazil are artificially inseminated, and this has been so for the last 20 years. Total semen sales in 1993 were 3.3 million doses, of which 2.5 million were national and 0.7 million (21% of total) were imported (Anonymous, 1994). Semen sales grew 25% between 1989 and 1993. Semen is produced by 22 private companies, two of which hold 67% of the market. There are also 33 companies selling imported semen. Semen of dairy breeds represents 41.6% of total sales (29.3% of Holstein-Friesian). Insemination is usually done by farm personnel trained in specific short term courses.

A recent study estimated the genetic correlation of yield in the USA with yield in Brazil for 149 Holstein sires with Holstein daughters in both countries using an animal model with the MTDFREML programme, with 266 764 first lactations in the USA and 21 515 in Brazil, mainly in the South Region (Houri Neto, 1996). The rather low estimate, rg=0.61, indicated that a local improvement programme would be justified. At present, only a very small scale progeny testing of Holstein-Friesian bulls is being conducted by one of the private AI firms and the Paraná state co-operatives.

The first progeny testing scheme in Brazil was an experimental project on hybrid *B. taurus x B. indicus* bulls commenced in 1977 by EMBRAPA with FAO/UNDP co-operation (Madalena, 1989). The project has been discontinued, but it managed to test some 90 bulls. It did show that the operations were feasible and that there was a market for semen of progeny tested hybrid bulls.

Based on the previous experience, the Milking Gir Breeders Association (ABCGIL) and the National Dairy Cattle Centre initiated a progeny testing programme for this breed in 1985. This is a small scale, conventional programme, testing approximately ten young bulls per year with both pure-bred and hybrid progeny in 31 to 44 farms specifically recruited for this purpose. After 1995 an animal model-BLUP has been used for genetic evaluation of bulls and cows (Verneque, 1996). Up to 1997, five batches have completed their test, totalling 41 bulls with average 35 daughters each. Predicted transmitted ability ranged from -154 to +314 kg 305d milk yield and reliability ranged from 75 to 89% (mean = 82%) (EMBRAPA\ABCGIL, 1997).

Economic success in the Gir programme, through increased semen prices (Madalena *et al*., 1996) and sales, including important exports, prompted other breeds to follow in the same track. The Guzerá Breeders Association

initiated a similar programme with the National Dairy Cattle Research Centre in 1994, and the new breed Girolando (Holstein-Friesian x Gir) is organising a programme on the same lines.

A group of Guzerá breeders is running a MOET nucleus selection scheme since 1994. This is a private venture with technical co-operation of the Department of Animal Science, Federal University of Minas Gerais. Donors are screened in the whole breed on the basis of absolute milk yield, confirmed at a central farm when necessary, and moved thereafter to a private MOET centre. Pregnant recipients are transferred back to the farm. where progeny are being tested for growth and milk yield. The aim is to produce full-sibships of 4 males and 4 females. Eight out of the first 22 donor cows were not suited for MOET. On average over 41 flushes, 10.7 structures were collected per flush and 5.8 were transferred resulting in 4.1 pregnancies, so the results are considered satisfactory (Penna *et al*., 1998).

9. General considerations

When considering ways of increasing recording one could start by stating the objectives. Clearly, publicity should not be a concern of public efforts, since it only benefits some herd owners. Indiscriminate subsidies for recording did not result in genetic improvement in the past.

Genetic improvement is a major reason for recording, but the cost should be borne mainly by those directly benefiting from it, i.e. selling improved animals or genetic materials. The main constraint for the implementation of modern breeding programmes in Brazil and other Latin-American countries is the lack of investors in that field. Where they exist, such as in the small scale operations described above, they manage to organise and to pay for the necessary recording, generally with the co-operation of universities or research centres. Also, nucleus breeding strategies could be adopted to make genetic progress even when there is no generalised recording (Smith, 1988), coupled with the subjective screening recommended by Timon (1993).

Thus. improved management stands out as the main reason for action to increase recording, There is a sector of farmers that may pay for technical assistance and that would easily buy modules of milk recording packages, provided they are offered quick and reliable report returns, as shown by the incipient experiences described. In my opinion, the main reason why these packages have not grown before was the certification-oriented official milk recording. As a result of industry deregulation and increased national and international competition, it is likely that improved management will drag along recording. There are already several Brazilian computer softwares in the market, plus some foreign ones, and some private recording firms have been established.

On the other hand, there is a large sector of small farmers that would have extreme difficulties to pay for recording. This stems from the strong inequality of income distribution and it is likely to continue for a long time. Some argue that those farmers will be pushed out by "the market", which seems to me a naive view, considering the social consequences of migration to urban centres increasing unemployment and criminality. Moreover, we have a re-flux movement claiming for land, and it does not make sense to feed it with more people expelled from their farms.

A survey of 920 small dairy farmers conducted by Silvestre (1996) showed some results relevant to recording. The sample was restricted to farmers registered at the extension agency of Minas Gerais (EMATER-MG) that used mostly family work and obtained at least 80% of their income from the farm, which should be smaller than 50 to 100 ha, depending on locality. Average herd size was 14 milk and 8 dry cows (plus followers) and average daily milk production was 70 l. Thus, a cost of recording of US$ 1.4 per month (the lowest operational cost of the schemes described) would imply in an expenditure of US$ 19.6 per month, equivalent to 3.4% of milk receipts, which is clearly too much when the legal minimum wage is about U$ 88. Thus, milk recording in those farms ought to be funded from specific programmes, preferably with an extension/technical assistance aim. Also, low cost recording schemes must be devised, as. for example, through farmers own recording. A technician visit would still be necessary to supervise record keeping and to show how to use the reports, which could be tied up with other extension activities. Dairy plant involvement would be essential to collect forms and milk samples.

Although education level of farmers in the above sample was low, incidence of recording was surprisingly high and suggest that it could be augmented by appropriate promotion. Only 3% of farmers were illiterate but 76% had just primary education (36% incomplete). Nonetheless, 32% recorded bull servicing/calving and 14% recorded milk yield, while 15% kept accounting records.

It is interesting to note that 90% of the farmers owned the farm and 81% lived on it. They had, on average, 3.9 children, 41% of which worked only in the farm and 26% were just studying. Income from dairying was 73% of total income. These figures show the social importance of dairying.

The role of universities and research centres in the development of milk recording, both for large and small farms, is absolutely essential as it is there that lies the country's technical leadership. Real life data for research and post graduate education have a very high value for those institutions to devise solutions for the national dairy industry problems. It should not go unnoticed the fact that we face a tremendous thrust of propaganda\lobbies to sell expensive inputs, including cattle and genetic materials, distracting attention from the pursuance of locally suitable

solutions. In particular, there is a dearth of data on economic returns from different production systems which could be obtained from recording programmes.

Finally, it should be considered who is going to do the job of increasing milk recording, should funds be available for it. In my personal opinion, recording will grow through the efforts of dedicated individuals, rather than of governments or institutions, as did happened up to now. The real challenge of any scheme to promote recording is to locate, support and integrate those individuals throughout the country, developing many other pilot schemes as the ones already established, possibly on a free trial basis for, say, a couple of years. As has happened in other countries, the demonstration effect of such programmes would have a major impact in multiplying the number of herds and regions adopting the scheme.

10. References

Anonimous. 1994. Holandês segue na frente. Rev. Gado Holandês. yr 60, vol. 431: 28-34.

EMBRAPA-Gado de Leite/ABCGIL. 1997. Programa Nacional de Melhoramento do Gir Leiteiro. Resultados do 5° grupo de touros. Leaflet, Juiz de Fora. pp. 5.

Ferreira,V.C.P., Madalena, F.E., Lemos, A.M. & Teodoro. R.L. 1995. Variação temporal do efeito do bicromato de potássio na conservação de amostras de leite destinadas à análise em laboratório central. Arq. Bras. Med. Vet. Zoot. 47: 583-591.

Freitas, M.A.R., Guilhermino, M.M., Zambianchi. A.R. & Grossi. S.F. 1997. Monitoring Brazilian dairy herds. Past. present and future. Proc. Ann. Meet. EAAP. Viena. Abstract 589.

Henderson, C.R. 1983. Avaliação de vacas e touros. An. 1° Simp. Nac. Malhoramento Genético de Bovino Leiteiro no Trópico, EMBRAPA-CNPGL. Juiz de Fora, 137-182.

Houri Neto, M. 1996. Vantagens e desvantagens do uso do sêmen importado para produção de leite no Brasil. An. 1° Simp. Nac. Melhoramento Anim. SBMA. Ribeirão Preto, 135-138.

Lerner, I.M. & Donald. H.P. 1966. Modern Developments in Animal Breeding. Academic Press. London and New York.

MAARA. Ministério de Agricultura. do Abastecimento e da Reforma Agrária. 1995. Sumário de Touros. Brasília. DF, pp. 35.

Madalena, F.E. 1986. Economic evaluation of breeding objectives for milk and beef production in tropical cattle. Proc. 3rd Wld. Congr. Genet. Appl. Livest. Prod., Lincoln. 9: 33-43.

Madalena, F.E. 1993. La Utilización Sostenible de Hembras F_1 en la Producción del Ganado Lechero Tropical. FAO Anim. Prod. Hlth. Paper 111, pp. 98.

Madalena, F.E., Verneque, R.S. & Teodoro, R.L. 1985. Fatores que influenciam os preços do sêmen importado. Rev. Brasil. Genet. 8: 377-384.

Madalena, F.E., Madureira, A.P., Penna, V.M. & Turra, E.M. 1996. Fatores que afetam o preço do sêmen bovino. 1. Raças Nelore e Gir leiteiro. R. Soc. Bras. Zootec. 25: 428-436.

Madalena, F.E., Abreu, C.P., Sampaio, I.B.M. & Ferreira Sobrinho, F. 1997. Práticas de cruzamentos em fazendas leiteiras afiliadas à Cooperativa Central de Produtores Rurais de Minas Gerais. R. Soc. Bras. Zootec. (in press).

Penna, V.M., Madalena, F.E. & Alvim, M.T.T. Open MOET selection nucleus in Guzerá**.** Proc. 6th Wld. Congr. Genet. appl. Livest. Prod. Armidale (in press).

Ribas, N.P. 1996. O controle leiteiro no Paraná. Anais 1° Simp. Nac. Melhoramento Anim. SBMA, Ribeirão Preto, 123-127.

SEBRAE/FAEMG. 1996. Diagnóstico da Pecuária Leiteira de Minas Gerais. Belo Horizonte. pp. 102.

Silvestre, J.R.A. 1996. Diagnóstico da Pecuária Leiteira nas Pequenas Propriedades de Minas Gerais. EMATER-MG, Belo Horizonte. pp. 27.

Smith, C. 1988. Genetic improvement of livestock using nucleus breeding units. Wld. Anim. Rev. 65: 2-10.

Timon, V. 1993. Strategies for sustainable development of animal agriculture-an FAO perspective. In: Strategies for Sustainable Animal Agriculture in Developing Countries. FAO Anim. Prod. Hlth. Paper 107, 7-22.

Verneque, R.S. 1996. Testes de progênie coordenados pelo CNPGL. Anais 1° Simp. Nac. Melhoramento Anim. SBMA. Ribeirão Preto, 132-134.

Zoccal, R. 1994. O Leite em Números. EMBRAPA-CNPGL/FAEMG. Belo Horizonte. pp. 131.