4 RESULTS and DISCUSSION

4.1 Biological coefficients

The general picture that emerges from the results of this study (table 4.1) coupled with the results of other studies in the region (table 4.2) confirm the low performance of the Holstein-Friesian in the tropics as compared to its performance in temperate regions. A number of authors (WEBSTER, 1993; GANGWAR et al, 1965; REGE, 1991) ascribe this to climatic stress, lower levels of husbandry practices, and the inferior quality of tropical forages.

The 42% increase in annual milk yield (AMY) since MARPLES and TRAILS (1967) made a study on the Holstein- Friesian can be attributed to the continued use of the ever-improving genetic value of imported semen through the years and to the progressive increase of knowledge among farmers on how to manage exotic breeds. Since AMY combines production and reproductive abilities in dairy cows, it is usually used to make comparisons in performance among individual animals, herds, regions and studies. It was calculated as milk yield per day of CI corrected to 365 days.

Table 4.1: Descriptive statistics : Biological coefficients

Trait	Bounds of inclusion		n	mean	SD	CV %	Min.	Max.
	lower	upper						
MY (kg)	-	-	343	3266	969	29.7	766	7293
LL (days)	161	499	343	322	61	18.9	172	499
CI (days)	300	765	268	444	92	20.7	306	737
AFC (days)	540	1460	102	968	207	21.4	571	1447
BAFC (years)	-	-	9	2.37	0.19	8.02	2.1	2.7
LP (years)			289	4	-	-	1	10

Data analysed covers a period from November 1975 – February 2002

MY = Total lactation milk yield
CI = Calving interval
LL = Lactation length
AFC = Age at first calving
BAFC = Bull age when its first calf or offspring is born
LP = Length of production or use of cow (productive life)

Table 4.2: Comparison of studies made in the East African region: biological coefficients of the Holstein-Friesians breed.

Reference	Study location	MY kg	CI days	AMY kg	LL days	AFC months
This study	Lake Victoria crescent region, Zero grazing & fenced dairying	3266	444	3702	322	32
Nassuna (2001)	Peri-urban, Kampala-Uganda Zero grazing and fenced dairying	3929	464	3090	338	na
Marples & Trail (1967)	Central region, Uganda institutional farms, fenced dairying	3197	447	2611	na	na
Ojango (2001)	Kenya Large scale farms	4541	406	4082	300	31
Rege (1991)	Kenya	3577	411.6	2984	na	35.1
Kiwuwa (1972)	East Africa	2923	429	2487	na	34

na = not available AMY = Annual Milk Yield

The longer CI in NASSUNA's study (2001) as compared to that in this study can be attributed to the former study being based on peri-urban farms whose owners are usually part-time dairy farmers, hence cows on heat are more likely not to be serviced or serviced late due to poor or missed detection of heat. In this study, the majority of farmers where fully committed to dairy farming. The long CI, as has been established in both these studies, can be blamed on poor heat detection especially in zero grazed animals and on post partum true anoestrous. The low heritability estimates of CI, which range from 0.00-0.10 (MAO, 1984) indicate the more influential role of the environment over this trait.

Heat detection aids like heat expectancy charts and Bovine Beacon from OmniGlow are recommendable especially given the fact that approximately 70% of all heats occur between 10:00 pm and 6:00 am (OMNIGLOW, 2005; OSEI et al, 2005) and only 50% of the heats are detected (IAEA, 2002). More training and sensitization of farmers on how to detect heat especially in the zero grazing system is exigent. JORDAN (2005) points out that many studies have shown that failure to detect oestrus is the single most costly management error in dairy herds.

In a study conducted by ELWISHY (1976), on farms in the central region of Uganda, inactive ovaries were found to be responsible for anoestrus in 92.9% of cows three months post partum. NASSUNA (2001) further reports that resumption of oestrus occured 96 days post partum, and 46% of the cows that did not conceive immediately to the first insemination underwent a period of sexual inactivity before they started cycling again. WEBSTER (1993) singles out inadequate nutrition to be responsible for this observed reduction in fertility. During the early stages of lactation, priority in terms of nutrients is given to milk production and in the process reproductive functions are disadvantaged (ROXSTRÖM, 2001). This energy imbalance becomes more pronounced in the tropics where nutrition is usually a major limiting factor to production. Proper feeding of lactating animals especially in the early stages of lactation is critical to fertility parameters such as CI, which greatly influence returns in breeding programmes. Anoestrus due to heat stress should also not be underestimated (GANGWAR et al., 1965). SMITH (2005) reports that in Southern USA, conception rates can be as low as 10-20% during summer. Zero grazing pen units with roofs made of heat insulating local material (e.g., grass thatch) could reduce on heat stress of the animals.

A 1% improvement in CI (i.e., decline in CI), as shown in this study (see table 3.12.), results into 380 UGS more profit per mature cow per year. As CI decreases, there is an increase in revenue from the sale of more male calves and excess heifers as needed for replacement; the delay in income from male calf sales and milk from the next lactation is reduced, that is, calf and milk opportunity cost, respectively, go down (GONZÁLEZ-RECIO et.al, 2004); and the reproduction costs go down as the number of inseminations needed per conception goes down. However, because of an increase in the number of calves born, rearing costs, that is, feeding and veterinary costs of calves and heifers go up, but these costs are outweighed by the aforementioned increased revenue sources.

Increasing CI from 365 days to 400 days, reduced annual milk yield (AMY) by 10% of Friesian animals kept in the peri-urban area of Kampala (NASSUNA, 2001). This fact is unfortunately not well conceptualised by farmers who usually look at maximum daily milk yield or total lactation yields (MY) rather than AMY which gives a better picture of farm profitability.

Age at first calving (AFC) compares favourably with that of Kenya and is within acceptable levels for tropical conditions. Results of a study on the Iranian Holstein-Friesian by NILFOROOSHAN and EDRISS (2004) indicate the optimum AFC to be 24 months and to be highly influenced by environmental factors. LOSINGER and HEINRICH (1996) showed production to be lower when AFC is greater than 27 months. STRANDBERG (1992) found a slight increase in length of productive life with increased AFC up to 30 months, followed by a plateau and then a decline.

AFC is basically determined by age at puberty which may be delayed by under-feeding, disease or parasites; perturbations that are not uncommon in the tropics. Heifers reach puberty at 30 to 40 percent of the average mature weight. At this time, the hormonal patterns that regulate the oestrus cycles begin developing and result in the heifer coming into heat on a regular basis (GRAVE and MCLEAN, 2003). LOSINGER and HEINRICH (1996) recommend the breeding of heifers to be based on body weight rather than age.

These findings suggest that there is still a need to decrease on the AFC through improved disease control and nutrition of heifers. Decreasing AFC would impact positively on genetic progress through a reduction on the generation interval that would result into earlier use of proven bulls (PB), hence leading to earlier realisation of returns for the breeding programme.

The major reason why animals leave the herd could not precisely be established. The length of four years productive life is rather low in these production systems. Farmers prefer to keep their animals, especially relatively high yielders, as long as possible in their herds. GILL (1976) points out that the highest profits come from high yielding cows that are able to remain in the herd for several lactations.

The better biological coefficients of Kenya as compared to those of Uganda can be explained by the former country having a longer history of dairy farming than the latter, and is as such more experienced in the management of exotic dairy cows. For example, commercial use of AI started 20 years earlier (1941) in Kenya than in Uganda.

Table 4.3: Descriptive statistics - Services per conception (SC)

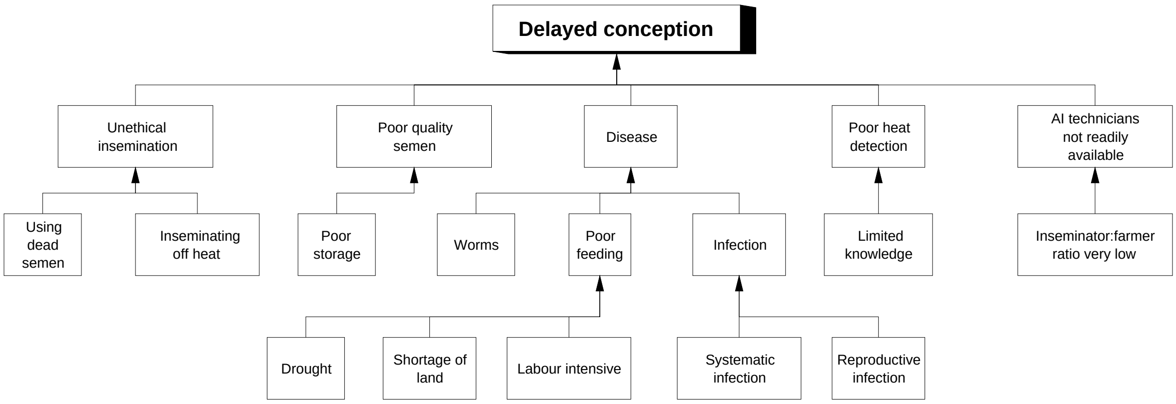
Type of service	Database used	n	mean	SD	CV	Min.	Max.
basically natural	Panacea	280	1.45	0.93	64.1	1	6
artificial insemination and natural	Access	391	1.54	0.88	58.3	1	4
exclusively artificial insemination (AI)	AIDA	193	2.40	1.41	58.2	1	6
all types of services weighted together		844	1.70	1.09	64.1	1	6

Data analysed covers a period from November 1975 – February 2002

Natural service, as expected, has the lowest services per conception (SC). The problems associated with heat detection, timing of service, and semen quality in terms of viability are ably solved by the use of a bull. The major limitation of natural service is usually, though not always, the inferior genetics as compared to AI sires and the problems associated with keeping of a bull. JORDAN (2004) asserts that using genetically superior AI sires increases genetic progress in herds 3 or 4 times than what is achieved with natural service. Standing heat behaviour, the most reliable sign for predicting when cows will ovulate and, therefore, when they should be inseminated, cannot be expressed in solitary confined zero grazed animals hence making proper heat detection and timing of AI difficult. This is exacerbated by the reduction in duration and intensity of oestrus expression due to climatic stress. GWAZDAUSKAS et al. (1973) are of the view that regardless of management and nutrition standards, services per conception are usually higher in warmer climates. SANDHIPIROJ (1999) reports a figure of 2.75 for imported Holstein cows from Canada to Thailand, despite being raised under good feeding and management system on government demonstration farms. Early embryonic death due to both low metabolisable energy diet and high solar heat load may be responsible for repeat breeding in animals under the fenced dairy system (NASSUNA, 2001).

Improvement of this parameter is one of NAGRC's greatest challenges which has to be tackled from all angles of interrelated/interacting factors on which it clings as identified by farmers during the LSRP diagnostic survey (see figure 4.1). For example, farmers have to be trained in fertility management, skills of inseminators have to be enhanced, quality control of semen has to be effected etc.

Figure 4.1: Problem-causal tree for delayed conception in cattle - zero-grazing systems

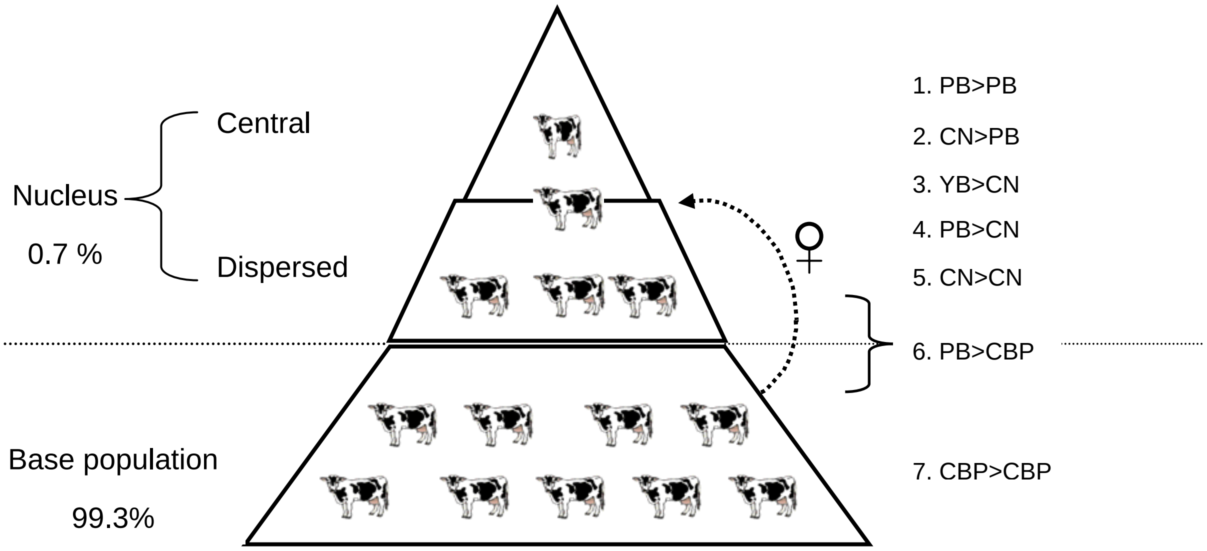


Source: LSRP Diagnostic Survey Report – Jinja district (LSRP; 1999b)

4.2 Population structure

The size of the breeding population is 100,000 animals with the nucleus and the base population making up 0.7 % and 99.3% of the population, respectively. The nucleus consists of two units: the central unit that will be based at Njeru stock farm and the dispersed unit which will consist of farmers in the fenced dairy production system. It is envisaged that farmers who will be part of the dispersed unit should have enough cows, at least twenty, for contemporary testing of daughters of different bulls, use exclusively AI, and carry out intensive recording of their herds. Splitting the nucleus into two minimizes the risks associated with concentrating stock and resources in one unit (e.g., in case of disease outbreak). The dispersed unit also offers a possibility of increasing the nucleus size through recruitment of more farmers on the programme. This is far easier than trying to increase on the size of the central unit through acquisition of more land – a difficult task in the locality of Njeru stock farm. Progeny testing with use of a high proportional of young bulls (PCYB) in the nucleus is to be used. A fixed number of 4 PB is to be selected for each round of selection. Semen from PB will be used to disseminate genetic gain attained in the nucleus to the base population.

Figure 4.2: Population structure and selection groups



PB = Proven Bulls

YB = Young Bulls

CN = Cows in the nucleus

CBP = Cows in the base population

4.3 Gene flow

The flow of genes in the system is schematically presented in Figures 3.3 and 4.3 and is discussed under two pathways, sire and dam pathways.

Sire pathways

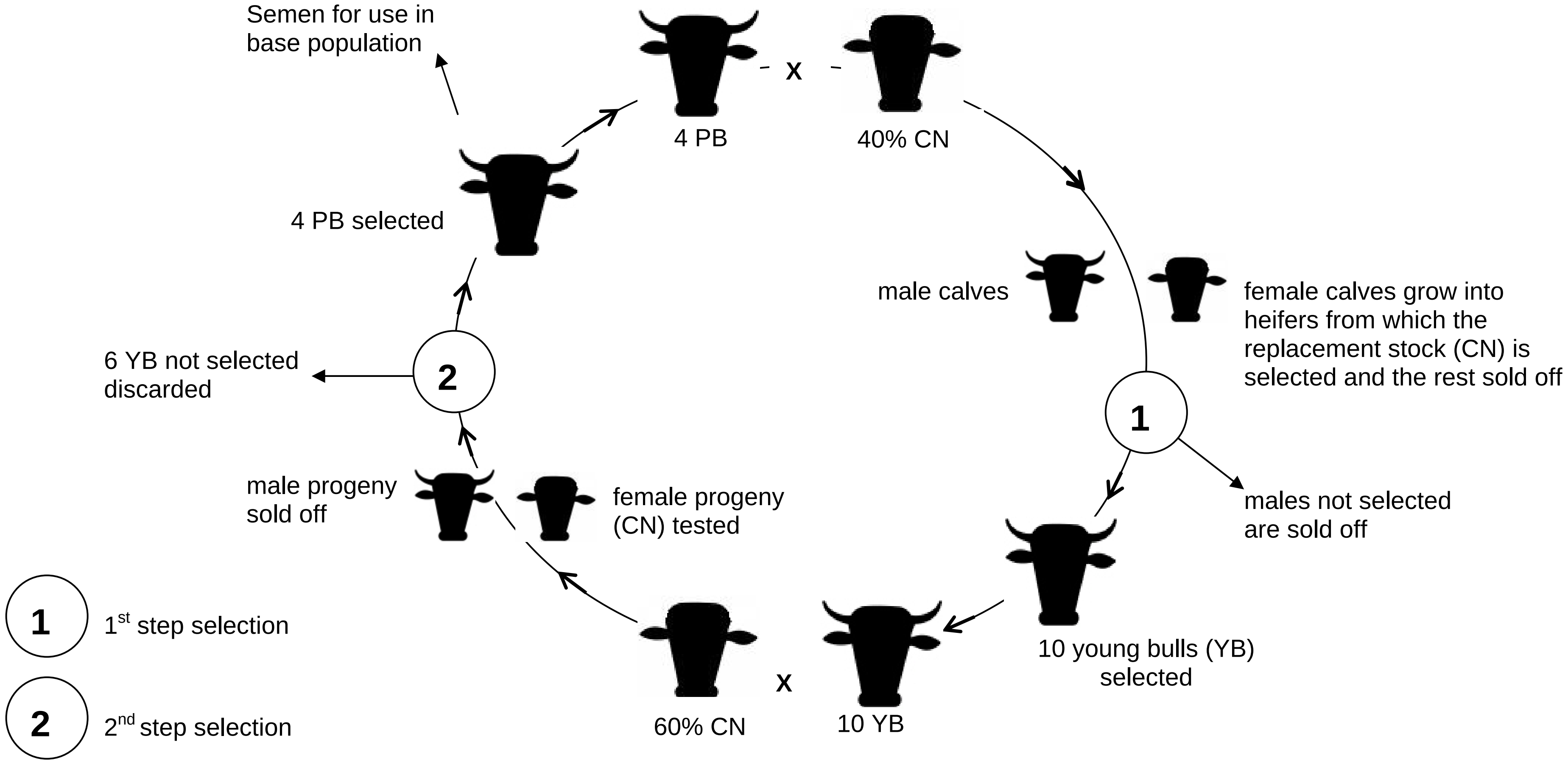
- All males in the nucleus are offspring of PB.
- PB are selected in a two-step procedure.
- PB are mated to 40% of CN to produce both male (1. PB> PB) and female animals (4. PB>CN).
- During the development of males, and at a certain point, selection takes place to remain with only 10 YB. Selection is based on the performance of their dams. This is the first step in the selection of PB.
- Assuming that each YB is capable of becoming a PB, so much semen as will be needed from each YB is collected after which they are slaughtered.
- The 10 YB are then mated to 60% of CN. The males resulting from this mating are disposed off and the females (3. YB>CN) are kept for progeny testing. After progeny testing, 4 out of the 10 YB are selected and are then known as PB. This is the second step in the selection of PB.

- Semen from PB is used to service cows in the base population (6. PB>CPB). The females resulting from this mating are used further in the base population.
- Males produced in the base population are not to be used for breeding purposes.
- For the first years, semen for PB will be imported to start off the programme. WELLER (1994) recommends the importation of small amounts of semen of proven bulls from other populations to produce the first crop of young sires.

Dam pathways

- CN mated to PB produce both male (2. CN>PB) and female animals (5. CN>CN).
- CN mated to YB produce males which are disposed off, and the females (5.CN>CN) are used for progeny testing the YB.
- Basing on own performance and on the performance of the dam, selection is done on all CN.
- CBP are mated to PB to produce females (7. CBP>CBP) which are used further in the base population. The males resulting from this mating are not used any further. It is assumed that there will hardly be any selection in group 7. CBP>CBP. Since proven semen is to be used in the base population, there will always be excellent females in this tier which will be brought into the nucleus.

Figure 4.3: Progeny Testing with a high Proportion of Young Bulls in use



4.4 Breeding schemes

Six breeding schemes in 3 groups were modelled. The first group, made up of schemes, I, II, and III, enabled us to define a basic situation, which we considered to be the optimal one, that is, 10 YB + 0.6 PCYB, 6 inseminations per daughter record (Ins/DR), population and nucleus size of 100,000 and 700 animals, respectively. The two other groups were made up of schemes IV, V and VI, which involved varying certain parameters of the basic situation. The criteria for evaluating the schemes is described in Chapter 3 (Materials and methodology).

4.4.1 Scheme I - Simultaneous varying of YB and PCYB

Table 4.4: The effect of increasing the proportion of cows mated to young bulls (PCYB) and the number of young bulls (YB) on the **annual monetary genetic gain** (Ugcp) and on the average number of daughter records per young bulls (DR/YB) in brackets.

	PCYB			
YB	**0.5**	**0.6***	**0.7**	**0.8**
5	0.87 (11)	0.87 (14)	0.84 (16)	0.80 (**18**)
10*	1.00 (5)	**1.01** (7)	0.99 (8)	0.93 (9)
15	0.97 (3)	0.98 (4)	0.96 (5)	0.91 (6)
20	0.92 (2)	0.95 (3)	0.94 (4)	0.84 (4)

* optimal combination or option

Figure 4.4: Annual monetary genetic gain: relative comparison of options

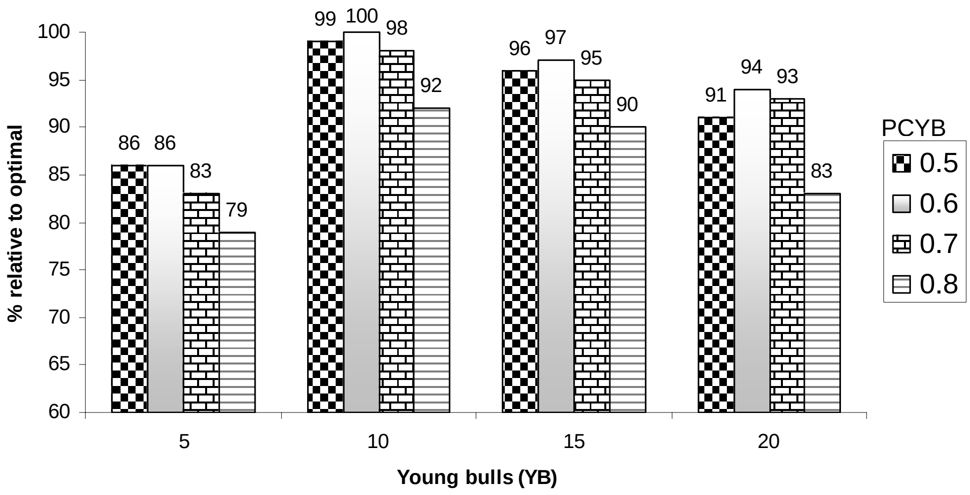


Table 4.5: The effect of increasing the proportion of cows mated to young bulls (PCYB) and the number of young bulls (YB) on **discounted return** and **discounted profit** (Ugcp)

	Return				Profit			
YB	PCYB				PCYB			
	0.5	0.6	0.7	0.8	0.5	0.6	0.7	0.8
5	1.05	1.04	1.00	0.94	1.00	0.98	0.95	0.89
10	1.32	**1.36**	1.34	1.29	1.24	**1.29**	1.27	1.21
15	1.29	1.33	1.34	1.30	1.19	1.23	1.24	1.20
20	1.21	1.29	1.32	1.21	1.08	1.16	1.19	1.08

Figure 4.5: Return: relative comparison of options

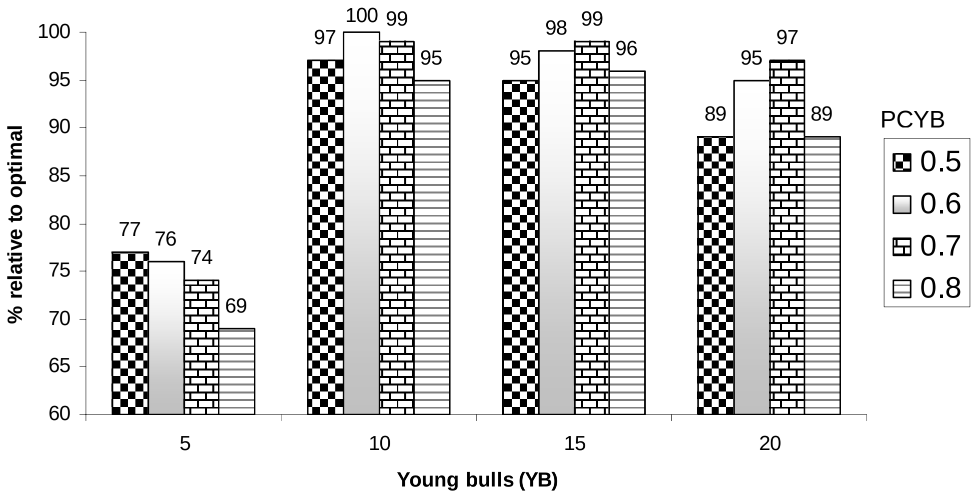
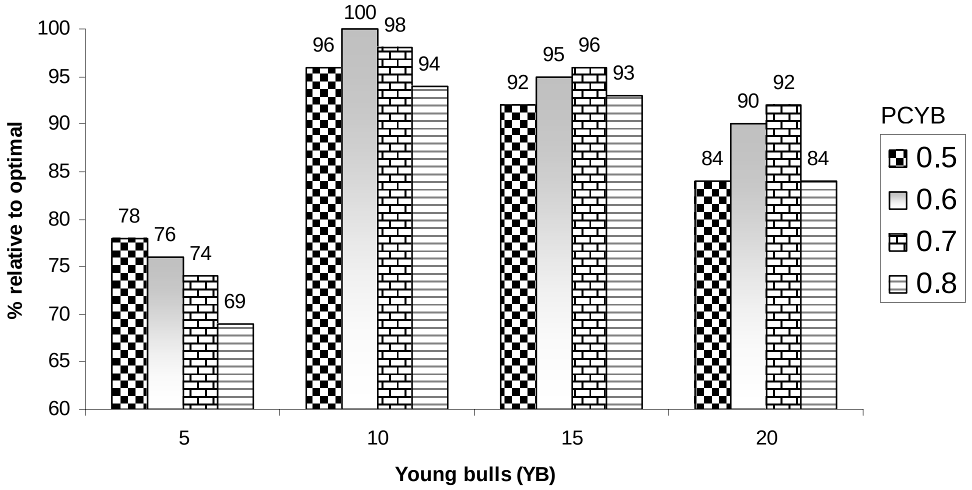


Figure 4.6: Profit: relative comparison of options



The optimum option in this scheme is at 10 YB + 0.6 PCYB, which registers the highest Annual monetary genetic gain (AMGG) at 1.01, a return (R) of 1.36, and a profit (P) of 1.29 Ugcp. These three evaluation measures follow more or less the same trend with variations in YB and PCYB (see figures 4.4, 4.5 and 4.6).

Increasing PCYB around 10 YB

From 0.5 PCYB, AMGG increases marginally by 1% to reach a peak at 0.6 PCYB then drops by 2% to 0.7 PCYB. From the latter to 0.8 PCYB, the drop is by 6%. Beyond 0.6 PCYB, proven bulls (PB) contribute increasingly less to the nucleus with an increasing number of dams being mated to YB, that is, the gene proportion of YB (3. YB>CN) goes up while that of PB (PB>CN) declines. The genetic value of YB is lower than that of PB and as such correspondingly contribute less to genetic progress. In other words, the more influential role of YB means less realisation of the genetic superiority of PB. However, accuracy in selection of PB, the critical link to transferring genetic gain to the base population, goes up. For example, the selection accuracy achieved by 0.7 PCYB is 3.69% higher than that of PCYB 0.6 (see appendix V). Reason: each YB is mated to more cows resulting in an increase in the number of daughter records per young bull (DR/YB); thus, increasing on the accuracy in the selection of PB.

Mean generation interval decreases with increase in PCYB; a positive effect for the breeding programme. The higher PCYB is, the higher is the proportion of genes from YB which have a shorter mean generation intervals of 2.4 years as compared to 7.8 of PB.

Increasing YB around 0.6 PCYB

Beyond YB 10, AMGG starts to fall. First, as the number of YB increases, each bull will have fewer cows to mate with resulting in fewer DR/YB. Second, the selection intensity of YB decreases as the proportion of selected YB increases. The two factors result into a decline in accuracy of selecting PB, thus leading to a decline in genetic gain, which translates into a reduction in AMGG. The variable costs, semen collection and storage, which are dependent on the number of YB increases (see appendix IV) as the amount of semen that will have to be discarded after selecting the 4 PB increases.

Expected daughter records per tested young bull (DR/YB)

The higher the number of DR/YB, the higher the accuracy of selecting PB. 7 DR/YB are expected with the optimum option. The highest number of DR/YB, that is, 18 is achieved with option 5 YB + 0.8 PCYB; however, a decline in AMGG by 21% and by 31% in returns and profit from what can be achieved with the optimum option is a major set back for this option. The results also clearly show that it is too risky to use 20 YB because of the peril of not having any records at all in the end. The highest DR/YB that can be achieved with 20 YB for any of the four PCYB variations is 4.

Costs

Costs occur exclusively in the nucleus, but are borne by the whole population (divided among all animals in the population) because the benefits of genetic gain in terms of returns are realized in the whole population. They are expressed as costs per animal, and are divided into fixed and variable costs.

It was assumed that 50% of the actual cost associated with recording is directly related to breeding activities. Records are used for other activies e.g management, marketing strategy, etc., hence, these other activities bore the rest of the costs. It could be argued that the paramount purpose of recording in the nucleus is for breeding activities, and these other uses of records can be seen as playing a minor role, therefore the 50% assumed costs of breeding may not be justified. This is true for the central nucleus, but it should be noted that the calculations for these costs were based on farm visits in the dispersed nucleus and zero grazing farms in the base population. Promotion of record keeping in the base population will be done in anticipation of the gradual increase of the dispersed nucleus size and the possibility of recruiting excellent females from the base into the nucleus.

Semen from 10 YB which are to be progeny tested is collected and stored. After the 4 PB from the 10 YB are selected, semen from the 6 bulls which are rejected has to be discarded. This discarded semen is what causes the real cost of semen production and storage. An increase in YB would mean more semen being discarded since only 4 PB are to be selected for each round of selection regardless of the number of YB from which they are to be selected from.

Table 4.6: The effect of increasing the proportion of cows mated to young bulls (PCYB) and the number of young bull (YB) on **annual genetic gain** of **milk yield** and **calving interval**

	Milk yield (kg)				Calving interval (days)			
YB	PCYB				PCYB			
	0.5	0.6	0.7	0.8	0.5	0.6	0.7	0.8
5	33.58	33.38	32.58	30.99	0.13	0.13	0.13	0.12
10	38.63	**39.13**	38.07	35.91	0.15	**0.16**	0.15	0.14
15	37.51	37.85	37.19	35.06	0.15	0.15	0.15	0.14
20	35.49	36.48	36.12	32.58	0.14	0.14	0.14	0.12

Figure 4.7: Annual milk yield genetic gain: relative comparison of options

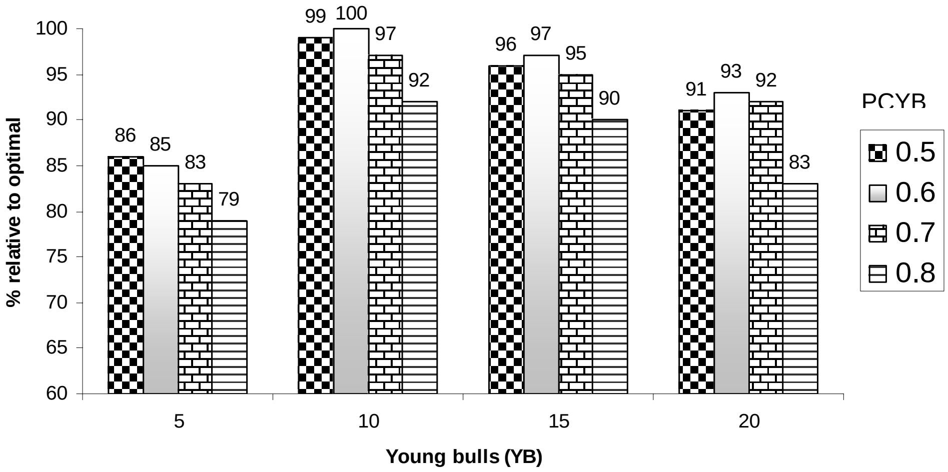
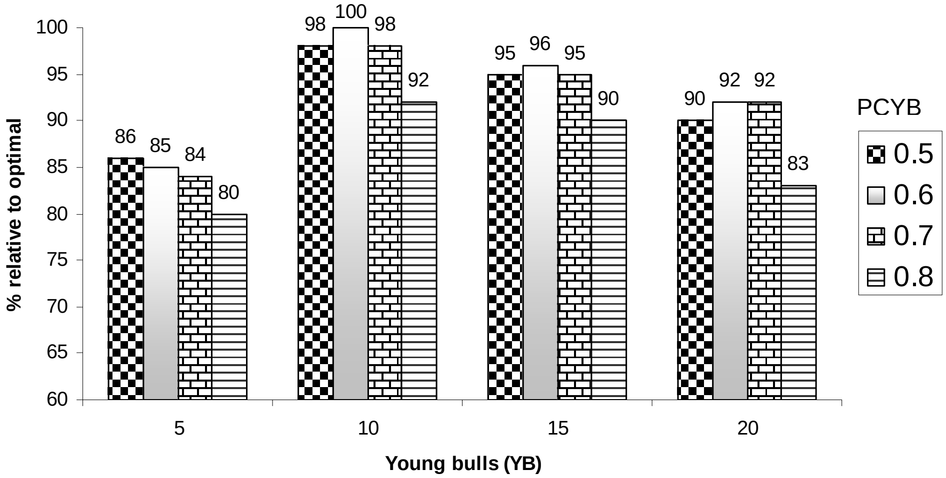


Figure 4.8: Annual calving interval genetic gain: relative comparison of options



With the optimum option (10 YB + 0.6 PCYB), the expected genetic gain per year of the progeny of the selected animals per selection cycle is 39.13 kg MY and 0.16 days increase in CI. Improved genetic gain per year in milk is associated with the undesirable effect of increased CI. Although this option is the best in genetic gain for milk, it is also the worst in CI. Undeterred improvement in MY would, in the long run, be deleterious to CI; therefore, it is necessary to minimize deterioration of this trait. This could be done by adjusting the selection index in such a way that CI has null genetic gain.

Table 4.7: Comparison of selection groups: results of selected features per generation

	NUCLEUS					BASE POPULATION	
	1	2	3	4	5	6	7
	PB>PB	**CN>PB**	**YB>CN**	**PB>CN**	**CN>CN**	**PB>CPB**	**CBP>CBP**
Tested animals	10	195	78	10	195	10	0
Selected animals	4	156	10	4	156	4	0
Accuracy of selection index	0.60	0.54	0.26	0.60	0.54	0.60	0
GI (years)	7.8	4.9	2.4	7.8	4.9	8.8	5.9
MGG (Ugcp)	10.99	2.21	4.79	10.99	2.21	0.00	0.00
GG-MY (kg)	423.75	85.42	183.54	423.75	85.42	423.75	0.00
GG-CI (days)	1.69	0.34	0.72	1.69	0.34	1.69	0.00
Return - Total (Ugcp)	0.006	0.034	0.013	0.005	0.006	1.299	0.00
Return - Milk (Ugcp)	0.006	0.034	0.013	0.005	0.006	1.303	0.00
Return – CI (Ugcp)	0.000	0.000	0.000	0.000	0.000	-0.004	0.00

GI = Generation Interval
MGG = Monetary Genetic Gain for the aggregate genotype
GG-CI = Genetic Gain Calving Interval
GG-MY = Genetic Gain Milk Yield

Table 4.8: Percentage return from selection groups

Groups	% returns
1.PB>PB 3.YB>CN 4.PB>CN	2
2.CN>PB 5.CN>CN	3
6.PB>CBP	95
7.CBP>CBP	0

Accuracy of selection is highest for groups 1. PB>PB, 4 PB>CN, and 6. PB>CPB which have PB pathways. This can be explained by their selection being based on more sources of information; however, waiting for more information especially of the progeny for these groups leads to longer generation intervals.

Because of the genetic superiority of PB, GG-MY and GG-CI are highest with PB pathways. Likewise MGG, the monetary expression of genetic gain which can only be attained in the breeding unit (nucleus) is highest in group 1. PB>PB and 4 PB>CN. The values for these two groups are same because their selection is based on the same sources of information.

PB contribute roughly 133% higher to genetic gain in the system than YB; therefore, increasing the proportion of young bulls (PCYB) beyond 0.6 would be disadvantageous to the programme.

Genetic gain is achieved only in the nucleus, but realised in the whole population. Realisation of genetic gain, which translates into returns, is highest in group 6. PB>CBP, that is, 95% of returns from the genetic gain. This group, a connecting link between the nucleus and the base, is in the tier which makes up 99.3% of the total population, thus making its multiplier effect of genetic gain to be the highest. Implications:

I. Dissemination of improved genetics to the base population is a critical link in the programme.

II. Attention should be paid to cows in the base population as regards their management if they are to fully exploit the improved genetics emanating from the nucleus.

III. Since cows in the base population contribute half to the genetic makeup of individuals, it is important to have some form of selection among cows in this tier. Best females should be mated to best sires.

IV. The nation-wide benefits of the programme through its total economic approach is demonstrated by a lot of farmers in the base with one or two cows, who do not invest in the programme being the major beneficiaries of improved genetics.

V. For long term breeding perspectives, a broader base with more use of improved genetics should be strived for.

4.4.2 Scheme II - Varying YB at very close range around the optimal

The scheme tries to establish whether the optimal number of YB found in scheme I is really the optimal one, or whether this number is somewhere slightly below or above the optimum.

Table 4.9: The effect of increasing the number of young bulls (YB) using the optimal PCYB of 0.6 on the **annual monetary genetic gain (AMGG), discounted return (R)** and **discounted profit (P)** in Ugcp. In brackets: % relative to optimal option.

YB	AMGG	R	P
8	0.99 (98)	1.29 (95)	1.23 (95)
9	1.00 (99)	1.32 (97)	1.25 (97)
10*	**1.01 (100)**	**1.36 (100)**	**1.29 (100)**
11	1.01 (100)	1.36 100)	1.28 (99)
12	0.99 (98)	1.34 (96)	1.25 (97)

* optimal

The AMGG for YB 10 and 11 are the same; however, it is more profitable to use YB 10 because the costs associated with having an extra bull, which does not bring in more returns are avoided. When YB is increased to 11, a decline in profit by 0.77% from that obtained with the optimal option is registered.

4.4.3 Scheme III - Varying the number of Inseminations per daughter record (Ins/DR).

The scheme investigates the influence of Ins/DR, a parameter highly influenced by management, on the programme.

Table 4.10: The effect of increasing the number of inseminations per daughter record (Ins/DR) on the **annual monetary genetic gain (AMGG), discounted return (R)** and **discounted profit (P)** in Ugcp. In brackets: % relative to optimal option

Ins/DR	AMGG	R	P
4	**1.06 (105)**	**1.45 (107)**	**1.37 (106)**
6	1.01 (100)	1.36 (100)	1.29 (100)
8	0.97 (96)	1.28 (94)	1.21 (94)
10	0.94 (93)	1.23 (90)	1.15 (89)

The economically superior variation of 4 Ins/DR, though feasibe with an improvement in fertility management, is not practical given the present management status of the nucleus herd (see details of this illustration in table 3.22). It would require reducing on the current 2.4 inseminations/conception (INS) to 1.6. One approach would be to intensify heat detection, especialy in the nucleus herd, by use of milk progesterone (P_4). This assisted reproductive technology (ART) is currently used by NAGRC. Milk P_4 results at breeding have shown that approximately 6 to 13 % of animals bred are not in true oestrus (DRAKE and O'CONNOR, 2001). Results of a study on zero grazing systems (NASSUNA, 2001) show that oestrus detection in cycling cows during the first 120 days after calving down was very low. Although two thirds of the cows underwent ovarian rebound within the first 60 days after calving down, heat was not seen until 126 days post partum because over 60% of the cows that underwent ovarian rebound either cycled silently or cycled normally but were not detected by the farmers. Use of milk P_4 would increase heat detection accuracy and facilitate early intervention in fertility problematic animals. This, in addition to other interventions that improve INS as discussed ealier in this chapter, would lower Ins/DR. The primary limitation of using milk P_4 is the number of samples required to adequately provide a clean hormonal profile. This is aggravated by the critical time period within which samples have to be collected and the lengthy analysis of samples. The radioimmunoassay (RIA) procedure, which NAGRC uses to determine P_4 levels is costly, putting in doubt it ultimate benefits in terms of profitability to the programme.

RHODES (2005) mentions new procedures that are currently being tested for more rapid analysis of milk P_4 and which, eventually, may be cheaper than what is being used. Owing to the aforementioned limitations, use of this ART in the dispersed nucleus may be problematic; hence regular visual observation coupled with use of fertility records will remain the most important fertility management tool. The role management (environmental influences) plays in terms of returns of a breeding programme is clearly illustrated in this scheme.

4.4.4 Scheme IV – Restricting calving interval genetic gain

A restriction can be put on the genetic gain of CI so that it does not deteriorate with improvement in MY. The antagonistic relationship between MY and CI is made worse by CI having a relative economic importance of only 2.3% in the selection index. Under milk quota systems, functional traits like CI impact greatly on the profit of dairy farmers (GROEN et al., 1997) by increasing farm efficiency through reducing on the costs of inputs. In Uganda, on the contrary, where there are no milk quotas increasing farm efficiency through higher outputs of milk is economically more important than improving on cost-reducing fitness/functional traits. Additionally, milk production is at a stage of production, where output increases at an increasing rate with each additional unit of input. Therefore, increasing input in form of improved genetics for the MY trait leads to a higher product output and as such increases farm efficiency. This scenario of production explains why the relative importance of CI in the selection index is extremely low as compared to MY. In order for the CI not to become worse, its economic weight is increased in such a way that it has null genetic gain per year. In other words, it is controlled from becoming worse. This is achieved with an economic weight of 0.241 Ugcp instead of 0.019 Ugcp, in which case its relative economic importance in the selection index increases from 2.63% to 25.72% (see table 3.15) It is the ratios of the economic values of the traits in the index rather than their absolute values, expressed in genetic standard deviation, that determine the direction of selection (WELLER, 1994). Influencing this ratio, would in the long run hinder the worsening of CI.

In a study on dual-purpose cattle, HECKENBERGER (1991) showed that up to 50% error in estimating economic weights (v) had only a minimal effect on the monetary genetic gain (MGG). However, due to the correlations of traits to each other, their proportional contributions to MGG is highly influenced by erring in estimating their economic weights because of a shift in the importance and contribution of the individual traits to MGG.

Table 4.11: Comparison of optimal options of **Scheme I** (no restriction on CI) and **Scheme IV** (restricted CI genetic gain)

	Feature	**no restriction**	**restriction**	**+/- change (%)**
Annually				
	AMGG	1.01	1.00	-0.99
	Return	1.36	1.34	-1.47
	Profit	1.29	1.26	-2.33
Group 6. PB>CPB per generation				
	Total Return	1.29	1.28	
	GG-MY	**424**	**415**	
	GG-CI	1.69	-0.06	
	R-MY	1.30	1.28	
	R-CI	-0.004	0.002	

AMGG = Annual monetary genetic Gain
GG-MY = Genetic gain in milk yield
GG-CI = Genetic gain in calving interval
R-MY = Return on milk yield
R-CI = Return on calving interval

Imposing genetic gain restriction on CI brings along with it a negligible decline in AMGG, R and P. The decline in total monetary impact per generation on group 6. PB>CPB, where most of the returns for the breeding programme are realised, is also very miniminal. As expected, returns from CI per generation improve. Implication: It is strongly recommended that CI be restricted during the implementation of the programme.

Scheme V - Reducing the nucleus size to 500

Table 4.12: Effect of reducing the nucleus size to 500 on **annual monetary genetic gain (AMGG), discounted return (R)** and **discounted profit (P)** in Ugcp and the relative % change (+/-) to the optimal option in the basic breeding programme.

Feature	Nucleus size = 700	Nucleus = 500	+/- change (%)
AMGG	1.01	0.93	-7.92
R	1.36	1.22	-10.29
P	1.29	1.14	-11.63

Reducing the nucleus size to 500 reduces AMGG, R and P. Fewer cows are mated to YB leading to a lowering in the accuracy of selecting PB. The cost per dam goes down (see appendix XII.) as they are fewer cows in the nucleus on which performance recording is done, yet the population which bears these costs does not change in size. The larger the nucleus size, the better it is for the programme. Recruiting more farmers in the dispersed unit of the nucleus is one way in which the nucleus size could be increased.

Scheme VI: Reducing the population size to 50,000

Table 4.13: Effect of reducing the population size to 50,000 on **annual monetary genetic gain (AMGG), discounted return (R), discounted profit (P)** and **costs** in Ugcp and the relative % change (+/-) to the optimal option in the basic breeding programme.

	Population size		
Feature	100,000	50,000	+/- change (%)
AMGG	1.014	1.014	0
R	1.364	1.375	1
P	1.286	1.249	-3
Total cost	0.078	0.126	+ 61
Fixed costs	0.031	0.062	+ 100
Variable costs			
Semen production and storage	0.030	0.030	0
Recording	0.017	0.034	+ 100

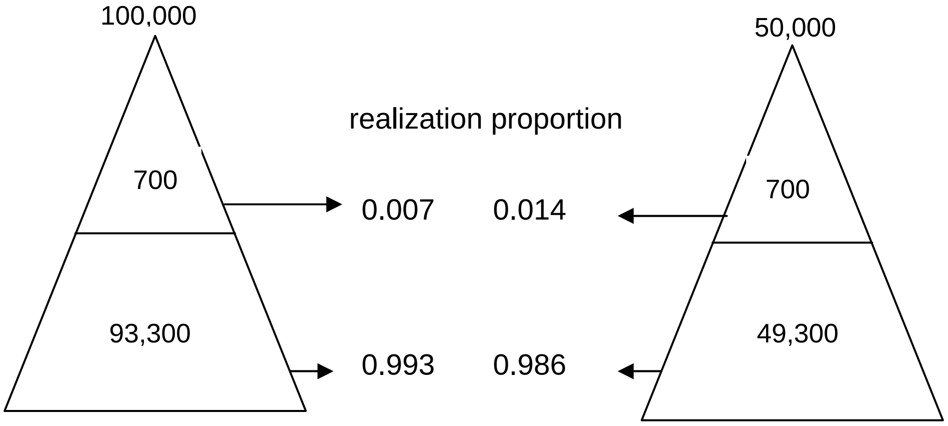
AMGG doesn't change because all the genetic gain is achieved in the nucleus whose size is not affected by changing the population size. As long as the nucleus size is the same, fixed and recording costs as well as returns within the nucleus will be the same. However, the returns and the costs are calculated in relation to the entire population thus, leading to their increase when the population size is reduced. The increase in costs is far higher than the returns per standard animal, hence the decline in profit. Semen production and storage costs are dependent on the population size. Fewer semen doses will be required from each bull when the population size decreases. 13,774 semen doses of YB are required for a population size of 100,000. Reducing the size to 50,000 would proportionally reduce production to 6,887 straws for each YB. Semen related costs, calculated per standard animal, are therefore, constant for any given population size.

Table 4.13: Effect of reducing the population size to 50,000 on the **percentage return** from the selection groups

	Population size		
Groups	100,000	50,000	Difference % points
1.PB>PB 3.YB>CN 4.PB>CN	1.862	2.898	+1.036
2.CN>PB 5.CN>CN	2.927	3.268	0.341
6.PB>CBP	95.247	93.834	-1.413
7.CBP>CBP	0	0	0

The % return from selection groups with male pathways increases by about 1 percent point in the nucleus and decreases by 1 in the base population. With a reduction in the population, the genetic gain realisation proportion in the nucleus increases from 0.007 to 0.014 while that in the base population decreases from 0.993 to 0.986 (see figure 4.9). Genetic gain translates into returns hence the changes in the aforementioned returns for the two tiers. The larger the population size, the better it is for the programme. The population of exotic cattle and their crosses in Uganda is estimated at 285,000 heads with the Holstein-Friesian making up the biggest percentage. Most farmers who keep exotics prefer to use AI, therefore through improvement and expansion of AI services more farmers can be recruited on the programme, thus increasing the population size

Figure:4.9: Comparison of 100,000 and 50,000 population sizes



Concluding remarks

The optimal option in Scheme IV (appendix VIII) is the most appropriate one and is regarded as the optimal scheme which NAGRC should implement. The scheme has the following features:

i. a population of 100,000 animals of which 700 are in the nucleus
ii. 10 YB or test bulls from which 4 proven bulls (PB) are selected
iii. 0.6 PCYB
iv. 6 inseminations per daughter record (Ins/DR)
v. progeny testing takes place in only the nucleus
vii. exclusive use of AI in the nucleus
viii. genetic gain disseminated to the base population via PB
ix. a restricted selection index in regard to CI
x AMGG of 1.00 Ugcp, R of 1.34 Ugcp, and P of 1.26 Ugcp is got.

The higher PCYB is, the less realisation of genetic superiority from PB, but there is a lowering in the mean generation interval. Ins/DR is greatly influenced by INS which is dependent on management. The higher the population and nucleus size are, the better it is for the programme. All the genetic gain is achieved in the nucleus, but 95% of all returns are realised in the base population. The implies that the scheme has nation-wide benefits. Its total economic approach is demonstrated by a lot of farmers in the base population with one or two cows, who do not invest in the programme being the major beneficiaries of improved genetics.