NEW PERSPECTIVES AND OPPORTUNITIES FOR IMPROVING REPRODUCTION IN DUAL PURPOSE CATTLE

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Abstract

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Traditionally, cattle raised under the tropical conditions of the lowland tropics have been dedicated to beef production. However, in the last years, considerable interest has been given to milk production. Hence, the logical step has been the development of dual purpose cattle, thus avoiding losing the income generated by the sale of beef. This concept is particularly important, as the introduction of specialised dairy breeds has mainly proved an unsatisfactory solution to increase milk production in the area. Dual purpose systems, however, have been limited due to poor reproductive performance and are facing considerable dilemmas such as: a) degree of heterosis needed in the cattle for optimal production and adaptability to the tropics; b) suitable management systems, i.e. dual purpose cattle where the main income is beef and milk production is just an added bonus, or conversely, where milk is the main income for the farmer; c) insufficient economical resources of the farmer, those with only subsistence levels as opposed to farmers with certain investment capacity; d) choice of breeding systems, artificial insemination versus natural mating; e) implementation of feeding practices, capacity to implement strategic supplementation in contrast to cattle raised almost exclusively at pasture; and f) adequate marketing of dairy products in the tropics. These considerations related to the strength and weaknesses of dual systems are discussed in this review.

1. INTRODUCTION

The cattle population of Latin America accounts for about one-third of the total number of bovines found in the tropics worldwide, which was estimated to be about 740 million [1]. Reviews on the performance of cattle raised under tropical conditions have shown that these animals fall far short of their maximum potential. For example, Sere and Vaccaro [2] found that the average milk production for the Latin American region was 1070 kg per lactation, compared to 3586 kg for Europe and 5259 kg for the United States.

Management systems can obviously be considered responsible for the vast differences. However, for Australia, where conditions are probably similar to those of Latin America, average milk production was 2873 kg per lactation. Chicco and Schultz [3] estimated that only 25% of the milk and 50% of the beef requirements for the region are produced in tropical areas. Studies by the FAO conducted from 1984 to 1989 have indicated that developing countries account for only about 30% of world beef production.

On the other hand, it has been customary to transfer technology developed in industrialised countries to the developing world, with the aim of improving traditional husbandry procedures for livestock management. This approach has been reasonably successful with cattle raised in environments similar to those for which the technology was created. In Latin America for example, this is particularly true for Holstein cattle living in temperate zones. Nonetheless, it is estimated that almost two-thirds of cattle raised in this region is concentrated in the lowland areas, where the native breeds of cattle, predominantly a mixture of European and Indian crossbreeds, are raised under harsh environmental conditions. The economical success of pure European breeds in such environments has been seriously questioned [4].

This situation has created the need to adapt imported technologies to the unique local conditions prevailing in the Latin American lowland tropics. However, few research efforts have focused on answering questions created by using systems developed in other areas of the world. Also, available results have been generally difficult to interpret due to he diversity of conditions where the

animals are raised. Moreover, few studies have been concerned with the evaluation of existing methodologies that are perhaps more suitable for the region than sophisticated techniques created elsewhere.

Consequently, appropriate technologies will have to be created to maximise the reproductive potential of these animals. This is not an easy task, as there is a need to identify the constraints to optimal productivity inherent in each specific management system before any effort is made to improve cattle production. Also, constraints need to be identified wherever research is needed to overcome the obstacles.

It is certainly not easy to conduct the type of applied research needed to address these problems. It calls for a sound understanding of the target farming system, requires an interdisciplinary approach and must judiciously combine empirical on-farm studies with advanced laboratory techniques. The ultimate aim should be to develop cost-effective interventions based largely on indigenous resources. The objective of this paper is to analyse some of the common constraints that jeopardise the reproductive performance of dual-purpose cattle raised under tropical conditions and to formulate general recommendations that might be suitable for the region.

2. REPRODUCTIVE PERFORMANCE

2.1. Degree of heterosis needed in cattle for optimal production and adaptability to the tropics

There is substantial evidence that certain breeds, particularly of the *Bos taurus* type, tend to have their age at first calving much earlier than *Bos indicus* breeds. However, the interpretation of the data rather than the nature of the data itself may account for some variation. Table I adapted from the review of Galina and Arthur, [5] shows that age at first calving usually occurred about 40 months for the *Bos indicus* breeds and 32 months for the *Bos taurus*. Taking these data in isolation one would argue in favour of the benefits to be gained by the rearing of European breeds in the tropics, as they calve earlier in the herd for the first time, and subsequently have a similar calving interval to *Bos indicus* breeds. However, this is most likely the wrong conclusion as it ignores other important considerations. For instance, European cattle are usually allocated in the best pastures of the farm, putting Indian breeds in disadvantage. These native animals are judged on the basis of their natural resistance to the environment, to be capable of doing well on poor pastures. Moreover, few studies published on the reproductive performance of a particular farm provide enough information for account to be taken of the quality of the management system, or nutritional practices, nor do they detail variables, such as the percentage of animals being culled, stocking rates, or breeding methods; i.e. artificial insemination as opposed to natural mating. This is understandable when we consider that most of these studies are retrospective, making it difficult to ascertain the conditions of these animals years before the onset of the study.

TABLE I. AVERAGE AGE AT FIRST CALVING IN MONTHS IN DIFFERENT CATTLE BREEDS UNDER TROPICAL CONDITIONS

Breeds	No. of Studies	Mean	Standard Deviation	Standard Error	Minimum	Maximum	95% Confidence Interval
Bos Taurus	86	32.2	5.9	1.9	26.0	47.2	27.0–37.5
Bos Indicus	65	44.4	6.4	2.1	33.6	54.8	38.7–50.1

Productivity of cattle in the tropics is poor; it has been observed that under the present conditions, about 30% of the replacement heifers will not reach weaning or branding. While another 20% will not even calve for the first time prior to their release from the herd [6]. This situation gets

worse when cattle of European origin are introduced into the tropics. Vaccaro and co-workers [4] monitored the production and life expectancy of imported Holsteins to Venezuela; 81.3% of the calves born from these animals died before one year of age, and the number of calvings recorded for these animals during their lifetime in the herd was only 1.2.

As a consequence, crossbreeding of *Bos taurus* and *Bos indicus* breeds has emerged as a useful alternative for cattle production in the tropics. Nevertheless, a definite methodology has yet to be established. For example, Plasse [7] demonstrated that upgrading Criollo cattle to Zebus has been successful only up to the second generation. Cunningham and Syrstad [8] in an excellent review on crossbreeding techniques in *Bos taurus* and *Bos indicus* cattle raised for milk production, concluded that in the crossbreeding systems predictions depend on the estimated level of additive and heterosis effects. The accuracy of the prediction will depend on the validity of these estimates in the environment in which the system was implemented. All this means that crossbreeding with a particular combination of breeds in one location may not be appropriate to another environmental situation. Similarly, Galina and Arthur [5] indicated that when crossbreeding *Bos taurus* and *Bos indicus*, the performance of the resulting crosses was in accordance with the amount of the taurine genotype present in the animals. However, further crossbreeding of the resultant F1 gives unpredictable results. In this same study, it was found that interspecies crossbreeding did not favour reproductive performance and unspecified crossbred cattle showed the worst accomplishment. Similar findings were reported [9] in a large comparative study of dairy, beef and dual-purpose cattle. The worst performance was obtained in the latter type (Table II). In general, it is agreed that for adequate performance and endurance, it is desirable to have at least 25% of *Bos indicus* blood in the crossbred animal. However, to add to the controversy, a recent study containing large numbers of animals [10] clearly demonstrated that the resulting crossbred between *Bos taurus* and *Bos indicus* above ½ of heterosis increased the frequencies of disposals due to health, accident and other causes, reinforcing earlier findings of this group [11], indicating that animals raised under low or high management in Brazil, the F1 crosses outperformed the combinations from ¼, until almost pure-breds. These long-term studies strongly indicate the need of establishing F1 programmes for milk and meat production in the tropics. Nonetheless, more studies are necessary as the disparity in information could be due among other things to the effect of heat stress, this in turn affecting the cascade of reproductive hormones. However, this important concept requires investigation as some breeds are better adapted than others to tropical conditions are. More information is needed on the environmental causes of poor reproductive performance of the various genotypes raised under tropical conditions, as to be able to gain an insight into the physiological mechanisms responsible for these effects.

2.2. Suitable management systems

Dual-purpose cattle raised under the conditions of the lowland tropics are exposed to an array of management systems, which affect their performance. In a study carried out in Mexico [12] it was found that cows predominantly of European breeds housed in comfortable environments tended to calve in the cool winter months, whereas similar type cattle, maintained in poor conditions calved in the hot spring-summer season where natural pastures are available. Similarly, a comparison of the onset of ovarian activity in Holstein and Jamaica Hope raised in the tropics [13] found cyclic levels of progesterone indicative of ovarian activity as early as 20 days postpartum, concluding that Holstein cattle, at least under their conditions, were capable of cycling just as early as animals raised under more temperate conditions. These data indicate that given suitable management systems, specialised cattle can outperform more traditional, rustic stock. However, adequate conditions demand an investment in suitable housing facilities, which many producers in the tropics cannot meet.

2.3. Insufficient economical resources of the farmer

It has been said that reproduction is a luxury function and poorly fed animals will have a difficult time to reproduce adequately. As farmers in the developing world have serious problems in producing a constant food supply, it is not surprising to find poor nutritional status of cattle as a major setback to the reproductive efficiency of the herd. This situation is usually aggravated when farmers

depend solely on products closely related to the rainy season and can offer little or no supplementation during the dry season. As this has been a usual problem in developing countries, studies in which scientists have tried to identify constraints in animal reproduction have always noted that year-to-year variation in the rainy season precludes the drawing of firm conclusions as to a policy to establish, for example, the choice of a breeding season or strategies for reproductive management in the dry and wet seasons, two distinct conditions. In the past, semi-intensive units were programmed to have a low economic investment with a modest income from selling meat or milk. Therefore, reproductive programmes were kept to a minimum, as there was not an immediate economic pressure to become more efficient. However, in many countries, demand for land from the less affluent sectors of society, has created the need for farmers to become more efficient in the use of the land. Therefore, it is not unusual to find excellent examples of adequate supplementation or even better, good management decisions in the use of improved pastures. As a consequence of these shortcomings, professionals involved in the sector of animal health and production have an important challenge in front of them, that of assisting farmers in planning strategies to maintain cattle in a good plain of nutrition based on the skilful use of the local resources.

TABLE II. AVERAGES OF REPRODUCTIVE PARAMETERS IN CATTLE RAISED FOR DAIRY, BEEF AND DUAL PURPOSE UNDER MEXICAN CONDITIONS (VALUES WITHIN PARENTHESIS INDICATE THE NUMBER OF STUDIES)

Reproductive Parameter (days)	Dairy	Beef	Dual Purpose
Age at puberty	457 [a]	529 [a]	547 [a]
	(10)	(13)	(15)
Age at first service	586 [a]	691 [a]	729 [a]
	(10)	(20)	(12)
Age at first conception	602 [a]	779 [b]	885 [c]
	(14)	(26)	(23)
Age at first calving	925 [a]	1049 [b]	1133 [c]
	(35)	(29)	(68)
Interval from calving to first oestrus	65 [a]	68 [a]	94 [b]
	(35)	(35)	(50)
Interval from calving to first service	71 [a]	85 [a]	129 [b]
	(17)	(16)	(25)
Interval from calving to conception	139 [a]	150 [a]	154 [a]
	(56)	(64)	(76)
Calving interval	435 [a]	437 [a]	426 [b]
	(73)	(78)	(112)

Uncommon letters within rows indicate a significant difference ($P < 0.05$)

2.4. Choice of breeding systems, artificial insemination (AI) versus natural mating

In relation to semen preparation, judged by the case reports obtained from the users of AI, the quality of the frozen semen prepared nationally, or imported from abroad, is quite satisfactory. Also, providers of the services related to storage and AI equipment have kept abreast of new developments, usually emanating from the industrialised world. Although not proven, a possible constraint to the industry has been the inadequate preparation of the technical staff inseminating cows. Still, in many developing countries, veterinarians in charge of the services on the farm, carry out the insemination procedure, whilst making their daily visit. Consequently, cows in the farm are inseminated at a predetermined time, irrespective of when they start showing signs of oestrus. Although these personnel have been professionally trained to provide veterinary services, one must not overlook the possibility that they are poorly trained in AI procedures; once again, research is needed to clarify these important points.

In farms where a layman carries out the AI technique, in many instances they have had little exposure to the use of AI prior to their training. Technical schools in charge of providing them with adequate practice are scarce. Furthermore, retraining, a most important consideration of AI technicians [14] is almost non-existent in developing countries. Surveys to evaluate the performance of AI technicians are mandatory if AI is to improve in the region.

An important consideration of decline in the use of AI is the high number of cows requiring repeat services. A common factor related to his failure is the increasing number of dual-purpose herds with clinical signs of uterine infections, particularly in the early postpartum period. Although there is a pressing need to elucidate the causes of this shortcoming, surprisingly there is little research authored by scientists in the developing world contributing to solve this problem. More important, whereas in one location this phenomenon is rather apparent, other similar areas have failed to report any incidence at all. Figures estimating repeated failure to conceive after AI have shown that at least 25% of the herd is not getting pregnant after three or more inseminations [15].

Finally, one cannot overlook the possibility that oestrus detection in these rather semi-intensified farming systems, is a major cause of concern. It has been calculated [9] that farmers are only detecting about 40% of the animals in oestrus.

3. IMPLEMENTATION OF FEEDING PRACTICES

Nutrition is considered to be one of the most important factors affecting cattle performance in the tropics, due to the low quality of tropical forages (low protein and energy) and seasonal variation in dry matter production. Thus, farmers in the lowland tropics are faced with the challenge of finding suitable sources of protein and energy with agricultural by-products available locally. Therefore, several supplementary feeding strategies have been proposed to surpass this shortcoming. Development of feeding and management systems based on fresh sugar can are feasible, whereby each hectare planted with sugar can may be converted to 15 000 kg of milk or 500 kg meat per year in dual purpose production systems in the tropics [16].

Strategic supplementation with bypass protein and fat for dual-purpose cattle has been assessed in the Colombian tropics during the dry season [17] and it was concluded that supplementing cows gave better total productive performance due to lower weight losses, higher milk production, better pregnancy rates an heavier calves at birth.

Another alternative of supplementation has been implemented with the use of molasses. Molasses-urea based supplements have been evaluated in dual purpose cows raised in the humid tropics of Mexico. For instance Castillo and co-workers [18] found that milk production was 0.8kg/cow/day higher in cows supplemented with molasses plus 3% urea. Another alternative of giving molasses is through multinutritional blocks based on urea molasses UMMB. The primary purpose of these supplements is to provide a broad spectrum of major and trace minerals [19]. Therefore by manipulating the rumen microflora through feeding UMMB an improvement in the digestive efficiency of crop residues can be achieved [20]. In Indonesia, Hendranto and co-workers [21] showed that Friesian dairy cows given UMMB supplementation increased total milk yield by 28% compared with unsupplemented controls over the 18 weeks of lactation. Mata and Combellas [22] found that inclusion of cottonseed (30%) in UMMB improved fertility and reduced liveweight losses. In addition supplementation through multinutrient blocks before the calving season affected the reproductive performance of cows with low body condition score [12].

In some countries legumes have been used as a source of protein. The tree legumes, e.g. *Gliricidia, Erythrina* and *Leucaena* have great potential as sources of legume fodder [19]. The high protein content of the leaves of *Gliricidia sepium* makes it particularly useful as an animal feed, especially as a complement to poor quality forages [23].

The overall performance of pasture-based production systems depends largely on the quantity of feed consumed and used beyond maintenance by the animal (6.kg of DM/100kg LW, and 7% of crude protein) [24]. Pasture management can affect productive performance in dual-purpose cows. The best balance between high production (milk production/ha and cow) and reproductive performance was found in the high stocking rate farm (1.5 cows/ha) in the humid tropics of Mexico

[25]. However this must be interpreted with caution as variations are to be expected in the general management of the farms and the forage availability throughout the year.

There is a pressing need to investigate on suitable methods of supplementation, particularly those economically feasible to farmers in dual-purpose systems. This principle becomes of primary importance as the twenty first century approaches for two reasons. First, traditional beef cattle enterprises based on extensive systems are facing serious problems for adequate implementation, for example countries like Costa Rica, with long tradition in raising beef cattle stocked 7.5 million heads in 1975. Nowadays, these numbers have been reduced to three million. Secondly, dual-purpose cattle systems are becoming more common in the tropics as it gives low-income farmers the economical diversity needed for subsistence.

4. ADEQUATE MARKETING OF DAIRY PRODUCTS IN THE TROPICS

Milk production is highly seasonal in the tropics, this is all concentrated in the rainy season and little milk is available in the dry season. This shortcoming creates two problems: a) collection of milk is circumscribed in certain periods of the year, leaving the investment, such as milking lorries and cooler containers, poorly used in certain periods of the year; b) infrastructure for preservation of milk, such as pasteurisation, long lasting skim milk, or even dehydrated as powder, is not economically feasible as again the plant will be working at capacity only part of the year. Alternatives such as breeding cattle to calve in the dry season are in need. However, feeding alternatives to complement grazing have to become feasible, as only milk produced exclusively from grazing is highly variable, since climatic changes can alter the growth of pasture by 50% in a period of only 7 to 10 days. Also, Aluja and McDowell [26] found that average production above 8 litres required supplementation. Otherwise reproductive performance could be affected.

More research is obviously needed in all the headings indicated in this review, particularly how we could increase our crossbreeding programmes of *Bos taurus* x *Bos indicus* breeds in accord with improving feeding practices.

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