LARGE SCALE CROSSBREEDING OF *BOS INDICUS* WITH *BOS TAURUS* IN THE TROPICAL RAIN FOREST CLIMATE OF KERALA IN SOUTH INDIA - 28 YEARS EXPERIENCE.

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Introduction

The state of Kerala in India has predominantly an agrarian economy, with crop production providing the major income for farmers. The economy is also supported by animal husbandry in many of the farm households. Geographically Kerala lies in the tropical rain forest belt with a two season pattern and two monsoons spread over eight months. The main food crops are paddy and tapioca, while the cash crops grown are coconut, rubber, pepper, cashews, tea, coffee and spices. The population density is one of the highest in the world with 654 people per km^2, therefore placing extraordinary pressure on land availability for crops and cattle. The native non-descript zebu-type cattle of Kerala, evolved over long periods, are poor in milk and reproductive performance but have adapted very well to the tropical environment with regards to heat and disease resistance. The local zebu are small in stature with an average body weight of 150-250 kg standing 1.1-1.2 meters high. The average age at first calving is 51 months and the average lactation yield is estimated at 500-700 kg/200 days.[1,2] The average calving interval is long at 21 months[2]. The number of AI per conception is 2.4 for field animals[2]. These non-descript zebu type cattle could not satisfy the milk needs of the state. To improve the milk production to 1500 L per lactation by genetic improvement alone would have taken 150-200 years. Replacement of local stock with exotic dairy breeds was not practical. Past experience has shown that transplantation of such temperate breeds into the tropical rain forest climate is not economical because of poor adaptability, susceptibility to tropical diseases and non-availability of suitable management. Therefore, a programme of limited crossbreeding of local zebu cattle with *Bos taurus* dairy breeds was implemented as a practical means enhancing the milk yield. Crossbreeding offered the most promising approach to evolve a type of cow which could be maintained economically under prevailing village conditions. The purpose of this paper is to present data supporting crossbreeding between local non-descript milk breeds with top genetic material of temperate *Bos taurus* milk breeds, as the best currently available means to converse local poor producing cattle into crossbreds of high productivity.

The breeding policies

In 1963 a cattle cross-breeding programme was started in the high ranges of the Cardamom Hills with *Swiss Brown* (*Braunvieh*) being the temperate donor breed. At that time (1965) the cattle population of Kerala was 2.8×10^6.[1] The purpose of crossbreeding in the state farms was to compare the productive performance of animals with different exotic inheritance under controlled conditions and then to propagate them into the target cattle population through large scale artificial insemination (AI). Strict breeding policies were adopted and aimed at a stabilisation of the temperate (exotic) blood level at 62.5%. Once this was achieved, inter-se breeding with heavy selection ensued. Figure one illustrates

the early breeding policy. The crossbreeding activities were extended in the mid-seventies over the whole southern part of Kerala. However, after having studied the performance of a large number of different crossbreds (50%, 62.5%) in the field, and, having considered the farmers preference, the original breeding policy was modified, limiting the indigenous inheritance to 50% (fig 2). In 1983 the new cross breed created was named **"Sunandini"**. Over the years the main exotic donor breeds used included *Swiss Brown*, *Jersey* and, more recently American and Canadian *Holstein*. The new crosses became very popular and their creation and multiplication were undertaken on a massive scale in the whole state of Kerala. In 1987 the cattle population of Kerala had increased to 3.4×10^6 animals with 53% of the breedable females being crossbred.[3] Presently there are three established AI stations with 100 bull capacity, producing two million doses of frozen semen per year. There are 1600 breeding centers established all over Kerala covering 1.7 million breedable stock and the number of inseminations in 1991 was 1.5×10^6.

Milk Production of Crossbred Cows

Table I. Least square means of standard lactation milk yield (kg) of different genetic groups in Mattupatti Farm (1964-1982).

Genetic group		n	x	sd.
Non descript		254	723	804
Brown Swiss	50%	336	2366	563
Brown Swiss	75%	244	2414	515
Brown Swiss	62.5%	567	2364	529
Brown Swiss	Pure	184	2231	485

Table I shows the average (305 days) milk yield of crossbreds of different genetic groups along with the parent stock. All these animals were housed under similar management and climatic conditions on a state farm. There was an almost three-fold increase in milk production in crossbreds compared to Zebu. Among the three different crossbred groups, those with 75% exotic inheritance had a marginal advantage over the other two (50% and 62.5%). Additionally crosses with 75% exotic inheritance seemed to perform better on the state farms with better management systems, than did those animals kept under village conditions[4]. Although the purebred animals had the genetic production capacity of more than 5000 kg milk, the actual performance was about 2000 kg/lactation lower and was at the level of the crossbreds. Their milk production was probably limited by poor adaptability to the tropical environment. The results of changing milk production over the years from crossbreds of the state farm and the villages may be seen in Table II.[5]

It is evident that the production level both in the breeding center and in the village conditions significantly increased through years from 1983 to 1989. This was mainly attributed to continuous selection and improvement in the management regime. There was a significant difference between the milk production of crossbreds at the breeding centre and villages. This difference widened over time and was likely due to the following reasons: the herd replacement was better managed and the genetic potential of crossbred cows was better utilized. The state farm was heavily involved in more intensive fodder production schemes

thus directly increasing feed supply to animals. The personnel had better training and the group of animals was more homogenous compared to the field conditions.

Table II. First standard lactation milk yield (kg) of crossbreds in the breeding centre and villages.

Year	Breeding Centre			Villages		
	n	x	sd	n	x	sd
1983	13	1721	402	1627	1480	481
1984	40	1890	420	1763	1640	539
1985	37	1884	484	1865	1669	511
1986	22	2240	504	1943	1691	570
1987	22	2580	562	1987	1726	530
1988	21	2371	471	1892	1732	548
1989	17	2453	627	1474	1662	536

Progeny Testing

Kerala has the distinction of being the only state in India where large scale AI is conducted combined with a sire evaluation programme to ensure genetic quality of the bulls and where exclusively frozen semen is used. The progeny testing programme currently in use is designed to transmit genetic progress through selection of bulls to breed bulls and cows to breed bulls. This has the advantage that the number of young bulls raised for AI service can be limited to the actual number of yearly replacement bulls required, the generation interval is shortened and the storage of large quantities of semen of young bulls is not necessary. Figure 3 shows the progeny testing programme schematically. The selected top five percent of the 45 proven bulls are used on top cows maintained in the state farms and in the farmers' herd to produce the next generation bulls by nominated mating. The semen of these young bulls born from proven sires are used for test AI. This is different from a classical progeny testing and breeding scheme. It has been found that the young bull programme gives an annual genetic gain more or less equal to that of a classical progeny testing programme where the best 10 per cent of bulls are used as sires of bulls and the best 25 per cent of the bulls are used as sires of dams.[6] It has an added advantage of reduced expenditure on sire evaluation. The first several batches of progeny testing bulls showed encouraging results with up to a 250 kg milk increase in lactation yield per generation.

Breed and type of cattle.

The progeny testing programme as it is implemented permits the selection of breeding bulls irrespective of the exotic breed or combination of exotic breeds. The new breed which is being evolved has the genetic pool from various breeds. While efforts are made to improve the crossbreds through the various sire evaluation techniques including progeny testing, the population is not closed. Periodically semen is imported from bulls belonging to *Brown Swiss*, *Jersey* and *Holstein* breeds, and crossed with high yielding Indian Zebu dairy breeds such Sahiwal, Gir and Rati. The bulls (50% cross) thus produced are directed into the regular progeny testing evaluation. In a recent comprehensive field study on cattle holdings in Kerala, the farmer's preferences for

breed and milk yield were investigated.[7] The results showed that farmers did not really distinguish between the breed crosses and the preferences are simple reflections of exposure to a certain breed. One-third of the farmers had no breed preference. In their recommendations these authors stated that the genetic quality of the bulls used for AI should be the primary consideration and that the new breed evolved should have good production potential, a good dairy temperament, be of medium size and have reproductive efficiency. In quantitative terms the new breed should have an age at first calving between 30-32 months, a first lactation yield of 2000-3000 kg/305 days, an adult body weight between 350-400 kg, a wither height of 105-115 cm and an intercalving period of 13-14 months. The low weight and small size make the animal adapted to the small farmers of Kerala and their existing management.

Socioeconomic Impact of Crossbreeding.

The transformation of a sizeable proportion of low- producing local cattle into high- producing crossbreds has significantly improved milk production in Kerala. While the number of male animals showed a reduction to about 50% over the period studied, the females had a marked increase in numbers which showed that the farmers shifted their utilisation of cattle in favour of milk production. The per capita availability of milk in the state during 1964/65 to 1985/86 has increased steadily from 33 g per-capita to 128 g in 1985/86 to 160 g in 1991.[3,5] This trend, not corrected for a population increase of 30% over the time period studied, is continuing. The total milk production in the state during the period increased from 0.22×10^6 to 1.2×10^6 metric tons in 20 years, an approximate increase of 600%.[3,5] The relative contribution of different segments in the Kerala cattle population to milk production has recently been studied.[8] Briefly, from 1977-1987, 73% of yield increase was attributed to the average increase of lactation yield in the crossbred cow and 12% to the increase in number of crossbreds, compared to 2% and 13% respectively of the local non- descript Zebu cow. A survey on cattle holdings in 1990 showed that the cost of milk production from local cattle was 40% more compared to the crossbreds.[7] The marketable surplus of milk was higher in households with crossbreds.[7] This shows that the gross income per cow unit is certainly higher when crossbreds are reared. The shift from low-input, low-output multipurpose local cattle to medium-input medium-output crossbred cattle has increased both, direct and indirect job opportunities.[6] It has been shown that 46% of households keep cattle and have been spending 4 to 6 hours a day for managing the cows. The indirect employment generated for cattle keeping, dairying and an allied sectors has not been quantified but is considered to be substantial.[9] The increased production and per-capita availability of milk increased the nutritional status of the population. The annual intake of milk of the people has increased and more so with those who keep crossbred cattle in comparison to native cattle.[7] This fact may be one of the most significant achievements of the crossbreeding programmes in the rural sector of the state.Current research concentrates on age of maturity of crossbred bulls at the AI stations, on reproductive performance of crossbred cows in the field, and on integrated fodder production by the marginal farmers.

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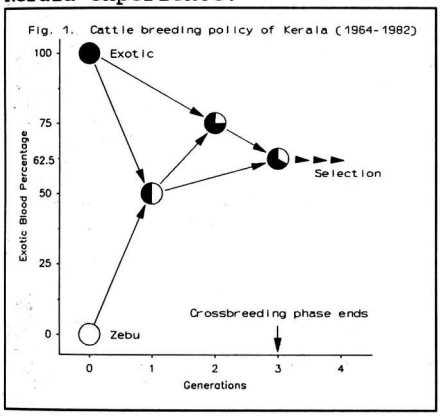

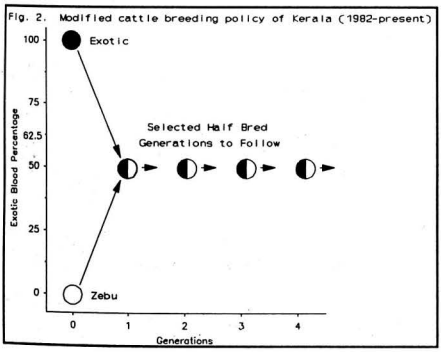

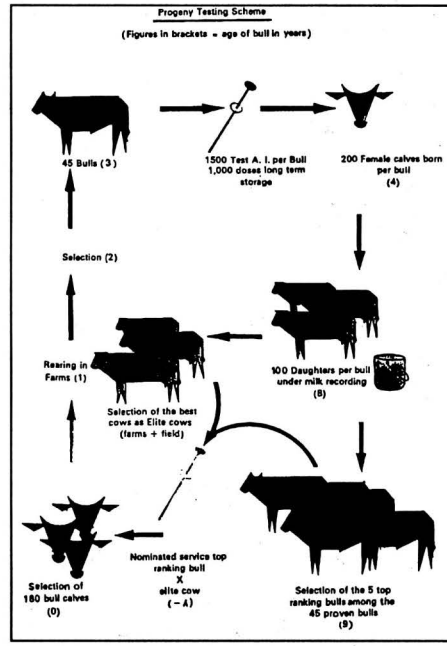

Figure 3.Kerala Progeny Testing Scheme

Summary

Over a period of 28 years a programme of limited crossbreeding of local zebu cattle with Bos Taurus dairy breeds was implemented in Kerala as a practical means enhancing the milk yield. Crossbreeding offered the most promising approach to evolve a type of cow which could be maintained economically under prevailing village conditions. The total cattle population has increased from 2.8 x 10^6 (1964) to 3.4 x 10^6(1987) animals. However the yearly total milk production over the same time span has increased from 0.22 x 10^6 to 1.6 x 10^6 (1990) metric tons. The

per capita availability of milk has increased from 33 grams to 181 grams per day, not corrected for increase of population of about 30%. In 1991 53% of the breedable female cattle population was crossbred, showing 5 times the productivity of the local zebu non-descript type animals. During 1990 1.5 x 10^6 AI were performed using frozen semen produced in 3 AI centers and distributed via 9 regional semen banks and 1500 AI units. A field progeny testing program is in place and designed to breed bulls and cows to breed cows. The temperate breeds used for this large-scale crossbreeding have included over the years Brown Swiss, Jersey and Holstein resulting in the creation of a new breed called **"SUNANDINI"**. The optimal balance of exotic (temperate) to indigenous blood inheritance has been determined scientifically to be at around 50%.

Zusammenfassung
Waehrend den vergangenen 28 Jahren wurden in Kerala erfolgreich lokale Zebu mit Bos Taurus Milchrassen gekreuzt. Die Praxis der limitierten Einkreuzung erwies sich als die beste Methode ein Kreuzungsprodukt zu entwicklen, das den gegebenen lokalen Verhaeltnissen am meisten angepasst werden konnte. Die Rindviehpopulation ist von 2.8 x 10^6 (1964) auf 3.4 x 10^6(1987) Tieren angestiegen. Im Vergleich dazu ist die jaehrliche Milchproduktion ueber den gleichen Zeitraum von 0.22 x 10^6 auf 1.6 x 10^6 (1990) Tonnen angestiegen. Die Pro-Kopf-Konsumation von Milch ist von 33 G auf 181 G pro Tag angewachsen, dabei ist ein Bevoelkerungszuwachs von 30% nicht miteingerechnet. Im Jahre 1991 waren 53% der zuchtfaehigen Rinder Kreuzungstiere, mit einer 5-fachen Milchleistung der lokalen nicht reingezuechteten Zebu. Waehrend 1990 wurden 1,5x 10^6 Gefriersamen-Besamungen gemacht. Dieser Samen wurde in 3 Besamungstationen produziert und via 9 Samenbanken und 1500 Besamungszentren verteilt. Ein erfolgreiches Nachzuchtpruefungsnetz garantiert Zuchtfortschritt. Jersey, Braunvieh und Holsteinrassen waren die Donorrassen fuer das Kreuzungsprogramm. Die neue Rasse heisst **"SUNANDINI"** und hat einen optimalen Fremdblutanteil von 50%.

Resumen
Durante un periodo de 28 anos, un programa de cruzamiento controlado entre ganado Cebu nativo (*Bos indicus*) y razas lecheras *Bos taurus* fue implementado en Kerala con el objeto de obtener un incremento en la producion de leche. El cruzamiento de esta razas permitio abordar el programa de mejoramiento con miras a desarrollar un tipo de vaca que puediese ser mantenida en las condiciones prevalentes de las pequenas poblaciones de la region. La poblacion total ganadera ha sufrido un incremento de 2.8 x 10^6 (1964) a 3.4 x 10^6 (1987) cabezas y el incremento en la produccion lechera total en el mismo periodo de tiempo ha sido de 0.22 x 10^6 a 1.6 x 10^6 (1990) toneladas metricas. La disponibilidad per capita de leche ha subido de 33 gramos a 181 gramos por dia; esto sin haber corregido para el incremento en la poblacion de un 30%. En 1991, 53% del ganado hembra en capacidad de ser servido fue cruzado con otras razas y la produccion de leche ha alcanzado 5 veces lo producido por el ganado Cebu nativo. En 1990, 1.5 x 10^6 inseminaciones artificiales (IA) se llevaron a cabo usando semen congelado producido en 3 centros de IA y distribuido por medio de 9 bancos regionales de semen y 1500 pequenas estaciones de IA. Un programa de pruevas de progenie a nivel de campo fue iniciado para producir toros provados. Las razas europeas usadas en este programa fueron: Pardo Suizo, Jersey y Holstein. Este cruziamento dio origen a una nueva raza llamada "SUNANDINI". El balance optimo de sangre exotica y sangre nativa necesaria ha sido determinado cientificamente y se considera que es alrededor del 50%.