

Systems of Milk Production in the Andean Region of Colombia: A Comparative Study

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Introduction

In this paper, an attempt is made to analyse the systems of dairy production practised in two areas of the Andean region of Colombia: the north high plateau of Antioquia (NHP-Antioquia) and Quindio Department, both located in the central range of mountains. Specialised dairy is the common system in NHP-Antioquia, whereas both specialised and dual-purpose systems are practised in Quindio. Holstein is the major dairy breed and *Pennisetum clandestinum* the major grass species in the area.

Colombia is located in the northern corner of South America. The country has frontiers with Panama, Venezuela, Brazil, Peru, and Ecuador and a long coastline with both the Atlantic and the Pacific Oceans. Colombia has a total area of 1,141,784 sq.km, and by 1996 had a population of close to 39,500,000 (34 inhabitants per sq.km). The country is divided into five geographical regions: Andean, Atlantic (Caribe), Amazonian, Orinoquia, and Pacific. The Colombian Andean region is located in the centre of the country and covers an area of about 352,000 sq. km (31% of the total). The Andes spread from Chile in the south to Colombia and Venezuela in the north. In the south of Colombia the range divides into three branches – west, centre, and east– that cross the country from south to north. The two main rivers of Colombia, the Magdalena and Cauca, run along the two valleys set between the eastern and central and between the central and western ranges of mountains, respectively. Both rivers flow into the Atlantic Ocean.

About 80% of the Colombian population live in the Andean region, which is the centre of the agricultural, economic, social, cultural, and political life of the country. The Andes are the source of the continental waters of Colombia, the major source of hydroelectricity for the country, and home to the coffee plantations that have been the engine of the Colombian economy since the mid 19th century. The three major Colombian cities, Bogotá (the capital), Medellín, and Cali are all located in the Andes. The Andean region has a total population of nearly 32 million, with an average 90 inhabitants per sq.km, compared to the national average of 34.

The temperature range in the Andes is determined by the altitude: a warm 24-30°C at 200-1,000 masl; a medium 18-24 °C at 1,000-1,800m.; a cold 14-18°C at 1800-3,000m; and a very cold <14°C above 3,000m. In the greater part of the region annual rainfall fluctuates between 1,000 and 2,000 mm with higher values of 3,000 to 5,000mm around the perimeter.

More than 60% of farms in departments like Boyacá, Cundinamarca, Nariño, Cauca, and Antioquia are smallholdings of less than 20 ha (Ministerio de Agricultura y Desarrollo Rural 1998). The soil has low fertility, which affects the incomes of farmers and encourages them to migrate to the cities in the search for better opportunities. The challenge for agricultural research has been to develop a sustainable farming system that improves the current state of the livelihoods of mountain people.

The Northern High Plateau of Antioquia Department (NHP-Antioquia)

Antioquia Department is situated in the north-west of Colombia. The north high plateau is located to the north of the capital city of Antioquia, Medellín, in the central range of the Andes. The region covers 258,100 ha and has a total population of 102,319 (39.6 per sq.km) (Tobón 1997). The altitude ranges from 2,200 to 2,600m and the temperature fluctuates between 13 and 16°C. The relative humidity is around 79% and the annual rainfall varies from 1,400 to 2,750 mm (Tobón 1997). The main economic activity is pasture-based dairy production. Pasturelands cover 189,382 ha, or 73.4% of the region. In 1997, there were around 203,000 head of cattle, with a total milk production of 810,250 kg per day. Pig farming is also important; the total pig population in the department in 1997 was 79,050 (Tobón 1997).

Soil fertility is generally low; soils have high levels of aluminium and low values of P, Ca, and Mg. The organic matter content fluctuates between medium and high, but the process of decomposition is slow because of the low temperatures. Less than 15% of the original forest remains. The importance of these forests and of the productive

systems of the area becomes even clearer when the fact that the Riogrande and Guadalupe dams, which supply hydropower to the national grid, are fed with the water of rivers that rise in the North Plateau.

Systems of milk production

Farms are generally small. Seventy per cent of the farms have less than 20 ha of land, with an average of 42 cattle per farm (Quiros et al. 1997). Quiros et al. (1997) carried out a descriptive study of the systems of production in the Antioquia northern high plateau. The two main systems identified were: 'pigs-pastures-cattle-milk with pastures fertilised by pig manure', cattle graze on the pasture but are also given concentrate feed; and 'pigs-pastures-cattle-milk with pastures fertilised with chemical fertilisers', similar to the previous one but with the addition of chemical fertilisation of the pasture. Some modified systems are found in sub-regions such as 'pasture-cattle-milk-chemical fertilisers without pigs' and 'pasture-cattle-milk', which is considered a backward subsistence system. *Pennisetum clandestinum* is the dominant grass cover in pastures. Other grasses found in pastures include *Holcus lanatus*, *Anthoxanthum odoratum*, *Paspalum sp*, *Lolium sp*, and *Trifolium sp*. Overall, 51.5% of the farmers use a system of dairy production that includes pigs. The number of pigs per farm is generally less than 100. Pigs are normally reared in buildings located at the highest point in the farm so that the manure-water mixture can be distributed to the pastures by gravity. The pigs are fed exclusively on commercial concentrates. The most popular cow breed is Holstein, although breeds such as Jersey, Ayrshire, Brown Swiss, and Blanco Orejinegro (blackears white, a creole breed) are also found.

Pasture is the main source of feed for cattle. Cows in milk are given concentrates as a supplement during milking (twice a day), normally 4-6 kg daily. Calves are fed 3-4 kg of milk daily, for 3-4 months. These calves are usually fed the same concentrates as given to cows. Dry cows are given concentrates for 20-30 days before calving. Natural service is the most common method of mating. Artificial insemination (AI) is used on 30% of farms, and 10% use both systems (Tobon 1997).

Productive parameters

The main productive parameters of dairy cattle in the area are shown in Table 12.1. Different authors report an average daily milk production per cow of between 10.5 and 12.1 kg. Aristizabal and Ramos (1995) reported a milk yield per lactation of 4,051 and 4,193 kg (305 days adjusted) for farms in the municipalities of Don Matias and Santa Rosa whereas Aguilar and García (1995) reported 2,668 kg per lactation (305 days adjusted) for farms in the municipalities of Belmira, Entrerrios, and San Pedro. The author considers that the first figures are probably representative of elite

Table 12.1: Productive parameters reported for dairy cattle on farms in the northern high plateau of Antioquia Department

	Don Matias municipality	Santa Rosa municipality	Belmira, Entrerrios and San Pedro municipalities
Daily milk per cow, kg	10.5 ¹	12.1 ¹	10.8 ²
Lactation, days	328 ¹	370 ¹	343 ²
Milk per ha per day, kg	7.05 ¹	14.2 ¹	20.8 ²
Calving interval, months	14.53 ¹	14.65 ¹	13.84 ²
Stocking rate, equivalent mature cattle/ha	-	1.67 ¹	2.4 ²
First calving, months	32.9 ³		32.7 ⁴
Sources: ¹ Aristizabal and Ramos 1995			
² Aguilar and García 1995			
³ Calderon and Sierra 1990 (cited in Tobon 1997)			
⁴ Figures for San Pedro municipality Jaramillo and Tobón (1991) (cited in Tobon 1997)			

herds, and that 2,668 kg per lactation (305 days adjusted) is likely to be closer to the real average for the seven municipalities of NHP-Antioquia.

Quindio Department

Quindio department is located in the centre of Colombia, on the west of the central range of mountains. Quindio covers approximately 1,930 sq.km. The region at an altitude of 1,200 to 1,700m is mostly dedicated to coffee production. Quindio, Caldas, and Risaralda form the 'coffee belt' of Colombia.

Dairy farming systems

The dairy production systems in Quindio were described in a joint study carried out by German Technical Cooperation (GTZ) and the Colombian Agriculture Institute (ICA) (Rodríguez et al. 1991). In most farms located below 1,700m, the cattle industry is associated with coffee growing (generally the major enterprise on those farms). There are two main systems of milk production: specialised dairy (SD) and dual-purpose dairy (DP). Specialised dairy systems are entirely focused on the production of milk; dual-purpose systems are focused on the production of both milk and calves. SD is practised in 38% of the farms and DP in 62%. Average farm sizes are 24 ha and 68 ha for SD and DP, respectively. About 66% of the farms have less than 30 head of cattle. *Cynodon nlemfuensis* and *Pennisetum clandestinum* are the prevalent grasses. *Cynodon nlemfuensis* is found mainly on the farms below 1,700m; *Pennisetum clandestinum* is the major grass at higher altitudes. Holstein is the major breed in the SD systems with some herds of Brown Swiss. Norman (a French breed) and its crosses are the common breeds on DP farms. In the DP system, calves suckle the cows before and after milking and are weaned when they are seven to nine months old. Calves are usually sold between 7 and 18 months of age for

further rearing. In the SD system (both in Quindio and the high plateau of Antioquia), calves are separated from the dams three to five days after calving and male calves are sold for slaughter shortly afterward. Female calves are fed milk in buckets for 31 to 120 days, between 90 and 630 kg in total. Very often the high amount of milk supplied makes the rearing of female calves uneconomic.

Productive parameters

The average daily milk production per cow is 8.5 kg in the SD and 4.2 kg in the DP system (3.4 kg if cows are milked once daily and 5.7 kg if they are milked twice daily). The average daily milk production per hectare is 12 kg and 4.5 kg respectively. The average stocking rate per hectare is 3.6 in SD and 2.1 in DP.

Development Strategies

Both farmers and the institutions working in rural development aim to increase farm production. In the next paragraphs, two productive strategies for the regions described above are analysed.

The conventional approach

The conventional technical approach tries to obtain the maximum milk yield per cow and per unit area by increasing the use of concentrates; upgrading the Holstein herds, using artificial insemination, and applying large amounts of chemical fertiliser. This approach is heavily dependent on investment and capital. It is inappropriate in NHP-Antioquia where the milk producers are mostly poor and have relatively small farms. Although it might be suitable for wealthier farmers, it still has a number of drawbacks. Even for rich farmers, milk produced in a system based on the use of costly inputs will not be able to compete with the lower-priced milk available in the international market. Since Colombia has an open market policy, application of this conventional approach will lead to a higher dependency on imported inputs at both farm and national levels. Currently, all dairy genetic resources, whether in the form of semen or live animals, are imported, as are most of the raw materials used for concentrates. This means that self-reliance of farmers is not fostered. Another drawback is that a certain level of environmental degradation is unavoidable in a system based on grazing of monocultures of grass on slopes. Chemical fertilisers may help improve the concentration of elements like N, P, and K, but they contribute to the development of soil erosion and changes in soil texture.

A new approach

The new approach is not aimed at maximising the production per animal or per unit area, as this would be dependent on 'imported' inputs. Rather it aims at increasing

farm production as a whole, with fewer imported inputs and greater reliance on local resources; a move from 'monoculture' pastures with few grass species to development of pastures with a diversity of fodder plants ('polycultures'); and an integrated production system that includes production of milk, beef, pork, multipurpose trees, energy, organic fertilisers, and earthworms.

The key elements of this approach are as follow.

- Crossbred Holsteins with some zebu (*Bos indicus*) or creole blood (1/4-1/2 zebu or creole) instead of pure Holsteins (like Brown Swiss and Ayrshire). The cows in the specialised dairy systems of NHP-Antioquia and Quindio only yield around 3,000-4,000 kg of milk per lactation; they do not produce more not because of lack of genetic potential but as a result of poor feeding, management and ecological conditions. Keeping purebred Holsteins will only serve to reinforce the impact of these constraints, not to solve them.
- Dual-purpose system instead of specialised dairy. The use of restricted suckling (even with high-grade Holsteins) will provide a cheaper rearing method for calves and a better control of mastitis. In the Colombian specialised dairy systems, between 90 and 630 kg of milk is not sold anyway, but supplied to the female calf. By using crossbred cattle, it is also possible to produce male calves that are suitable for beef production (see Preston and Leng 1987).
- Establishment of polyculture plots for cutting close to the main facilities (house, barn, milking parlour, pigsties). These plots supply feed for cattle and pigs and food for people. Association of different plants in the same plot has been shown to have benefits in different areas of the Colombian Andes between 1,400 and 2,500m. Some of the plants used in this system are *Trichanthera gigantea*, *Tythonia diversifolia*, *Morus alba*, *Boehmeria nivea*, *Erythrina edulis*, *Phaseolus vulgaris*, and sugar cane (Table 12.2).

Table 12.2: Plants associated in polycultures in farms in the Colombian Andes

Latin name		Altitude range masl	Family	Eaten by
<i>Trichanthera gigantea</i>	Tree	0-2,300	<i>Acantaceae</i>	Ruminants, pigs, hens
<i>Tythonia diversifolia</i>	Shrub	0-2,500	<i>Asteraceae</i>	Ruminants
<i>Morus alba</i>	Shrub	0-2,500	<i>Moraceae</i>	Ruminants, pigs, hens
<i>Boehmeria nivea</i>	Herb	1,000-2,200	<i>Urticaceae</i>	Ruminants, pigs, hens
<i>Erythrina edulis</i>	Tree	1,800-2,500	<i>Papilionaceae</i>	Ruminants (leaves), pigs (seeds), people (seeds)
<i>Alocasia macrorrhiza</i> ¹	Herb	0-2,500	<i>Araceae</i>	Pigs
<i>Phaseolus vulgaris</i>	Herb	1,000-2,500		People
<i>Saccharum officinarum</i>	Grass	0-2,300		Ruminants (whole plant, stalk, tops, bagasse), pigs (stalk, juice), people (processed juice)

¹ A promising plant currently being evaluated by CIPAV

- Establishment of tree-grass associations in grazing areas. In Colombia, the association *Pennisetum clandestinum* - *Alnus acuminata* has been shown to be beneficial in areas above 2,000m. Recently, Giraldo and Bolivar (1999) reported interesting results in Antioquia with *Pennisetum clandestinum* and *Acacia decurrens*, with marked differences between acacia planted at low density or at high density, and with control *Pennisetum* monoculture plots (Table 12.3). In the areas covered by this study, *Pennisetum clandestinum* is intensively attacked by pests such as *Draeculacephala clypeata*, *Hortensia similis*, and *Collaria scenica*. It is common practice to spray pastures with chemicals two or three times between grazing episodes, which are approximately 50-60 days apart. The chemicals used are expensive and toxic to both humans and animals. By contrast, observations over a two-year period showed chemicals to be unnecessary in areas planted with *Acacia decurrens-Pennisetum clandestinum* because pests caused no important damage (Giraldo A, 1999 personal communication¹).
- Closing off of marginal areas to allow the natural regeneration of trees. This is a good option that can save the cost of tree planting; in the long-term these areas can supply poles and firewood (Lotero and Tafur 1999).
- Multipurpose live fences as a source of poles, firewood, and fodder, and for wind control. Some species of trees that can be used for this are: *Eucalyptus sp*, *Trema micrantha*, *Delostoma integrifolium*, *Erythrina edulis*, *Montanoa quadrangularis*, and *Croton sp*.
- Biogigesters should be an essential component of all farming systems. They produce biogas while maintaining the fertiliser value of the manure. Biogas can be used for cooking, for heating for piglets, and to generate electrical power (Zapata

Table 12.3: Biomass production of the association *Pennisetum clandestinum* - *Acacia decurrens* planted at two densities. Antioquia Department, Colombia¹

	Control ²	Low density ³	High density ⁴
Pennisetum yield, kg dry mass per ha per cycle	2,130a	2,084a	1,397a
Edible biomass per tree, g dry mass	-	3,386a	884a
Total edible biomass ⁵ , kg dry mass per ha	2,130a	3,462a	2,378a
Firewood per tree, kg fresh matter	-	8.5a	1.5a
% Pennisetum	88.95a	93.05a	79.82b
% other grasses	8.12a	3.74b	11.78a
% weeds	2.94a	3.03a	8.85a

Source: Giraldo and Bolivar 1999

¹Values in the same row with the same letter are not significantly different, Duncan analysis (P < 0.05)

²Control is *Pennisetum clandestinum* without trees

³407 trees/ha

⁴1110 trees/ha

⁵grass yield plus edible fodder of 18 month-old *Acacia decurrens* trees

1999). In addition, biodigesters control odour, which is a growing problem in areas of pig production. CIPAV has been working with plastic biodigesters since 1986 and now have a great deal of knowledge and experience in this field. Two sizes are used: a small 'family-sized' digester 1.25m in diameter and 3-10 m long; and a large 'industrial' digester 2.5m in diameter and 20-25 m long. The family type is suitable for smallholders with 5-15 sows, while the industrial type is suitable for about 100-120 sows. The current cost of these biodigesters in Colombia is about US\$ 250 and US\$ 1,300 for the family and industrial types, respectively. This includes the cost of digging the trench, roofing, a fence, inlet and outlet boxes, and the plastic. The effluent from biodigesters can be used for the organic fertilisation of pastures and polyculture plots.

- Earthworms grown on cattle manure produce high quality fertiliser. In a commercial farm located in Antioquia the author observed excellent results in earthworm production on cattle manure following the addition of some pig manure (about 5-10%). The earthworm compost is a very valuable fertiliser for the polycultures, and can be an important source of income in some places where there is a high demand for compost, mostly for greenhouses.

Conclusions

In the Andean region of Colombia the negative effects of the conventional livestock production systems are becoming more evident day by day. A great deal of research still needs to be carried out to develop and formulate alternative strategies and approaches, but it is important that these options are based on the integration of cattle and pig raising, polycultures of herbs and multipurpose trees, and organic fertilisation. The initial research results obtained in different agroecological zones in the Andes have shown the long-term advantages of such an approach.

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