

SYMPOSIUM ON "ASSESSMENT OF CROSS BREEDING PROGRAMMES"

Chirman : DR. N S. RANDHAWA

Convener : DR. PREM NARAIN

A symposium on "Assessment of Cross-breeding Programmes" was held during the 32nd Annual Conference of the Indian Society of Agricultural Statistics at Punjab Agricultural University, Ludhiana, on December 21, 1978 under the Chairmanship of Dr. N. S. Randhwa, Director of Research, Punjab Agricultural University, Ludhiana. The Convener for this symposium was Dr. Prem Narain, Joint Director, Indian Agricultural Statistics Research Institute, New Delhi. Twelve papers were contributed to the symposium out of which only nine were actually presented whereas the abstracts of the other three were made available. Relevant tracts from these papers are given in following paragraphs :

Prem Narain*

Strategy of cross-breeding in livestock and poultry

2. For the success of a cross-breeding programme in different species of livestock and poultry, the essential requirements are (i) choice of exotic breed for the region taking into account the stresses of nutrition and environment in the region; (ii) testing for the existence of hybrid vigour and the techniques for maintaining it around 50% if it exists; and (iii) the choice of an appropriate level of exotic inheritance. However, for the evaluation of a new breed, after the desirable genes have been introduced in the material, it is necessary to adopt a scientific method of selection based on progeny testing schemes.

Cross-breeding in cattle

3. The problem of choosing an appropriate exotic breed of cattle depends very much on the region in which it is to be adopted. For instance, in a region like Punjab where sufficient infra-structure for producing better nutrition in terms of cultivated fodders and concentrates exist, it may be beneficial to adopt a heavy exotic breed

* Indian Agricultural Statistics Research Institute, New Delhi

like Holstein-Friesian. But in a hilly region of Himachal Pradesh where one can't afford to provide better nutrition and health care, a smaller exotic breed like Jersey would be quite suitable. The requirement of an appropriate level of exotic inheritance has however to be decided from the statistical angle by analysing appropriate and adequate data. For this purpose, the Indian Agricultural Statistics Research Institute (IASRI) has taken up a comprehensive project for collecting data on different grades of cross-bred animals available at Military Dairy Farms all over the country. Since the scheme of cross-breeding at such farms has been going on for a very long time, this is perhaps the only source of data which can provide some definite answers to the questions posed. Recently, with the help of this data it has been shown how the amount of increase/decrease in milk production or the number of days by which calving interval increases/decreases due to a unit increase in the level of exotic inheritance can be estimated. It has been concluded that infusing exotic germ plasm beyond 75% level may result in significantly lowering the lactation yield coupled with an enhanced calving interval. The third requirement of deciding on whether to maintain hybrid vigour or to evolve a new breed is one on which there is no definite answer.

A plan for evolving a dairy breed utilising cross-bred cattle available at Military Dairy Farms

4. At the instance of the Committee of Experts for Dairy Farms a plan for evolving a dairy breed making use of animals of different grades due to crossing Friesian bulls with Sahiwal cows, available at Military Dairy Farms has been prepared by the IASRI. It is proposed that 90 foundation cows, mostly second and third calvers could be chosen from animals belonging to the grades ranging between half-bred to three-fourths whereas the male should be 12 in number in the first set and should be half-breds between Sahiwal and Friesian. The cows so chosen should be randomly mated with the bulls of the first set. After about 15 months of the starting of the programme the second set of half-bred bulls should be brought in. The third set may come in after another 15 months and the herd may be closed thereafter. The programme of interse mating with the intensive selection of both males and females may be followed. While selection among the cows may be based on their own performance the selection among the bulls may be on the basis of their progeny performance. The strength of the adult females of 900 at the inception of the programme will decline and fluctuate around 580 but will settle down to about 552 when the programme stabilises. The pattern of breeding would then consist of allotting 92 best cows

to the best two proven bulls for securing 10 males for breeding use and mating the remaining 460 at random to 10 young bulls which are sons of the best two proven bulls of an earlier set previous to the immediately preceding one for testing. The intensity of selection in the case of males may be kept one out of 5 whereas the scheme for selecting females is so optimised as to have maximum genetic gain per year.

Cross-breeding in buffaloes

5. Cross-bred superiority is expressed most strongly in an animal with the largest possible proportion of different genes. To obtain such an animal it is necessary to make parents which have been bred along completely different lines and are thus unlikely to have many genes in common. The breeds of buffaloes existing in the country have undergone selection for different objectives under different ecological *niches*. They are likely to have different genes and by adopting cross-breeding among themselves, one could break the plateau and obtain cross-breeds which are far superior in the production over pure breeds. We have breeds like Murrah and Nili-Ravi which are large body-sized with high milk production but with moderate fat percentage and poor heat tolerance. On the other hand we have breeds like Surti and Bhadawari which are medium-sized with moderate milk production and in the case of Bhadawari we have animals with high fat percentage as well as better heat tolerance. We can therefore combine the characteristics of high milk production with higher fat percentage and lesser heat tolerance by adopting a suitable cross-breeding programme such as a diallel crossing program involving the four breeds mentioned above.

Cross-breeding programme with sheep

6. In the case of the wool production in sheep, it has been found that an efficient technique for improving the production is to adopt cross-breeding of indigenous animals with animals of exotic breeds. The statistical problem involved is that of determining the appropriate level of exotic inheritance based on several production characteristics, at which the programme should be stabilised. Some recent work conducted at the IASRI have indicated that D^2 -Statistic and discriminant function should be very useful techniques in this connection. It was found that a comparison of the different grades of sheep, derived from crossing Kashmiri ewes with Rambouillet rams, can be best made by a linear discriminant function combining greasy fleece weight, fibre-diameter, fibre-length and fleece density in an optimum manner. The discriminating power of this function

was found to be much higher than those based on the individual characteristics. On this basis half-breds and three-fourths do not differ significantly and optimal level of exotic inheritance could be taken as 50%.

Economic evaluation of cross-breds in poultry for Meat

7. An all India Coordinated Project on Poultry for Meat (Broiler production) has been launched by the Indian Council of Agricultural Research (ICAR) using the cross-breeding method. It aims at evolving a broiler with 1.5 kg of weight at 10 weeks age by crossing in-bred strain of New Hampshire, Whits Cornish and White Rock with experiments conducted at different centres in the country. In addition to production and reproduction data collected in the project, economic data on costs of reproduction and raising of broilers are also collected, the economic merits of broiler strains and their crosses can be evaluated and an efficient cross-breeding programme developed. In this connection, IASRI have taken steps to collect economic data in this project with a view to develop profit functions for broiler production as well as to study the relative economic merits of different strains of poultry and the crosses between them with the help of such functions.

Cross-breeding and future performance

8. In most of the cross-breeding programmes the aim is to compare the present performance, preferably on economic considerations, of the various cross-breds and choose the best one. There is however, another aspect of cross-breeding where one is concerned with choosing breed or crosses and using them in a selection programme so as to maximise the economic merit over the next 10 or 20 years. In such a case, besides estimating potential genetic progress, we have also to consider the costs of the scheme and relate them to their potential economic benefit. For this purpose a discounted cash flow method is used where returns and costs incurred in any year are discounted back to some base year in which the selection decision is made.

R. Nagarcenkar*

Optimum level of exotic inheritance for cross-breeding

9. The paper was presented by Shri M. Gurnani, Associate Professor, Division of Dairy Cattle Genetics, N.D.R.I. Karnal, as desired by the author who could not attend the symposium due to unavoidable reasons.

* National Dairy Research Institute, Karnal.

10. As many as nine breeds of European cattle have been used for cross-breeding with Zebu cattle in India from time to time. Data on 7500 crossbred cattle from 19 farms distributed in various parts of the country were collected. These were progeny of Friesian Jersey, Brown Swiss and Red Dane bulls, and had different levels of exotic inheritance. To investigate the optimum level of temperate dairy cattle inheritance for cross-breeding in India, the criteria used were efficiency of milk production on the basis of net energetic efficiency and dairy merit. L. S. model used for analysis of the data considered effects of season, period, farm and level of exotic inheritance breedwise.

11. On the basis of ranking of different genetic groups according to their performance, it is recommended that the choice of exotic breeds should be Friesian all over the country except in arid tracts or areas with low input levels, where the choice should be Jersey. The breeding policy recommended is use of superior Friesian and Jersey bulls in the 1st stage to breed indigenous cows and heifers. In the 2nd stage selection of half-bred bulls from institutional farms is advocated for intensive progeny testing programme in the field and the institutional herds, and use of top ranked sires for wide scale use on the cross-bred progeny, to maintain half-bred exotic crosses after interse mating and culling for performance of economic traits. Subsequently the process of identification of elite dams as future bull mothers and use of superior ranked cross-bred bulls is recommended on a continuing basis, to evolve a crossbred dairy cattle population with appropriate genetic homeostasis.

12. For meeting the large scale requirement of exotic bull semen, nineteen centres in the country have been identified for location of temperate dairy cattle farms. It is recommended that these farms should import semen of top sires from temperate countries to generate young bulls locally in adequate numbers for wide scale use in the field during the 1st stage. Use of frozen semen technology is recommended for wide adoption for proper implementation of the programme and optimum utilization of sires for breeding purpose.

B.G. Katpatal*

**All India Coordinated Research Project on
Cattle (ICAR)**

13. The ICAR has initiated this project at 6 centres in the country involving cross-breeding between Indian breeds and exotic

*Project Coordinator, I.V.R.I., Izatnagar.

breeds. At the 3 centres viz. Izatnagar, Hissar and Haringhatta it is the Hariana Cattle which is combined with Holstein-Friesian, Jersey and Brown Swiss. But at the other two centres viz. Rahuri and Jabalpur it is Gir breed and at the centre at Lam it is the Ongale breed which are used to cross with the exotic breeds. The project aims at developing a breed of dairy cattle suitable for specialised dairy farms, intensive milk production areas and other areas of commercial milk production. The breed should have a minimum milk production of 2,000 kg. of milk per lactation with a herd average of 3,000 kg of milk per lactation and a fat test of not less than 3.5%. Different combinations of crosses of selected Indian breeds with three exotic breeds of cattle are raised and recorded for growth, production, reproductive efficiency and economics of milk production. The mating design adopted is intended to produce second generation cross-breeds comprising a maximum of 6 genetic groups of three-fourths bred animals of any two of the exotic breeds used in the project. While at the Gir Centre, only the Holstein-Friesian and the Jersey are used at the other centres, all the three exotic breeds are involved. Considering the importance of Jersey for early maturity and higher fat content in the milk and the Friesian for high milk production, the Jersey and Brown Swiss combinations in the second generation have been eliminated at all centres except Haringhatta. The frozen semen from at least 10 bulls of each exotic breed is used at each Centre. The bulls used have sire indices of not less than 5,500, 4,500 and 4,000 kg for the Holstein-Friesian, Brown Swiss and Jersey breeds respectively.

14. The results of the first generation animals at Haringhatta, Izatnagar, Hissar and Rahuri attest that the crosses of the three exotic breeds with the Hariana and the Gir are well adapted to the climatic conditions of the dry and humid tropics regions and show great promise for improving milk production. The increases in milk yield obtained from cross-breeding are greater with the Hariana, Gir and non-descript cattle than with the Sindhi and Sahiwal breeds. The Holstein crosses have demonstrated a better growth rate and higher milk production than the other crosses. The three-fourths level of exotic inheritance in the latter crosses renders them more susceptible to infections at early ages than the half-bred levels.

P.U. Surendran*

Assessment of cross-breeding programme of Kerala

15. Cross-breeding has been in vogue in Kerala during the last thirty years. Introduction of exotic blood into local animals was found to give increased milk yield from the crossbreds. The problem that immediately calls for attention is the determination of the exotic blood level in the crossbred that would induce optimum milk yield. Also, as the crossbred males may have to be used for draught purposes their working ability may have to be assessed. Further, the adaptability of the crossbred to the local climatic conditions has to be examined; incidence of disease, mortality, feed intake etc. are some of the characteristics by which this could be assessed. With these objectives in view a cross-breeding scheme was started in Chalakudy near Trichur in November 1957 with financial and technical assistance from I.C.A.R. Grading up of the local animals with Sindhi blood also formed part of the scheme. The scheme was prematurely wound up to in March 1971. Results obtained broadly justified crossbreeding for increased milk yield from the progeny. However, no exotic blood level in the crossbred for optimum milk yield could be recommended. It was found that the crossbred males could be used for draught purposes.

16. Even though there is lack of information as to the level of exotic blood in the crossbred for optimum milk yield, cross-breeding is being widely practiced in Kerala. This has helped to increase the proportion of crossbreds among cattle. In a recent survey conducted by us in Trichur Taluk it was found that 40% of the cattle as a whole and 33% of the cows were crossbred. The milk production also has considerably increased. One of the new problems arising out of cross-breeding in which Artificial Insemination is widely practiced is the onset of infertility conditions in animals. Agricultural Universities have to take cognisance of such problem and suggest remedial measures.

B.R. Mangurkar**

Genetic consequences of cross-breeding in cattle

17. The paper was presented by Dr. S.B. Gokhale, BAIF, Pune as desired by the author who could not attend the symposium due to unavoidable reasons.

* College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy.

**The Bharatiya Agro-Industries Foundation (BAIF) Uruli-Kanchan, Pune.

18. The breed differences for maximum production efficiency have been exploited in cross-breeding experiments in cattle. The small scale of experiments and/or inadequate statistical details are the major limitations in arriving at the valid conclusions from these experiments. The present review surveys the important results of cross-breeding projects and highlights the conclusions wherever possible.

Inheritance of economic traits

19. The additive gene-action appears to be important in case of milk yield, since cross-breeding in tropics usually involves the use of sires of a productive exotic breed on females of a low producing indigenous breed. However, the results indicate that, the possible role of non-additive gene-action cannot be ignored. The body weights of cross-breds at various ages can also be explained on the basis of theory of additive gene-action. Maternal effects may be important during earlier growth period and non-additive gene-action would play significant role at some stage. The proportionate contribution of non-additive gene-action for body weight trait may be least when breeds of dissimilar size are crossed. The introduction of temperate inheritance into Zebu population results into early maturity. There is no evidence regarding heterosis effect for maturity at least under good managerial conditions. The half bred temperate Zebu crosses are comparatively well buffered with respect to reproductive efficiency in females. However, it is important to know whether apparent deterioration in reproductive performance of the second generation cross-breds can be averted through intensified management and selection. The abortion rates and fetal losses are very likely to rise with increasing level of European breeding. Half bred appear to possess superior survival rate. There are indications of significant non-additive gene-action with respect to survival rates amongst cross-bred populations.

Systems of breeding

20. The systems of breeding dealt in this review include grading, crossing of two pure-bred lines, criss-cross breeding, reciprocal recurrent selection and cross-breeding for development of new breed. Amongst these, criss-cross breeding and cross-breeding for development of new breed show promise and it is necessary to compare these two systems objectively with due consideration of the financial consequences.

Changes in the structure of cattle population

21. The present rates of A.I. with exotic semen are not likely to effect the structure of cattle population in India in significant manner. The qualitative and quantitative changes might be discernible in isolated pockets where cross-breeding experiments would be concentrated. The birth of cross-bred male calves and their survival rate need to be considered in evaluating the changes in the structure of cattle population, since these cross-bred male calves would be contributing to the gene pool in successive generations.

B.R. Mangurkar and S.B. Gokhale*

Genetic and economic aspects of sire evaluation programmes for cross-bred cattle

22. Annual genetic gain was estimated by simulation procedure for cross-bred cattle population of 20, 50, 100, 300 or 1000 thousand. The cost of progeny testing bulls were calculated with variable progeny group size, bull purchase price, semen collection period in bulls and the cost per first A.I. to the stud. The estimate of annual genetic gain varied from 25.2 kg. to 40.4 kg. in different programmes. The semen collection period appreciably affected the cost of testing a bull. It would, therefore, be preferable to collect and freeze the required doses of semen in shortest possible period. Further, the increase in progeny size and consequent reduction in number of sampled bulls might be advantageous to economise in the testing programme and to achieve maximum gain per unit of cost-input. It was inferred that a testing programme which yields maximum genetic gain may not necessarily be optimum on economic considerations.

Sudershan Kumar**

Impact of cross-breeding programme in the Punjab State

23. It is an established fact that milk production in indigenous cattle can be increased to a considerable extent within a short period though cross-breeding them with highly productive exotic dairy breeds. A cross breeding programme was started in Punjab State during the Fourth Plan Period. This programme was intensified during the 5th plan period. For this purpose the entire State has been divided into three breeding zones. For each zone, the bulls

* The Bhartiya Agro-Industries Foundation, Uruli-Kanchan, Pune.

** Department of Animal Husbandry, Punjab, Chandigarh.

of distinct breed (Brown Swiss, Jersey and Holstein-Fresian) are being used for cross-breeding. The success of cross-breeding programme obviously depends upon availability of adequate number of pedigreed bulls. For the production of these bulls, a number of cattle breeding farms have been set up by the department in the State; Brown Swiss at Patiala, H.F. at Mattewara, Jersey at Ropar and B.S.X Sahiwal at Nabha.

24. Warm semen as well as frozen semen are being used for insemination in the State. For the production of frozen semen, three Frozen Semen Bank have been set up. Six liquid Nitrogen plants are also functioning for production of liquid nitrogen. There are more than 400 insemination units where frozen semen technique is being used for insemination.

25. More than 3 lac cross-bred calves have been produced in the State during the last 9 years. It is estimated that there are about 0.57 lac cross bred milch cows in the State. According to 1972 Livestock census, there were 8.73 lac milch cows in the State. With a view to evaluate the performance of C.B. Cows in the field, a milk recording programme was started in the I.C.D.P. Patiala, Ludhiana and Jullundur during the year 1975. A Milk Recorder is to record the milk yield of cross-bred cows both morning and evening by actual weighing after an interval of 28 days. The first milk record is to be made 15-45 days after calving:

S. Krishnamurthy*

**Crossbreeding of cattle for increased milk production an
assessment of present position**

26. Even though crossbreeding was taken up during the IV plan, the programme has been in effective for a little more than five years on a national scale in the important milk sheds including the Operation Flood areas. Major effort during the period has been directed towards the development of necessary infrastructure to support this programme. About 7800 exotic cattle have been imported since 1961 to date and 80% of these imports have been during last 7 years. With the imported cattle 55 exotic herds have been developed, varying in herd strength from 15 to 350 adult cows. The combined herd strength of adult exotic cows would be about 4500 in the country. These are with Department of Animal Husbandry,

* Department of Agriculture, Ministry of Agriculture and Irrigation, New Delhi.

Dairy Corporation, Indian Dairy Corporation, N.D.D.B., non-official organisations, foundations and private farmers. An estimated 10,000 insemination units are functioning in the milksheds and the effective coverage under breeding is not likely to exceed 15% of the breedable population in the country. There are about 965 exotic bulls located at A.I. centres (Jersey 710, Holstein-Friesian 120, Brown Swiss 90 and Red Dane 45) and only 175 crossbred bulls in the States. An estimated 3.8 million inseminations have been performed under all cattle development programmes during 1978-79 and the inseminations with exotic bulls could be about 1.5 millions.

27. An assessment of the crossbreeding programme on a national scale is difficult in the absence of systematic surveys and adequate data. From the papers presented at the National Conference on cross-breeding held at National Dairy Development Board at Anand (April, 1978) and other sources and also observations made under field conditions, the following comments could be made with regard to the programme :

- (i) The programme has already created a number of pockets in the country where a sizeable crossbred population is available and their performance has justified the approach taken up for cross-breeding. Particularly, the study made in the Indo Swiss Project in Kerala has given valuable information.
- (ii) In many areas there is lack of clear cut breeding programme to limit the exotic inheritance. This could lead to disappointing results particularly with regard to utility of males as well as the cross-bred female cows not showing adaptability.
- (iii) The cross-breeding programme has not yet fully geared itself for the production of high quality crossbred bulls and their progeny testing under farm and field conditions. Unless this is initiated, progressive genetic improvement is not possible.
- (iv) Crossbreeding in many areas is not being implemented as a fully integrated programme for providing all inputs. As a result of this in a number of areas the crossbred heifers are not showing early maturity and optimum inter-calving period.

K. C. Raut*

**Assessment of cross-breeding programme in a rural area
of West Bengal**

28. In Krishnanagar area of West Bengal, cross-breeding programme in cattle is in progress for more than 15 years with a view to improve the productivity as well as other production traits of animals. The Indian Agricultural Statistics Research Institute has undertaken a large scale survey since 1977 to evolve a suitable statistical methodology for working out the cost of rearing calves and maintenance of adult animals in this area. For this, a two-stage sampling design has been adopted taking villages as the first stage units. Utilising the data collected from 385 households visiting them at regular intervals of a fortnight for one year (1977-78), studies have been carried out to indicate the extent of improvement brought about after introduction of crossbreeding programme in the area.

29. The age at first calving of a cross-bred female was about 39 months and that of a nondescript one 51 months. Similarly, there was considerable difference in age at subsequent calvings of cross-bred and non-descript ones. The average lactation length of a cross-bred cow was 349 days and that of a non-descript cow 311 days. In the case of dry period reverse was the trend, the dry period being 180 days for a cross-bred cow and 267 days for non-descript cow. Comparing the level of production, it was observed that the average daily milk yield of a cross-bred cow in milk was 2.23 kg. and that of non-descript cow 1.11 kg. Examination of the distribution of animals according to their level of production showed that about 50 per cent of the cross-bred cows gave more than 2 kg. of milk per day but only 14 per cent of the non-descript cows reached this level of production.

R. M. Acharya and Mani Mohan**

**Genetic considerations in cross-breeding for evolving
new breeds of sheep**

30. The paper was taken as read as the none of the two authors could attend the symposium due to unavoidable reason.

31. Genetic consideration for evolving new breeds of sheep through crossbreeding viz. (i) choice of exotic and native breeds, (ii) effectiveness of the level of exotic inheritance, (iii) extent of

* Indian Agricultural Statistics Research Institute, New Delhi.

** Haryana Agricultural University, Hissar.

heterosis and consequences of interbreeding crossbreds, have been described. The limitations of usually available data from crossbreeding experiments in sheep carried out in India, viz. small size and non-contemporarity of genetic groups, non-availability of native and exotic contemporarity pure breeds and reciprocal F_1 s have been highlighted. The result of a long term cross-breeding experiments involving exotic fine wool breed-Rambouillet and native fine carpet/medium apparel wool breed-Chokla and extremely coarse carpets wool breed-Malpura have been described.

32. Results indicate that Chokla crosses though inferior in body weights and survival to Malpura crosses, produced heavier greasy fleeces of superior quality than Malpura crosses. There was little or no increase in grease fleece production, body weights (weaning and yearling) and survival with an increase in Rambouillet inheritance. However, there was substantial improvement in fleece quality. There was a large heterosis exhibited by these crosses in weaning and six month body weight, survival, six monthly greasy fleece weight. There was further improvement in growth, survival and fleece quality traits in Chokla and Malpura crosses on interbreeding F_1 s, while there was a slight decline in greasy fleece production. Based on multi-variate analysis using Mahalanobis D^2 statistic, three group constellations - i.e. $R \times M F_1$ and F_2 , and $R \times C F_1, F_2$ & $5/8$ and $R \times C 3/4, R \times M 5/8$ and $R \times M 3/4$ could be formed. These are being used for developing superior carpet wool, apparel wool and very fine wool strains of sheep respectively through interbreeding and selection.

P. N. Bhat, V. K. Taneja & R. C. Garg*
**Genetic Divergence in Sahiwal and Holstein X Sahiwal
 Cross² bred grades**

33. The paper was taken as read as none of the authors could attend the symposium due to unavoidable reasons.

34. Genetic divergence as measured by Mahalanobis's D^2 -statistic was examined in forty populations consisting of Sahiwal and its 39 Holstein crossbred grades based on three traits viz., age at first calving, first lactation yield and first calving interval. The clustering pattern of the grades was studied using canonical variate analysis. On the basis of closeness of distance, the forty grades were grouped in nine clusters. It was observed that Sahiwal were lowest

* Division of Animal Genetics, Indian Veterinary Research Institute, Izatnagar, U.P.

in performance, while 63/64H grade was distinctly better than other cross-bred grades. A linear increase in production traits with increases in exotic genes was not realised. It is suggested that by continuous back crossing of a population of inferior genotypes to a superior one, does not result in a genotype with production characters of the superior population.

P. N. Bhat*

Cross-breeding of dairy cattle of tropics for improvement of milk production

35. The paper was taken as read as the author could not attend the symposium due to unavoidable reasons.

36. It is observed that 600 million cattle live in tropics. In spite of this, milk production is low. Two major causes account for this disparity (a) low genetic potential for economic production ability and (b) lack of adequate nutrition. Results of selection experiments have not been rewarding and are unlikely to be of any consequence in the present socio-economic context. Crossbreeding of tropical cattle with improved dairy breeds has been efficient in introducing new genes into these cattle and is accepted as the only possible solution to the problem in the short run. Various crossbreeding experiments conducted so far have been described and their limitations pointed out. Genetic consequences of various systems of breeding for evaluation of new breeds/strain of dairy cattle which can adopt itself to tropical conditions have been discussed. The discussion relates to possible choice of breed/strain and the level of exotic inheritance at which the breed strain needs to be stabilized. The existence of hybrid vigour in crossbred cattle populations and its use in breeding system has been discussed. The effect of genotype by environment interactions has been examined and its application in a breeding systems in tropics suggested. It has been argued that there is no advantage of introducing genes from more than one exotic breed over Friesian and Red Dane in crossbreeding and stabilization programme. Jersey and Brown Swiss have shown no special advantage over the Friesians. It has been suggested that for best adaptable genotype, an exotic level of 50% is the most ideal. The results showed an overall improvement from Zebu of 217% in milk yield, 21% in age at first calving, 42% in lactation length and 17% in calving interval.

37. Winding up the symposium, the Chairman, Dr. Randhawa thanked the various speakers for their papers and appreciated that a

* Division of Animal Genetics, V.V.R.I. Izatnagar

wide range of views on the cross-breeding programmes in the various species of livestock have been expressed. He hoped that several important aspects such as the cost-intensive nature of the programme as well as minimum number of adult animals to be taken in a given programme would be looked into by the concerned scientists to enable the programmes to succeed. He also stressed the necessity of integrating such programmes with other development programmes in the field of animal husbandry.