204

Current Status and Factors Affecting the Success of Artificial Insemination in Small-holder Farms in the Mid Country Wet Zone of Sri Lanka

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ABSTRACT. *A questionnaire survey was conducted to determine the present status of artificial insemination (AI) in 200 small-holder dairy farms in five veterinary ranges (Gampola, Kundasale, Teldeniya, Udunuwara and Yatinuwara) in the Mid Country Wet Zone of Sri Lanka. The average land holding was 0.05±0.03 ha and the herd size was 2.75±1.66 animals, with 1.65 breedable cows, 0.7 heifers and 0.3 young bulls. Artificial insemination was used by 98% of the farmers and the quality of the AI service was graded as good by 70%, as average by 20% and as poor by 10%. The major problems associated with the AI service were identified as non-availability at the correct time (26%), need for many repeat services (23%) and more male calves born (6%).*

A subsequent longitudinal study was conducted in four of the above veterinary ranges (excluding Teldeniya). Detailed observations were recorded on cows receiving first AI and progesterone was measured by Radioimmuno Assay in milk samples collected on days 0, 10–12 and 21–23 after AI. The mean interval from calving to first service was 183±87.1 days (n=211) and the interval to conception was 194±93.9 days (n=143). The first service conception rate (CR) was 45% and overall CR was 50.2% (ranging from 31.3% in Yatinuwara to 60.8% in Udunuwara), with an average of 1.99 services per conception. The study showed differences in CRs due to location, feeding, body condition score, days post-partum, month, timing of AI, bull, semen type and origin, and technician.

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INTRODUCTION

The total cattle and buffalo populations of Sri Lanka are around 1.7 million and 0.8 million, respectively (Sri Lanka Livestock Statistics, 1991/92). Over 65% of cattle and 95% of buffaloes are of indigenous types, while the remainder are combinations of different genotypes as a result of cross–breeding programmes with exotic breeds (Richards and Agalawatta, 1981; De Silva *et al.*, 1985; Abeygunawardena *et al.*, 1996). Thus, the productivity of the dairy sector has been severely limited by the low genetic merit of the national cattle and buffalo population. Over 90% of these animals are reared by small–holders. The predominant genotypes, system of management and primary purpose vary with agro–ecological conditions and cropping patterns (Abeygunawardena *et al.*, 1996).

National development programmes have recognized the need to improve the livestock sector as a means of rural development and concurrently to achieve self sufficiency in livestock products, particularly in milk. Over the past 50 years attempts have been made to improve the productivity of cattle and buffaloes through cross breeding with superior sires and artificial insemination (AI) using semen from progeny tested bulls as the primary strategy (Livestock Development Strategy, 1988; Soni *et al.*, 1991). AI services are provided by the state through its regional veterinary offices and the inseminations are carried out mainly by state–employed inseminators (Abeygunawardena and Amarasekera, 1995).

Artificial insemination has been widely used in the wet zone of Sri Lanka, which carries 32% of the total cattle population and produces nearly 50% of the milk collected by the organized milk marketing network (Abeygunawardena *et al.*, 1994). Since this region also has a favourable climate, a cattle population with high proportion of *Bos taurus* blood, year–round vegetation and reasonably developed infrastructure including animal health and breeding services, it has high potential for increased milk production through further genetic improvement of cattle. In spite of widespread use of AI in this zone, recent studies show that the average productivity of the cattle population has actually declined over the last few years and is at present around 5 litres per cow per day (Abeygunawardena *et al.*, 1995b). Furthermore, although efforts have been made through various projects and programmes to improve AI services, the average first service conception rates (CRs) achieved appear to be less than 30% and repeat breeding is a major cause of infertility in cattle subjected to AI (Soni *et al.*, 1991; Abeygunawardena *et al.*, 1995a). Therefore, a study was undertaken with the

objectives of (a) assessing the present status and constraints of AI services and (b) determining the factors affecting the success of AI in small–holdings in the Mid–country Wet Zone of Sri Lanka. The first objective was achieved by undertaking a field survey with a structured questionnaire and the second objective through a long–term longitudinal field study.

MATERIALS AND METHODS

Field survey of small–holdings

A structured questionnaire was developed to collect information on: herd size, composition and breed types, methods of rearing, feeding, breeding and heat detection, preferences of farmers for type and breeds of semen and their perceptions regarding the AI service. The questionnaire was pre–tested for validation before use. Five veterinary ranges in the Mid Country Wet Zone region, namely Gampola, Kundasale, Teldeniya, Udunuwara, and Yatinuwara were purposively selected and 40 small–holdings were randomly selected from each veterinary range. Each farm was visited by an enumerator, the farmer interviewed and the animals examined to complete the questionnaire. The survey was carried out during the period January to December 1995 and included a total of 200 small–holdings. The data was tabulated and analyzed using a computer database (Microsoft Access).

Longitudinal field study

Four of the veterinary ranges which were covered in the above field survey, namely Gampola, Kundasale, Udunuwara, and Yatinuwara were selected for the longitudinal study on AI services. The study was conducted during the period January 1996 to June 1997. In liaison with the range veterinary offices and the inseminators serving these ranges, dairy cows receiving first inseminations following a recorded calving were monitored until they were confirmed pregnant. One of the investigators accompanied the inseminator and, at the time of AI (day 0), detailed information related to the farm, cow, semen and inseminator were recorded. A milk sample (10 ml) was collected into a bottle containing a potassium dichromate tablet as preservative. A second milk sample was collected 10–12 days later from the same cow and, if the cow was not presented for a repeat AI, a third milk sample was collected at 21–23 days after the AI. Dates of subsequent services, if any, were recorded for cows presented for repeat services. In all cases, those not returning to

service within 60–90 days after the last service were examined for pregnancy by rectal palpation.

Milk progesterone assay

Milk samples were placed in a refrigerator (4°C) within 6 hours of collection and transferred to the laboratory for processing within 7 days. They were centrifuged at 4°C and 1000 × g for 10 minutes, the fat-free fraction (skim milk) was drawn off and stored at –15°C until assay. Progesterone concentration was determined using a direct solid-phase Radioimmunoassay (RIA) employing antibody–coated tubes, ^{125}I–progesterone as tracer and standards prepared in skim–milk (kits supplied by the Joint FAO/IAEA Division, Vienna). The intra–assay and inter–assay coefficients of variation were 9% and 14.5%, respectively.

Data tabulation and analysis

The data were entered into the Artificial Insemination Database Application (AIDA) developed under Microsoft Access and supplied by the Joint FAO/IAEA Division.

RESULTS

Field survey

In the small-holdings surveyed, cattle farming was a secondary income generating activity, while the primary economic activity was either on–farm crop cultivation or off–farm employment. The mean (± SD) land extent of the small–holdings was 0.05±0.03 hectares, consisting of upland home gardens and lowland rice fields. All family members contributed to cattle farming activities such as cutting grass, cleaning the sheds and milking. The average herd size was 2.75±1.66 animals, with 1.65 breedable cows, 0.7 heifers and 0.3 young bulls. Friesian was the most common breed, with crosses of this and other European breeds (Jersey, Ayrshire and Shorthorn) being popular.

Management practices

Almost all farmers used a tie-stall system in small sheds which were mostly located adjacent to the dwelling house. Most sheds were ill suited for the purpose with unsatisfactory floors, feeding and water troughs, but had adequate light and ventilation. The majority of farmers (85%) practiced a 'cut–and–carry' system (zero grazing), while the remainder practiced a combination of tethered grazing and night feeding with cut grasses and fodder. Most farmers (>90%) depended on communal areas such as road sides, state reservations and uncultivable lands for supply of green feed. The principal grass fed was Guinea A. amounting to about 30–40 kg wet weight per cow per day, but the quality and the quantity varied much throughout the year. In addition, 1 to 2 kg/day of concentrate (usually a mixture of coconut poonac and rice bran) and 20–30 g/day of mineral mixture were fed around milking time. Milking was done twice a day and the calves, which were kept tied in the same stall, were allowed to suckle only after each milking.

Animal breeding practices

Most farmers (98%) used AI for breeding their cows, while the remainder used both AI and natural service. As the animals were usually tied in the stall adjacent to the farmer's house, they were under constant observation by the family members. Vaginal discharge was considered as the main sign of oestrus by 90% of the farmers, while frequent bellowing, restlessness and drop in milk yield were also considered as important signs. In deciding on the time for breeding a postpartum cow, 36% of farmers skipped the first few heats and served at the third or fourth heat, as they believed that early breeding resulted in reduced milk yield; 25% skipped the first and served at the second heat; 33% served at the first detected heat and 3% served anytime after 60 days from calving. The breed of semen was determined by the farmer's preference and availability of that type of semen, rather than on an accepted breeding policy or the dam's production levels. However, 43% had no specific preference while 33% preferred Friesian, 16% Jersey and 6% Ayrshire. The main reasons for preferring Friesian were that they liked the colour and potentially higher milk yield.

Farmers' perceptions regarding AI

The majority of farmers (70%) stated that the quality of the AI service could be graded as good, while 20% considered it as average and only 10% considered it to be poor. On the other hand, the problems associated with the AI service were identified as non–availability at the correct time (26%), the need for many repeat services to get cows pregnant (23%) and the birth of more male than female calves (6%).

Longitudinal field study

The fertility indices of cattle subjected to AI in four veterinary ranges, based on 211 first inseminations on smallholder farms, are given in Table 1.

Table 1. Fertility indices in cattle subjected to AI in four veterinary ranges in the mid-country wet zone of Sri Lanka.

Veterinary Range	Mean (± SD) interval (days) from calving to:		Conception rate (%) to:		Services per conception
	First service	Conception	First service	All services	
Gampola	131±51.5 (n=34)	113±50.6* (n=17)	50.0 (n=34)	50.0 (n=34)	2.0
Kundasale	170±114.0 (n=52)	188±74.8 (n=39)	34.6 (n=52)	45.9 (n=85)	2.2
Udunuwara	186±80.8 (n=84)	200±89.3 (n=73)	53.6 (n=84)	60.8 (n=120)	1.6
Yatinuwara	242±103.3 (n=45)	265±131 (n=15)	33.3 (n=45)	31.3 (n=48)	3.2
Overall	183±87.1 (n=211)	194±93.9 (n=143)	45.0 (n=211)	50.2 (n=287)	1.99

* Based on first service conceptions only

209

At the time of the first postpartum service, the mean body weight of the cows was 321.2±77.5 kg, the body condition score (BCS, on a 1–5 scale) was 2.7±0.4, and the average milk production was 7.7±4.1 litres per day.

Efficiency of heat detection

Results from milk progesterone assay for day 0 samples (n=177) revealed that 72.8% of the AIs were performed when progesterone was below 1 nmol/l, indicating that the cow could have been in heat, but 19.7% of AIs were done when progesterone was above 3 nmol/l, when the cow could not have been in heat. The remainder of the samples (7.5%) had values in the inconclusive range (1–3 nmol/l). Progesterone values for samples collected on days 0 and 10-12 (r=154) showed that only 54.5% of the animals had a normal ovulatory cycle, while 14.2% were either anoestrous, anovulatory or had short luteal phases. The progesterone values from all three samples (days 0, 10–12 and 21–23) were available for 123 services and this along with data from rectal palpation 60–90 days after service indicated that 43% conceived to that service, 5.6% had non–fertilization or early embryo mortality, 4% had late embryo mortality or persistent corpus luteum (CL), and 4.8% of cases had been inseminated during pregnancy.

Effect of different factors on success of AI

Farm factors

No differences in CRs were evident in animals managed semi–intensively and intensively. However, higher CRs were observed in animals fed with concentrates (40%) than in those not fed with concentrates (27%). When farms were grouped according to percentage of family income from dairy farming, those with less than 25% had an average CR of 26%, while those with higher proportion of income from dairying had CRs above 40%. For AIs performed 6, 12, 18, 24 and 30 hours after first detection of heat, the CRs were 25, 34.7, 38.1, 63.4 and 37.5%, respectively. The highest CRs (>60%) were recorded during the months of June, July, August and September, while the lowest (<30%) were recorded in March, April and November.

Cow factors

The CR at first service (45%) was lower than that to all services (50.2%). The CRs declined from parity 1 up to a parity of 5; thereafter the numbers were too small for comparisons. Animals with a BCS of 2 and below had lower CRs than those with BCS of 2.5 and above. Cows receiving their first service before 60 days postpartum had lower CR than those receiving the first service after 60 days. The data on other cow factors such as breed, body weight, milk yield, intensity and type of oestrous signs were inconclusive.

Bull/semen factors

Semen from 22 bulls had been used in the sample under study. Of these, semen from seven bulls had been used for more than 20 services and their CRs ranged from 18.2–70.4%. Semen originating at the Kundasale AI station gave higher CR (49%, n=181) than imported semen (30%, n=166). Similarly, locally processed chilled semen recorded higher CR (43.2%, n=36) than imported or locally processed frozen semen (39.8%, n=311). Data on effects of motility before processing were inconclusive.

Inseminator

In the present study, only one technician was monitored in each of three veterinary ranges (Gampola, Kundasale and Udunuwara), while two were monitored in the fourth range (Yatinuwara). The ages of the five technicians monitored ranged from 41–49 years. All of them had more than 2 years experience in AI and were also engaged in work other than AI. The overall CRs achieved by them during the study ranged from 27.8% (in Yatinuwara) to 58.5% (in Udunuwara).

DISCUSSION

In about a quarter of small–holdings in the Mid Country Wet Zone of Sri Lanka, cattle farming for dairy production is an integral component of a mixed farming system (Abeygunawardena *et al.*, 1996). As shown in this study and also by previous studies (Abeygunawardena *et al.*, 1995b), the animals are predominantly *Bos taurus* genotypes and the system of management is semi-intensive or intensive. Roughage feed is mostly natural grass from communal

sources and is supplemented with tree fodders and small quantities of concentrates. The average milk production recorded in this study (7.7 litres per day) appears to be low considering the potential of the genotypes in this sample. This could be attributable to inadequate and/or imbalanced feeding. The responses obtained during the questionnaire survey indicated that feeding of roughages as well as concentrates was limited, the former by availability and the latter by its high cost.

Most farmers resorted to AI for breeding their cows. This is likely to be due to the awareness of the value of AI for obtaining a calf of higher dairy potential. A further factor may be the unavailability of good quality stud bulls in their villages, since it is uneconomical and impractical to maintain stud bulls on small-holdings. The finding that the majority of farmers had no specific preferences for breeds or type of semen indicate that they are poorly informed about the relative merits and suitability of different breeds for their particular farming environment. This points to an important need to educate the farmers on breeding goals and the appropriate use of AI to achieve these goals.

In the present study the majority of farmers stated that the AI service provided was satisfactory. However, when questioned further, they identified several shortcomings which included non-availability at the required time and the need for repeat services to get their cows pregnant, indirectly indicating that the service was not fully satisfactory. Their reluctance to criticize the service directly could be due to socio-cultural factors or an apprehension that this may jeopardize future services.

The farmers' knowledge on reproductive management of cattle was clearly poor. The majority did not breed their cows until several months after calving. This was due to a misconception that early re-breeding adversely affects the milk yield of the cow as well as the growth of the calf. The average calving to first service interval in this study was 183 days, whereas in a previous study in this area (Abeygunawardena *et al.*, 1995c) the average interval from calving to first rise in plasma progesterone was around 75 days. While one of the reasons for the delay in first service could have been postpartum anoestrus due to poor nutrition as suggested by these authors, it is also likely that even those which returned to oestrus early in the postpartum period were kept unbred by the farmers due to the above misconceptions.

As evidenced from progesterone measurement in milk samples, the accuracy of oestrus detection by the farmers was poor. Around 20% of the animals presented for AI had high progesterone levels and therefore could not

have been in heat. Even in those with low progesterone levels at the time of AI, only about 55% appeared to have had a normal ovulatory oestrus. These results reinforce the findings of a previous study (Mohamed *et al.*, 1990) and indicate the need for farmer education, training and extension in this area as well.

The average first service CR was 45%, which can be considered within the lower range of acceptability for a developing country. However, two of the veterinary ranges studied had CRs below 35%, which is below acceptability. A large number of factors relating to the farm, cow, semen and inseminator were recorded in this study. However, given the highly heterogeneous nature of the sample, many of these factors did not have sufficient records in their different categories to allow accurate interpretation. Also, several of the factors were interrelated and therefore produced confounding effects. However, a few factors, as discussed below, were perceived to be of practical importance and were found to have an overriding influence on CRs. These provide insights to ways in which the fertility of cattle in this region, as well as the AI service, might be improved.

Higher CR was found in animals fed concentrates as a supplement to roughages than in those not fed concentrates. The importance of nutrition is also evidenced by the finding that cows with a BCS of 2.5 and above had higher CR than those with a BCS of 2.0 and below. Thus improved nutrition will not only reduce the postpartum anoestrus period as discussed above, but will also improve CR. The finding that farms with higher proportions of their total family income from dairying had higher CR than those with lower proportions indicate that these families attached more importance, and hence paid more attention, to the care of their cows. Presumably, this included better feeding and heat detection, resulting in higher fertility.

The timing of insemination relative to first detection of heat is known to be critical for achieving high CR (Peters and Ball, 1995). In the present study the CR increased as the interval increased from 6 up to 24 hours, and then declined. In theory, the optimum time for service is 12–18 hours after onset of 'standing' heat. However, in the present study, the animals were housed or tethered and there was no opportunity for them to exhibit standing heat. Thus it is likely that the farmers' reliance on signs such as vaginal mucus discharge and bellowing may have resulted in animals being detected during pro–oestrus, several hours before the actual onset of oestrus. This could explain the above results, since AI done 18–24 hours after detection by the farmer would mean 12–18 hours after onset of standing heat. The incorrect timing of AI can be a major constraint in many regions of Sri Lanka. This stems from the ignorance

213

of farmers regarding the importance of correct timing of service and the poor communication between small–holdings which are scattered and the AI service points which are few. Attention therefore needs to be focussed on addressing these deficiencies.

Variations in fertility were also observed due to bulls. Of the seven bulls from which semen had been used for at least 20 inseminations, one had very poor CR (18.2%), while two others had CRs below 45%. The continued use of such bulls in an AI programme is clearly unsuitable. A regular programme should therefore be instituted to monitor each bull used in AI and to cull those that have low fertility. Semen produced locally gave higher CR than imported semen. Assuming that the imported semen was of good quality at the point of origin, problems during subsequent transport, storage and/or handling could have been responsible for the decline in fertility. Also, higher CR was obtained with chilled semen than with frozen semen, whether locally produced or imported. This further stresses the need for special care in all operations associated with frozen semen. The findings of this study emphasize the need for provision of optimal conditions for transport and storage of semen, and also for routine monitoring of the quality at the point of receipt and during storage.

Factors related to the technique of performing AI are also very important determinants of CR in field AI programmes. These are influenced not only by the skill of the technicians, but also by their motivation, attitudes and the facilities available to them. In the present study, only one technician was monitored in each of three veterinary ranges, while two were monitored in the fourth range (Yatinuwara). Thus location was a confounding factor in interpreting the influence of technicians on CR in this study. However, the wide range of CR seen in individual technicians (27.8–58.5%) is noteworthy. Also, both technicians monitored at Yatinuwara had the lowest CRs. Further studies should therefore attempt to partition the effects of other factors such as location, bull and semen type in order to evaluate the true effects of technicians on CR. This would permit the identification of any deficiencies of the facilities available to them, or for further training to improve their skills.

CONCLUSIONS

The findings of this study indicate that the overall success rate of AI in small–holder farms in the Mid Country Wet Zone of Sri Lanka is in the lower range of acceptability, with high variability in CR among locations. This

can be attributed to many factors which can be broadly categorized between the AI service provider and the recipient. With regard to the provision of AI services, differences were attributable to the bull, the type and origin of semen and the technician. This highlights the need to ensure that all events in the chain from selection of bulls to field use of semen are done under optimal conditions. With regard to the recipient farmers, factors which contributed to differences in CR included the management system, feeding and body condition score of cows, detection of heat and timing of AI. Thus improving their knowledge and skills in these aspects of dairy cattle production is essential if the optimum benefits from AI are to be realized.

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