INSTITUTE OF AGRICULTURAL RESEARCH

ETHIOPIA

An Investigational Framework to Assist Livestock Development in Ethiopia with Special Reference to Breeding

based on the work of

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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An investigational framework is proposed to assist livestock development in Ethiopia, with special reference to breeding.

A team should be established, with supporting facilities, to be concerned with animal breeding, nutrition, management, pasture and range work. The team should be attached to the Institute of Agricultural Research of the Imperial Ethiopian Government, and should also be concerned with co-ordinated trials and livestock development programmes involving the Animal Production Division of the Ministry of Agriculture, specialized agencies, development units, and teaching colleges and institutions. Stress is laid on the need for recording and statistical services to ensure rapid and effective utilization of data.

Following a review of past breeding work with cattle and sheep in Ethiopia proposals are made for a framework for livestock improvement and for specific schemes to increase milk and meat production from cattle, involving crossbreeding, and meat from sheep, by crossbreeding and selection. Testing schemes to provide information necessary to future breeding policy in Ethiopia are formulated.

Suggestions are made for the part to be played by each organization, including the key role of the Institute of Agricultural Research, in an integrated programme of investigation and development.
The Institute of Agricultural Research of the Imperial Ethiopian Government requested FAO to send a consultant to review past work in animal breeding and to suggest a framework for the future. Since the work of animal breeding, nutrition, and management are inter-linked it was anticipated that the consultant's findings would impinge on these related aspects.

The Terms of Reference were:

1. Review past work in animal breeding conducted in Ethiopia especially by the College of Agriculture, Alemaya, and the Chilalo Agricultural Development Unit.

2. Determine the implications of past findings and of current development plans on the need for and type of animal breeding work appropriate to Ethiopia.

3. In the light of the above, suggest short and long-term detailed plans for animal breeding programmes, covering such aspects as improvement and upgrading of local types.

4. Associate with his work counterpart staff who are likely to be responsible for the implementation of the agreed-upon programme and give such staff as much training as is feasible in the short duration of the consultancy.
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- The Dairy Development Agency
- The Livestock and Meat Board
- The Chilalo Agricultural Development Unit
- The HSIU College of Agriculture
- Ambo Agricultural Institute
- Awash Valley Authority
INTRODUCTION

Background

The large potential contribution of a livestock industry in Ethiopia to the nation's health and economy has been stressed for many years in a succession of reports, studies and official statements. Until now, the resources devoted to improving the output from animal production in Ethiopia have, however, been very small compared with those devoted to crop production. The fact that improvements in crop production can be achieved more quickly should no longer stand in the way of a dynamic livestock development programme backed by relevant research, if the potential of livestock in Ethiopia is to be exploited.

Numerically, the cattle population, estimated at between 25 and 29 millions, is the largest of any single country on the African Continent. The sheep population is also agreed to be very large but rather variably estimated in recent years at 12 millions according to some recent documents and double that number according to others.

Markets for livestock exported from Ethiopia exist, or are most likely to be developed, in the first instance in countries of the Near East. The basis for these assumptions is contained in "Marketing Prospects for Ethiopian Livestock and Livestock Products in the Near and Middle East" a report of the Imperial Ethiopian Government Livestock & Meat Board, dated February 1972. Exports to European and other markets of fresh or frozen meat are likely to prove much more difficult until certain livestock diseases are brought under control, or eliminated, in Ethiopia. Specific livestock rearing projects in restricted areas might be made to provide an exception to blanket prohibitions. The establishment of disease-free zones should receive early attention but is not part of the present remit.

Approach

The development of livestock production in Ethiopia is seen as an integrated drive to improve breeding, nutrition, management and health of livestock. The basis of this development depends on sound factual information to allow evaluation of alternative policies. This, in turn, requires a framework of investigational work. The Institute of Agricultural Research is seen as having a key role in this, but not the only role. The framework is seen in terms of a co-ordinated effort involving the best possible utilization of all available facilities, no matter what the precise name or charter of the various organisations directly responsible. Some effort has already been wasted, and much more is likely to be, by a fragmented approach. Equally, no clear distinction should exist between 'research' and 'development' schemes; both need, and produce, facts for further advances. The one merges into the other. Development agencies and their sponsors should resist the temptation to dub as "research" things they do not wish to do because there is no immediate financial return. In their case 'research' is often no more than finding out what, in fact, they are achieving and providing some information for the future direction and progress of their work. Research bodies should resist the temptation to investigate problems in scientifically satisfying but in practice unrealistic situations. This last is a hard recommendation to make for a consultant who normally works as a research scientist, accustomed to all the privileges of academic freedom. However, it is a conclusion firmly reached in relation to Ethiopia's present needs and is the result
of a two-month period of study, discussion and travel in Ethiopia as an animal breeding consultant provided by FAO at the request of the Institute of Agricultural Research of the Imperial Ethiopian Government. In consequence of this assessment of the need for Ethiopian livestock development, the detailed recommendations have a strong practical orientation more concerned with achieving change and devising the most appropriate methods, than with finding out the reasons why changes occur. The exceptions to this are those few cases where the reasons for change themselves determine the most appropriate policy for future change.

Most of the details of the report are concerned with aspects of animal breeding since this is what the terms of reference required and because it is the specialist field of the consultant. The inter-related problems of nutrition, pasture and range management and animal husbandry, however, are not ignored. They form an integral part of livestock improvement and the breeding programmes proposed provide a framework within which nutritional and management studies can be carried out and achieve a greater relevance. The recommendations for a strengthening of existing staff and facilities for livestock work, and for the creation of a team to lead this development, are intended to be relevant to livestock production research and development in general, of which animal breeding is only an integral component.

Great stress is laid in the report and in the recommendations on efficient record keeping and effective utilisation of all data collected in investigational and development work. Without this the work might as well not be done. Deficiencies in this direction and poor design of trials have made much of the former investment in livestock improvement ineffectual.

The report is confined to cattle and sheep.
II GENERAL RECOMMENDATIONS

The recommendations are based on (i) an assessment of needs, (ii) consideration of past and present investigational work with livestock and (iii) the priorities for, and practicability of, various trials and development programmes.

Aims for improvement schemes

**Cattle**
1) To increase fresh milk supplies and milk products for urban areas (with the side effect of saving imports).
2) To improve the efficiency of meat production and the quality of the output,
   a. for an export market of live cattle and carcass meat;
   b. to meet the increasing home demand for "better quality" meat.

Both these aims should be met in considerable part as a by-product of the dairy industry.

3) To extend the improvement programmes for both milk and meat production to rural areas,
   a. to increase home consumption;
   b. to encourage a "cash economy".

**Sheep**
1) To produce an animal of larger size but roughly traditional type for export trade in live sheep.
2) To produce a sheep of a more fleshy ('European type') conformation and to develop an export trade in live sheep and carcass meat.

A fleshier and larger animal than generally available now will also help to meet the increasing home demand.

**Improvements and expansion of livestock production**

Production can be increased by:-

1) Improving the genetic merit of the animals;
2) Raising the quantity and quality of feed (including, most importantly, pasture) available to livestock;
3) Improving management, including disease control.
It is highly unlikely that attention to any one of these factors without simultaneous attention to the others will give as good an economic return as a joint approach. The rest of this report deals with genetic merit, which is basic, but the other aspects are not ignored. Livestock production should not aim at the maximum output per animal, but at the maximum output in relation to the investment of capital, land and labour. It follows that the genetic merit of animals should be assessed not according to their "potential" yield irrespective of the costs of the input, but in respect of their "potential" production under systems of feeding and management which are likely to be achievable in practice and which are economically realistic.

Successful realisation of the aims requires an underlying programme of investigations and development to test various alternative methods for achieving a continuous improvement in genetic merit, and a means of distributing this to the industry.

**Action required**

**A. Co-ordination**

The first line of action should achieve:-

1) the immediate coordination of future experimental work whether within the existing facilities or the proposed expanded framework. This will require the modification or replacement of some current lines of work which have outlived their usefulness.

2) meaningful utilization of past and future data collected.

Detailed proposals for the areas of coordination are given in a later section of this report as are comments on the utilization of the data collected.

The organizations called upon to cooperate and to coordinate livestock work are:

- The Institute of Agricultural Research
- The Animal Production Division of the Ministry of Agriculture
- The Dairy Development Agency
- The Livestock and Meat Board
- The HSI College of Agriculture, Alemaya
- The Agricultural Institutes at Ambo and Jimma
- The Agricultural Development Units e.g. CADU and WADU
- The Awash Valley Authority
- The organisers of the Ethiopian part of the "Beef from Molasses" project

Discussions among these bodies is already established through the National Livestock Research Committee on which they are represented.

**Implementation** should be immediate and calls for the appointment of staff who would most appropriately, but not necessarily, be attached to the Institute of Agricultural Research. This staff will be dealt with later in the report.
B. Expansion

The second line of action, arising from the planning during the first phase, requires an expansion of coordinated trials. Any special field work conducted at only one centre should be confined to solving problems related to specific local needs. Problems requiring laboratory investigation, and central laboratory and statistical services need not, with minor exceptions, be duplicated or subdivided. The work is also seen as integrated with that of departments concerned with animal nutrition, pasture production, and management.

Implementation should be within a year of completing the planning and not later than the beginning of 1974. Parts of the proposed scheme of coordinated trials could be put into operation much sooner, as, for example, within the Institute of Agricultural Research. This is to be encouraged. Implementation calls for more animals than at present, for the facilities to go with the animals including the provision of extra grazing land, extra feed, a limited number of additional buildings, and the further appointment of additional, specialist staff.

Detailed proposals for the areas of expansion and general suggestions for the facilities thought desirable are given in a later section of the report. Staff requirements are dealt with below. It should be noted that no call is made, meantime, for fundamental research aimed primarily at increasing scientific knowledge, nor is there a call for expensive back-up services involving biochemical analyses or blood typing. Biochemical work conducted elsewhere, however, should be kept under review in case possible future discoveries are made of characteristics strongly related to production or disease which are shown to be useful for selection or diagnosis. There is also no call for the establishment of meat laboratories for other than very simple, inexpensive, carcass evaluation in limited circumstances.

Responsibility and Finance

The focal point for the proposed work would be the Institute of Agricultural Research and the additional staff proposed would be supported by the Institute. However, the other organizations listed above would be involved.

Whatever form of financing and supervision is decided as appropriate for the expanded work with livestock, it should be carried out within the constitutional framework of the existing Institute of Agricultural Research.

Staff Required

The first line of action required additional staff for whom there is immediate work arising out of past and present experiments and breeding projects. The following are proposed:

A. A coordinator of livestock breeding research and development. Special qualifications required are a sound knowledge of modern concepts and methods of animal breeding and an understanding of feeding and production systems. He must be familiar with the
problems and needs of experimental design and statistical analysis
and with the interpretation and presentation of results. The man should
have demonstrated his ability to work well with other people and get
the best out of them. The post would NOT be suitable for a person requiring,
or desiring, a further period of post-graduate training other than the
occasional "short course" - usually for specialists - of weeks' rather
than months' duration.

B. A statistician to assist the coordinator and to be responsible for the
utilisation of data. Special qualifications required are training in
statistical methods applicable to livestock research with non-orthogonal
designs, and some computer orientation. This is a senior post. The
person concerned should be capable of giving guidance to others on problems
of experimental design and analysis and would be expected to supervise
and train juniors.

C. A "records" officer to work closely with the statistician and to be
responsible for the proper collection and maintenance of the data
collected from research and development projects (including coordinated
trials). This is not a job for a filing clerk. It involves an understand-
ing of the requirements of the experiments being recorded, involvement
in the recording procedures, checking of data collected, initiating
action for correction of errors or omissions, gearing the system towards
the utilization of the records and implementing the first steps in that
direction. The person should be responsible for the training and supervision
of records assistants and field recorders.

D. Assistants for the statistician and the records officer in numbers
to accommodate the available work. The tasks of record keeping and
statistical analysis of the records as well as preparatory work for
computer analysis can usefully overlap and the degree of specialization
in one direction or the other which is desirable will depend on the
volume of work and the numbers employed. The available work will increase
as the second line of action is implemented.

E. A publications and information assistant to facilitate the publication
and dissemination of information of the experimental work and coordinated
trials in progress at each centre, as well as information on policy and
new project proposals. This may not be a full-time post in the first
instance, but would become so with expanded work following the implementation
of the second line of action. This person would be directly responsible
to the coordinator or another senior scientist.

The second line of action if viewed from a limited animal breeding standpoint
(see below) requires only the earliest possible training of an Ethiopian animal
breeder (genetics) at least to the level of a post-graduate diploma in animal genetics
or an M.Sc. and possibly to Ph.D. level. Practical needs dictate that the emphasis
should be on quantitative (population) genetics and accordingly mathematical aptitude
is required. (Such a person, when trained, should be required to work within the
project for a stipulated number of years). In the meantime, additional support and
advice on animal breeding problems and analyses can be sought by the coordinator
(if qualified as proposed) from specialists at FAO Headquarters and from consultants.
The limited animal breeding viewpoint should NOT, however, be the intention. As stated, simultaneous attention to breeding, nutrition and management is likely to give the best return and some of the proposed trials involve all disciplines. Accordingly a strengthening of other departments within the Institute of Agricultural Research is called for. (Some of the posts proposed have no current equivalent). The aim should be to have a livestock team with a minimum of two really senior, qualified persons within each discipline.

- Cattle production specialist
- Sheep production specialist
- Additional pasture and range management specialist
- Production Economist oriented towards costing input-output relationships

Supporting staff for the new sections, for the enlarged pasture section and, if necessary, for the nutrition section.

Animal nutrition is, for the moment, better placed with two senior staff - an FAO specialist post (currently vacant) and a highly qualified Ethiopian Officer (Dr. Shankute Tessema).

The pasture and range management work should logically be included in the livestock sector, since its output is intended for livestock production and should be measured in such terms.
Any work involving cattle or sheep which has produced performance records is considered in this review, even if the trials were set up primarily to study nutritional or management problems and not breeding.

Specific Organizations

The following organizations are referred to:

- The Institute of Agricultural Research (4 stations)
- The Chilalo Agricultural Development Unit (CADU)
- The principal teaching institutions (HSTU agricultural college, Alemaya; and the institutes at Ambo and Jimma)
- The Animal Production Division of the Ministry of Agriculture
- The Dairy Development Agency
- The Livestock and Meat Board
- The Awash Valley Authority
- The private farm sector

The Institute of Agricultural Research

There are four stations on which cattle have been incorporated in the research programme over the past 4 years, namely Holetta Guenet, Melka Werer, Adame Tulu and Bako (which receives bi-lateral support from Germany). The stations differ in climate and topography from temperate highland (Holetta) to tropical lowland (Melka Werer) and with the other two intermediate. Four years ago heifers and bulls were purchased of each of 4 types of Zebu cattle - the Boran, the Horro, the Barka and the Fogera which are found in different regions of Ethiopia and are thought to represent distinct and relatively uniform types. The purchased heifers and bulls were placed at different stations. The Horro and Fogera at Holetta, the Boran at Adami Tulu, the Barka at Melka Werer and Horro and Boran at Bako. The work with the Fogera barely got off the ground before the animals were sold thus leaving Holetta with Horro cattle only. The cattle at Bako have only recently arrived and do not as yet enter into the experimental comparisons. The Horro cattle at Bako are not part of the same consignment which some years earlier had gone to Holetta and the Boran cattle are not from the same batch as those at present at Adame Tulu.

The four stations differ to an appreciable extent in climate and topography as well as in the management applied to the cattle. The philosophy of placing different breeds in different locations was that the locations should reflect the regions where the cattle originated. Further, the intention of the trials was to test the "potential" of the breeds by treating them as well as possible in terms of feed and management, although, in the event, the levels attained differ markedly among the stations. Records were kept (or intended to be kept) on body weight and on milk yield, as well as on reproductive performance and health.

The results to date have shown (as published in the Institute's reports) that the average yield in each of the 3 herds ranges between 500 and 700 litres per lactation with many cows giving less than 100 litres and a very small number in excess of 1,500. Whilst strict comparison of the 3 breeds involved is not valid because such differences are confounded with station differences, the results lend useful confirmation to the published evidence from other countries that Zebu cattle do not produce a great deal of milk and not sufficient for specialised dairy farming.
even when fed and treated relatively well. They also show that the number of cows with possibly acceptable yields for commercial milk production, even at an unambitious level, are so small that any selection programme to multiply the genes of these animals would be totally uneconomic and would probably encompass the lifetimes of several generations of animal breeders.

In terms of body size and growth rate all the animals, except the Boran, are relatively small and slow growing.

Some details relevant to each of the 4 stations are given below:

Holetta Guenet

This is the main station of the Institute, an hour's journey from Addis Ababa. It is equipped with laboratories and a library. The cattle work comprises, in terms of investment and staff, a small proportion of the total work of this station. Apart from routine observations of weight, milk yield, breeding records and health records on the herd of Horro cattle, trials have been in progress involving different methods of feeding and rearing calves.

Although a useful recording system and a plentiful supply of appropriate forms were made available for recording the performance on the Horro cattle, the use of the printed forms appears to have been discontinued during the period of stewardship of the FAO Animal Nutrition Expert and the observations recorded over large masses of sheets of paper and rough notes. It will be difficult and tedious to reconstitute proper records for each animal and summaries of performance. The reason for discontinuing a sensible, if not perfect, recording system is incomprehensible.

Dynamic and interesting work on pasture and range management has been initiated under the guidance of another FAO expert and there is a keen realisation that some of this work can be usefully integrated with studies involving, for example, breed comparisons on different treatments.

Melka Werer

The cattle work at this station, a day's drive north-east of Addis Ababa, represents a very small and rather neglected part of the work, most of which is devoted to cotton and other crops grown under irrigation. Housing for cattle is minimal and the grazing area available is unimproved scrub. Male and female animals are kept apart only with difficulty by attendants, and unintended matings almost certainly take place. There appears to have been little supervision or encouragement of the work with the Barka cattle at this station since it started and this is reflected by, for example, the irregular delivery of concentrates for feeding the cows so that in the midst of lactation they have periods without adequate feeding. The records show that this has had the expected results of reducing the milk yield of the herd and recovery after such a period of deprivation is not complete. A further example is the non-delivery of eartags so that calves born during the last 6 months preceding the consultant's visit had not been identified. Any attempt to do so must be subject to considerable errors. Further, examination of service and calving records shows clearly that a proportion of the animals could not have been the offspring of the bull recorded as the father (as indeed was predictable from the way in which the animals are kept.) Surplus stock have not been sold, and clearance of scrub land to give the cattle some more adequate grazing has never been allowed to get properly under way, in spite of the desire of the officer-in-charge of the station to see that this was done.
Too few bulls have been used so that the animals born on the station contain a high proportion of sibs and half-sibs which both restrict the sample of the breed being studied and would make it difficult to avoid in-breding without purchasing new bulls.

Adame Tulu The Institute of Agricultural Research has been given an area of land on this breeding ranch south of Addis Ababa, belonging to the Animal Production Division of the Ministry of Agriculture, which is devoted to breeding Boran cattle. This is the only one of the Institute’s stations concerned entirely with a livestock enterprise but the facilities available reflect the neglect and lack of central encouragement, or the absence of necessary finance, already observed at Melka Werer.

The actual trials in progress were the remnants of 2 crops of Boran calves reared on different systems to the time of weaning and then fed virtually ad libitum on hay and concentrates up to 2 years of age. The first crop of calves were the offspring of a single bull and the second crop of calves almost entirely the offspring of a second bull. The results have been written up in the Institute’s reports as representing the “growth potential” of the Boran breed. This is clearly misleading in view of the very restricted sample of bulls used as fathers.

The consumption of milk by calves reared by the Boran cows has been estimated by weighing calves immediately before and after sucking, a very time consuming business, and likely to be pretty unreliable since the scales are graduated only to the nearest 5 kg.

In addition to this enterprise a group of 47 cows from the Ministry’s Adame Tulu herd are being milked to provide yield data. There is a small group of Boran heifers now approximately 2 years old which have been mated at this somewhat early age for the breed.

Bako This station, 260 km. west of Addis Ababa, with a German as well as an Ethiopian concerned with the animal work, has now acquired two reasonably-sized herds, one of Horro cattle and the other of Boran. Observations on the animals have only just started but since the majority of the Horro cattle were found to have brucellosis there is at present no certainty that the animals will remain on the station. Arrangements have been made for extending and building some cattle housing and a milking parlour. It is also desired to inseminate the two Zebu types of cattle with semen from Friesian, Simmental and Jersey bulls and arrangements have been made to import this semen from Germany. This matter will be referred to later in the report.

The Chilalo Agricultural Development Unit

The purpose of this project, which receives Swedish aid, is to develop agricultural production in the Chilalo region south of Addis Ababa. Most of the effort is directed towards cropping, but the Livestock Section guided by four senior Swedish staff, is dynamic and aims to study and improve the milk production of the local cattle. Work has newly started on sheep to study the growth of local sheep and some crosses.

Cattle The total cattle herd, including all ages, exceeds 400 head. The majority of the cows in milk so far are the local Arussi cattle. The remainder comprise a few other Zebu types and crossbreds. Crossing has been mainly to the Friesian although some crossing to the Jersey has also taken place. Most of the cows now being bom
are crossbreds. These include first crosses, the quarterbred, threequarterbred, and a few $F_2$ ($F_1 \times F_1$). Because of the sub-division of the herd according to the 4 local types recognised (Arussi, Boran, Fogera and Barka) and the further sub-division of records from Friesians into those obtained from Kenya and those derived from imported semen, the number of sub-classes is substantial and the numbers within some of these sub-classes extremely small and unlikely to provide reasonable comparisons.

Crossing with the Jersey has been discontinued in favour of the Friesian. The precise reasons for this are not clear since the early results appeared to indicate that in milk yield the Friesian crosses did not yield appreciably more than the Jersey crosses. In view of the fact that the Jersey crosses weighed 30 to 50 kg less than the Friesian crosses at the age of 2 years, the slightly smaller animal may well be at a relative advantage on the peasant farms for which they are intended as milk producers. As against this, the smaller animal may be less favoured for draught purposes, important in this region, and some prejudice is reported against the Jersey colour since "black and white" has come to be popularly associated with high milk yield.

Sheep Work with sheep started in July 1971 with the purchase of approximately 140 local ewes some of which were found to be pregnant after purchase. The intention was to allocate 25 to each of four "breeds" of ram; the local Arussi, the Corriedale, a Hampshire-Merino cross, and a large type of Ethiopian sheep known as Kaffa. In the event the latter did not materialize. Unfortunately only one ram of each type was used and it is difficult therefore to distinguish between ram effects and breed effects. The preliminary results suggest that birthweight of crossbred lambs was approximately half a kg heavier than those of the local Arussi and that by 60 days the difference had not materially increased.

Although, it appears to be agreed that the two wool breeds used for crossing are inappropriate to the conditions, they were the only ones readily available. On the advice of the Swedish breeding consultant, two French "Bleue du Maine" rams are to be imported for use this year. The reasons for this particular choice of breed were not known.

Haile Selassie I University, College of Agriculture, Alemaya

Work is in progress to assess the relative merits of a number of breeds and crosses for beef production and other work is associated with dairying.

Sheep breeding trials were discontinued some years ago owing to disease problems.

The beef work started in 1961 with the purchase of 90 local cattle of a Boran type which were mated to Boran bulls from the Ministry's Adams Tulu station and with four Boran bulls from Kenya. The second phase of the work comprised crossbreeding the Zebu cattle to bulls of the following breeds:--

Hereford, Aberdeen Angus, Charolais, Brahman, Santa Gertrudis and Boran

One bull of each breed was used per year, but four bulls of each breed were available for use in rotation. The total number of oows in the herd at present is 190 thus the numbers per sub-class are rather small. The results up to 1967 have been published by Wagner and others (1969) and appear to show the crosses as having a 20 to 30%
advantage in weight and growth rate compared with the Boran.

The crossbreeding work is seen as having a part to play in the livestock development programme proposed by the Animal Science Department for the Dakata valley where the College have 10,000 acres of range land at their disposal. The proposals for this region are ambitious and include an eventual fattening of 2,000 steers per year and maintenance of a breeding herd of 600 cows. Whether this level of stocking and fattening can be maintained is as yet open to question and has not been worked out in detail. Since the carrying capacity of the land is reckoned to be 5 acres per animal and the anticipated calving rate between 70 and 80%, a great deal will depend on the amount of supplementary feeding which will become available from the intended irrigation covering approximately 1/10th of the total area. The scale of the operation clearly depends on this. However, although the undertaking is intended primarily as a commercial venture (with some compensation to the displaced nomads by way of water holes and other assistance) the project, if undertaken, will offer opportunities on a larger scale for comparisons of breeds and crosses.

Dairy cattle For some years the aim of the dairy herd management has been to produce as much milk as possible from pure Friesian cattle (mostly of Kenyan origin) alongside a small number of half- and three-quarterbred Friesians. The management and feeding levels supplied and the yields obtained are much superior to those of any other institutions or commercial herds in this part of Ethiopia. This is a mixed blessing since the system which is taught and applied is a long distance from that generally realisable. The herd provides relatively little information of interest from an animal breeding point of view.

Other teaching institutions

Agricultural institutes at Ambo and Jimma (the latter was not visited) maintain relatively small dairy herds which, because of numbers and breeding policy, have contributed little information of relevance to animal breeding. However, there is no reason why they should not form part of a coordinated programme whereby their resources can be used for other than purely teaching and demonstration purposes. In fact, it can be argued that some valid comparisons of breeds and crosses superimposed on the other work would be a positive contribution to teaching and demonstration.

The Animal Production Division of the Ministry of Agriculture

This Division has direct responsibility for one Boran cattle breeding centre at Adame Tulu, to the south of Addis Ababa, and a sheep breeding station at Debre Berhan, to the north. Other stations, until recently under the control of the Ministry, have been released for use by the Dairy Development Agency.

Adame Tulu This breeding station was started approximately 12 years ago with the introduction of 350 Boran females and 12 bulls from the region of Ethiopia bordering Kenya. The aim has been to develop an improved animal in terms of size and growth rate. Records have been kept on matings, parentage, deaths and disease, and live weight. Relatively little use has been made of the available records although a summary by a volunteer worker, D.A. Kinross, and a computer analysis done by Ato Hailu Kassa on birth weight (whilst on study leave in Denmark) have provided useful background. None of the work has been published. Selection of bulls has been on visual assessment and some regard to the records of dams and maternal
half-sibs, but no attempt has been made to follow a programme of performance testing or a scheme to maximize selection. No information is available from which to judge whether the selection practiced has resulted in genetic change in body size. The analysis by Ato Hailu Kassa suggests a heritability of birthweight (from intra-sire half-sib correlation) of the order of 0.15. The summary referred to suggests that the animals currently in the breeding herd are slightly superior in weight to all cows which have calved over the years.

Better utilization of the records might reveal more information and this seems feasible through collaboration with the Institute of Agricultural Research given the staff and money required for this purpose.

Debre Berhan The work of this sheep breeding station was usefully reviewed in August 1971 by A.G. Allathan as part of a study on sheep production systems in Ethiopia. The station, started 4 years ago, was stocked at the time of Allathan's visit with nearly 600 Merino ewes (a legacy in Ethiopia from former times) a little less than 300 of the local short-haired Ethiopian sheep and 37 Corriedale ewes. In addition there were a further 390 crossbred females derived from crosses of Merino ewes and Ethiopian ewes mated to Romney, Hampshire and Corriedale rams; the Ethiopian ewes were also mated to Ethiopian type rams. At the time of the consultant's visit in June 1972, the number of Merino ewes had been reduced somewhat and the crossbred sheep had produced lambs for the first time.

A point which appears to have escaped notice is that since only 3 Romney and 3 Hampshire rams had been in use over the 3 years of breeding at the station, the daughters of these rams have now been mated back to the same rams. Father-daughter matings are therefore bound to take place since rams are turned out in groups and individual matings are not controlled or recorded. The use of a small number of rams to represent their breed is to be regretted at all times. The rams should be used in sufficient numbers to be representative of their breeds and to avoid unnecessary in-breeding. In the particular case of father-daughter matings a noticeable and detrimental effect can immediately be expected on the growth rate and ultimate body size of the inbred lambs; an increase in lamb mortality must also be expected. The number of Corriedale and Ethiopian rams available for use in considerably larger and although the system of mating does not preclude the mating of close relatives, a general rise in inbreeding is less likely in these groups. Although the present breeding programme should be radically changed in terms of breeds, crosses and breeding systems, the very least that must be done immediately is to replace the Romney and Hampshire rams if these breeds are to be used again at this station with the present crossbred female stock which includes their daughters.

The land at Debre Berhan is much over-grazed as already pointed out by Mr. Allathan; contributing to this is the retention of all females even those surplus to flock replacement requirements. It is stated by Ministry officials that this was done in order to build up numbers for distribution to a sub-station. Further contributing to over-grazing are a substantial number of castrate males which are not to be sold below the arbitrary weight of 30 kg although it is clearly uneconomic for many of the animals to be kept until they reach such a weight. Further difficulties in the disposal of stock arise through the cumbersome and time-consuming administrative machinery which has to be invoked before animals can be sold.
Records are kept of birth weight and weaning weight as well as weights at disposal. The sire's breed, but not his identity, is recorded in addition to the dam's identity. Weaning is at an approximately fixed date but variable age, which makes direct comparisons of weaning weight somewhat difficult. The only summary of performance records circularised is that by Mr. Allathan, but averages for a further year, prepared by Ato Hailu Kassa, were shown to the consultant. Clearly no regular use is made of the records to compare the performance of the crosses in the breeding programme, or in a wider context to guide a developing sheep industry.

Other agencies concerned with livestock

Other organisations, some of very recent origin, which are relevant to the present discussion include the Dairy Development Agency, charged amongst other things with dairy cattle breeding and therefore of key importance; the Livestock and Meat Board concerned to a large extent with marketing, but with an interest in livestock development schemes particularly in relation to sheep and cattle for export; and the Awash Valley Authority which, as part of its irrigated pasture programme, has a considerable potential for livestock rearing which is currently exploited for commercial ends with purchased stock.

To date the Livestock and Meat Board have commissioned a number of surveys of cattle and sheep stocks and methods of husbandry in various regions of Ethiopia which provide useful background information.

Other sources of information

A number of dairy farms in the Addis Ababa region maintaining records were visited in 1971 by Dr. Speth (during in-service training from the Technical University, Berlin) and his summary of milk yields, calving intervals and breeding records make a most useful contribution in a situation of "information famine". However, in this survey the effects of farm environment are confounded with the effects of breeds and in only two herds were crosses milked alongside a pure exotic breed.

General Conclusions

The information which is available falls, broadly, into four classes:

1) Investigations where management and other aspects of environment are confounded with the effects of breeding and where any strict comparisons in terms of differences attributable to breeding are invalid.

2) Trials where total numbers are quite large, but where too many comparisons are being attempted so that subclasses are very small and there is little prospect of finding any statistically significant differences. Under these circumstances, average differences can be misleading.

3) Some quite large breeding projects where records have been accumulated but not used, or only inefficiently used, as an aid to the breeding programme and it is difficult to interpret the consequences.
4) Breed comparisons where insufficient care has been taken to make groups representative of their breeds, e.g. by using only one male as the father.

Most of the experiments and developmental breeding trials have been conducted without a clearly defined breeding strategy or programme. The actions intended to be taken in the course of experiments and trials have not, in most cases, been laid down and most of the decisions and actions have been taken on an ad hoc basis. Since staff changes occur frequently, further complications have arisen as original intentions were forgotten and new ideas superimposed. Inefficient experimental design and poor record keeping have contributed to the difficulties. A basic lack of understanding on the part of administrators of the needs of livestock and livestock research have added an occasional touch of chaos. Whilst all these deficiencies cannot be ascribed to each of the experiments and trials, the combination of factors has detracted greatly from the potential usefulness of the relatively small investment made over the past decade (but especially the last 4 years) which was intended to demonstrate the performance level and to change the level of genetic merit of livestock.
IV. A FRAMEWORK FOR ACTION

General Principles

1. The Alternatives for Genetic Change

(a) Selection within breeds
(b) Selection among breeds (breed substitution)
(c) Crossbreeding

and any combinations of these.

Selection within breeds depends, for its successful application, on the presence of genetic variation and the ability to detect it. It also depends on what proportion of the parents are needed to produce the next generation. The larger this proportion the less the progress. The rate of progress also depends on the speed with which successive generations (not only successive offspring) can be produced. With cattle, for example, progress by selection must be expected to be very slow. For a trait like milk yield which is not highly inherited, a rate of increase of the average yield of between one-half and one percent per year is the most that could be realistically expected. Thus to improve the milk yield of a well managed Zebu herd from its present average of 625 litres per lactation to the average of the best 25% of cows (1150 litres) would be a futile and unrealistic operation if other alternatives exist. By contrast, to improve the 2-year old weight of a breed of sheep by selection from an average of 35 kg to one of 40 kg might be entirely practical, because the trait is more highly heritable, more easily observed and earlier in life, the generation interval is less and, very importantly, the costs of selecting sheep for size would be a fraction of the costs of selecting cows for milk. The recommendations in this report take such considerations into account.

Replacing one pure breed by another (e.g. replacing local cattle with Friesians) might be contemplated if the difference in performance is large, provided the performance of the new breed is assessed alongside that of the old breed and under the conditions under which the breeds will have to be kept. Many farmers make this type of decision for themselves and relate the cost of the change to the likely returns. On a national scale, however, involving thousands, even millions, of animals replacement by importation is impractical, even impossible, to achieve over a reasonable period of years.

Crossbreeding is, in the first instance, a means of producing animals which are expected to be, on average, half-way in their performance between the average levels of their parent breeds. Such crossbred animals then provide an opportunity for "up-grading" to the better parental breed by successive matings to males of that breed. However, whether to "up-grade" further, and how far, or whether to maintain a 50:50 level, or even reduce the proportion of the blood of the "better" (e.g. exotic) parent depends on a number of circumstances the two most important of which are (i) the genetic combination best suited to the conditions under which the animal must live and (ii) the extent to which the first cross ($F_1$) is actually better than the half-way mark i.e. the extent to which it manifests the "bonus" of hybrid vigour.
Both these things may change with time if aspects of the environment (e.g. nutrition, management, health control) change. These considerations are relevant to determining the most suitable breeding policy to follow. These points are elaborated later in this report in a section commended for the particular attention of the Dairy Development Agency "Testing the relative merit of various grades of Zebu x Friesian ±±± with a view to determining the most suitable breeding policy for the Ethiopian dairy industry" (see Appendix 2). The matters discussed are valid, in principle, for any situation involving the use of crossbred animals.

2. Assessing genetic differences

The single most important requirement is that the groups (or animals) being compared must be kept together in one place under the same conditions of feeding and management. If the groups are treated differently it is not possible to say how much of any difference in performance is due to treatment and how much due to inheritance.

Another requirement when groups are compared (e.g. breeds or crosses) is that the groups should be representative of their type, by making sure that the parents of the animals being tested come from a cross-section of, for example, their breed and that many different mothers and fathers are involved. If, for example, only one bull or one ram of each breed is involved this is generally no more than a test of that bull or ram. Often there is more variation within a breed than there are average differences among breeds.

The numbers in each group must be adequate for the purposes for which they are intended. This is something which requires to be considered statistically when trials are designed.

Genetic differences between, for example, two groups may be important under one set of environmental conditions but of quite a different order, or even in the opposite direction, under another set of conditions. It is sometimes necessary, therefore, to make the same comparisons in more than one situation. This point is elaborated in part, later in this report, in the section "Testing the suitability and merit of Friesian bulls for Ethiopian condition". (See page 19)

In assessing genetic merit, the accuracy with which this is done must be considered alongside the speed with which the information is obtained, as well as the costs, and how much selection can in fact be practised among the tested animals since it is desirable to keep only the very best of the tested animals for future breeding, subject only to precautions to avoid inbreeding. It is the total progress over a fixed period of time that matters. For these reasons, performance testing (i.e. recording the individual's own performance) is nearly always more advantageous than progeny testing (i.e. recording the performance of the individual's offspring) even though the latter tells more about the individual's breeding merit.
3. **Coordinated work**

(a) **The reasons**

In order to realise the aims outlined earlier, more questions need to be answered than can reasonably be asked at any one station (farm). It is necessary normally to restrict the questions at each station to those which can be answered reliably within the limits of the facilities. When the resources of several stations are pooled the total amount of information obtained is greater (more questions are answered) than the sum of the separate pieces of information from each station in isolation. Some questions need to be asked at more than one station anyway. For example, is sheep breed "A" better than sheep breed "B" in the highlands as well as the lowlands? If the answer is "yes" it suggests that the better breed is generally useful, if the answer is "no" it suggests that special breeds may be needed for special conditions.

(b) **Requirements from each participating Station**

(i) In certain circumstances no more than to conduct trials within an overall strategy, to replicate where this is desirable and to avoid duplication where this is unnecessary.

(ii) For comparisons of breeds and crosses, to maintain at least one stock in common to all station (and obtained preferably from a single source) to act as a base line, against which the performance of other breeds and crosses (which are not necessarily in common) can be measured.

**Specific Schemes**

These are limited to matters considered important and readily investigated and where the answers, and as far as possible the animals produced in the course of the trials, will be of immediate practical use for further development.

(a) **Cattle**

(i) **Coordinated Comparisons of Cattle Breeds and Crosses**

The comparisons are to be made primarily in respect of growth rate, final size and milk production and secondarily in respect of "total dairy merit" and acceptability for draught purposes. "Total dairy merit" includes milk yield, reproductive efficiency, viability and disease resistance. It is not thought less important than single lactation milk yields, but takes longer to investigate. The trial has two breeding phases.

The questions to be asked in the first phase are, primarily: are there differences in merit among exotic breeds of sire? Are there differences in merit among Zebu breeds of dam? Are there differences among stations? Secondarily (and incompletely): Do breeds rank differently in their merit at difference stations? Thirdly (and only as a "hint" from the first breeding phase): Do specific breed combinations have particular merit?
The second breeding phase will answer the primary question: What are the relative merits of \( F_1 \), \( F_2 \), and \( 3/4 \)-bred animals? Since this will depend on the levels of hybrid vigour manifested by each cross it will contribute to an understanding of whether specific breed combinations should be further investigated.

The second phase will reinforce the information on all the main questions for which answers were obtained in phase 1. The details are described in Appendix 1.

(ii) Testing the relative merit of various grades of Zebu x exotic cross with a view to determining the most suitable breeding policy for the Ethiopian dairy industry

The development of dairying in Ethiopia will involve the widespread use of \( F_1 \) (Zebu x exotic) females as well as cows with other proportions of Zebu and exotic blood. The optimum proportion, however, will depend in part on the conditions under which the cows are kept, including climate, management, nutrition and health. The optimum proportion will also depend, however, on the performance of the first crosses relative to the performances of the Zebu and exotic parent breeds. The \( F_1 \) performance, in respect of yield, reproduction, health, economic returns, etc., may be exactly intermediate or better or worse than this. There is some reason to believe that it may be markedly better than the half-way mark particularly when "total dairy merit" and the economic returns, which include the by-product of beef, are taken as the criteria. It is not a foregone conclusion that continuous grading-up to the exotic parent is the right policy even in the Addis Ababa dairy development programme where dairy management and supervision are likely to be ahead of many other regions. However, though fifty percent of exotic blood may be all that is wanted in many situations, the continuous production of first crosses by mating Zebu cows to exotic bulls could prove too expensive. The most appropriate breeding policy, therefore, will depend on a variety of circumstances. The first step is to obtain information under practical dairy farm conditions to evaluate the alternatives.

The scheme proposed is complementary to that outlined earlier and in Appendix 1 but is confined to a single breed combination. The scheme is commended for urgent attention and action to the Dairy Development Agency in connection with the Addis Ababa Dairy Development Project. The information sought, however, is essential to the efficiency of further dairying developments in other, possibly less advanced, or rural areas. The scheme has been discussed with officials of the DDA and was prepared for that purpose in the detail given in Appendix 2.

(iii) Testing the suitability and merit of Friesian bulls for Ethiopian conditions

This scheme is of considerable practical importance for Ethiopia, but also it is likely to provide information to guide those who wish to use expensive imported semen, from bulls tested under one particular system of breeding and management, for use in an environmentally different set of circumstances
and a different breeding system. In immediate practical terms is the "proven" merit of a foreign bull applicable here and worth paying extra for? And if not what are the sensible alternatives?

The scheme is applied to a larger number of commercial farms and would need to be operated by the HDA with probable assistance in checking and collection of records from the IAR.

The scheme, as set out in Appendix 3, was prepared in some detail for discussion with officials of the MDA.

(iv) A collaborative programme for improved cattle meat production

Meat production can be considered as a by-product of dairying (or of the use of draught oxen) or in terms of specialized "beef" breeds. In practical terms, and in the foreseeable future, differences in "quality" between crosses from breeds in the dairy scheme (e.g. Friesian and Simmental) and crosses involving more specialized beef breeds are unimportant.

The "improved meat production" is visualised in terms of the more "fleshy" type of animal with a more "European-style" conformation said to be required for the export trade and the increasing home demand for this type of meat referred to earlier.

Two situations for intensive production developing in Ethiopia make it desirable to test the relative efficiency in terms of growth rate and meat output of the various breeds and crosses available. The situations are:

1. The "beef from molasses" project starting in 1972.

2. The irrigated pastures (lucerne mixtures) being produced as part of the rotation in the Awash Valley by the Awash Valley Authority (AVA) and elsewhere.

For the former scheme alone the potential production of meat, using the available waste molasses under optimal conditions, has been estimated as 8,000 t of meat per year which would meet the whole of the export requirement foreseen for the immediate future and leave a substantial amount for the home market.

Availability of sufficient numbers of the right type of cattle is a crucial factor (when in full operation, the molasses project might require 40,000 per year). Boran cattle would, under present circumstances, have to come from a considerable distance and may not be available at a sufficiently economic starting price, unless a high proportion of the output goes for export. Crossbred male animals from the dairy project are not expected to number more than a few thousand and it is unknown what proportion of these will be retained by farmers themselves for meat or draught purposes. The
local small Zebu, such as the Arussi tested at CADU, are likely to give low growth rates (at CADU Arussi heifers on ad lib hay and concentrates gained less than 400 g per day), but may be cheaper to obtain. These cattle would not of course meet the requirement of a "quality" conformation. The project may, therefore, ultimately require the use of crossbred animals produced specially for the purpose, which may be justified if most of the output goes for export at prices far above those obtainable locally. Breed comparisons are required to study the relative economics of using various breeds and crosses. The minimum biological parameters needed to facilitate the economic projections are initial and final live weight and duration of feeding period (this will provide daily gain) and meat output in terms of killing-out percentage. Group feed intake should be measured if possible. Purchase and sale price per kg live weight is likely to change with a number of extraneous factors not wholly related to breed merit, but should be recorded.

The breeds or crosses to be compared initially are:

Local Arussi
Arussi x Friesian (probably from CADU area)
Boran
Boran x Friesian

As other breed crosses become available they should be used e.g. the Friesian, Jersey, Simmental and Ayrshire crosses with various local breeds from the coordinated trials and dairy developments referred to. The Boran x Friesian and/or Boran should be included in each comparison as standards.

Twenty animals per group should be adequate. This figure should be revised (up or down) as data on variation in growth become available. The numbers, however, should depend more on establishing differences among the exotic sire breeds and Zebu dam breeds rather than on establishing, as significant, the predictable difference between the "pure" Arussi and the crosses.

The trial should be replicated on the irrigated pastures of the AVA to answer the equivalent questions for this different situation and to ascertain whether breeds rank in the same order of merit in the two situations. Data on feed intake - or stocking rate - are unlikely to be obtainable separately for breeds under the system operated. If necessary heart girth measurements might replace live weight, but weight would be much preferred and is possibly essential in the investigational period.

Dakata Valley A note on the project proposed by the Animal Science Department of the HSU College of Agriculture.

This project, referred to in the review section of the report, would clearly benefit from trials to determine the most appropriate breed or cross, particularly in respect of the breeding herds proposed for the supply of some of the animals for fattening. Such trials should be incorporated early in the project if it becomes operational. The information
obtained from the trials proposed above for the molasses and AVA projects, as well as the limited information from crossbreeding for beef at Alemaya, will be of relevance, particularly since a proportion of the animals are expected to be fattened in dry-lot and current predictions are that this would be uneconomic with local Zebu breeds. Animals for this purpose are therefore most likely to have to be produced by the breeding herd.

(b) Sheep

Meat from sheep in Ethiopia appears to be at a premium both in the export and the home market. Economics favour sheep compared with cattle where meat alone is the aim. Profit appears to be made even from fattening up, perhaps merely "filling-up" thin, relatively old sheep prior to slaughter. Under intensive, irrigated pasture conditions in the Awash Valley current indications are that small weaned lambs from the local sheep (weighing 4-15 kg) may reach 25-35 kg in 5 months and provide a substantial return. Price is determined almost entirely by live weight so that there is little incentive to be concerned about the composition of the live weight gain or whether, in the case of old sheep, it is entirely gut fill and fat. Sheep prices, however, vary seasonally and both demand and prices rise sharply during feast periods a factor to be taken into account in sheep production systems.

Taste preferences are alleged in favour of the thin local sheep on parts of the Addis Ababa market and of the lowland sheep (Somali Blackhead) on the Arabian peninsula. In the former case in particular, a virtue may be made out of necessity, but in any event some of the "flavour" may be associated with the vegetation grazed and, if so, bigger sheep of similar type should be equally acceptable. Marketing studies and local opinion, however, suggest an elastic demand for sheep meat and a growing one for the fleshier type referred to in the "aims" earlier in this report.

The genetic size of sheep can be readily influenced by crossbreeding, by selection, or both. Some of the low live weights of sheep marketed at present (15-25 kg at maturity, for example) are undoubtedly due to malnutrition, caused usually by overgrazing. Therefore, unless management is improved, the provision of genetically larger sheep is most likely to place such animals at a relative disadvantage. However, the availability of the potentially larger, fleshier and faster growing sheep may provide the necessary incentive to better grazing management and supplementary feeding. It is to be hoped that the severe overgrazing noted at Debre Berhan, where "better" sheep are kept, is not to be taken as evidence to the contrary and that the problems there owe more to administrative difficulties, exacerbated by distance from Addis Ababa, than to a lack of understanding.

Wool In agreement with the opinion of the Ministry officials and livestock specialists, as well as Mr. Allathan's report, the consultant feels that there is no longer any place, if ever there was, for sheep with wool as their primary product. Even as a by-product, however, it should be
discouraged when possible, since there is no ready market for it and a fleece adds management complications. In certain restricted areas, e.g. the Menz district where a "cottage" industry based on "wool" actually exists or where its development is more than a theoretical possibility, wool sheep can easily be introduced into the system.

**Hides and skins** These represent a valuable Ethiopian export. There is no reason to think that production of bigger, meatier sheep would detract from the quality and value of the skins (the larger size may enhance the value) but even if it did the "loss" would represent only a part of what is already a relatively small proportion of the value of a sheep sold for slaughter. With bigger sheep this proportion would be even less. It is pointed out in the IBRD/IDA report on the Development of the Livestock Industry in Ethiopia (November 1970) that the value of the skins sold can be greatly increased by improved processing. There seems to be no case therefore for any attention to skin in the genetic improvement of sheep for meat production. Hair sheep have an advantage over wool sheep in terms of quality of hide.

**Environments for sheep** It may be necessary to produce different sheep for

(a) the temperate highlands

(b) the drier, hotter, lowlands

and in each circumstance to differentiate between

- extensive range conditions and
- intensive fattening associated with irrigated pasture or with arable by-products.

It is not a foregone conclusion that highland and lowland regions require widely differing sheep since, broadly speaking, sheep of any one "type" are found in widely varying conditions, and in some other cases the matter has not been tested. However, there is sufficient evidence to proceed with caution before recommending a single type and the starting assumption will be made that different breeds are likely to do better in widely differing situations.

Equally, it will be assumed, in the first instance, that for intensive conditions breeds will be required that respond to the better conditions more efficiently than would range sheep, and that the more highly productive sheep may suffer unduly if kept on range. This should not, however, remain untested. If the potentially more productive sheep can perform at an acceptable level under poor conditions, and then respond well when given the chance, it could be crossed with a second breed to produce the lambs for fattening, or possibly produce "pure" lambs suitable for that purpose. In either event this system would be easier to operate than the more complex system of stratified sheep production practised in, for example, Great Britain, and advocated as a long term aim by Mr. Allathan in his study of sheep production.
systems in Ethiopia (August 1971). At present, the marketing situation does not appear to exist for so sophisticated, but otherwise worthwhile, a system, but the principle can be applied on a limited scale.

**Overhead costs of production** When sheep are produced directly for slaughter the aim should be to reduce overhead costs by using the smallest type of mother consistent with the ultimately required size of the lamb at slaughter. In still more highly intensive systems the aim should be for more lambs per ewe (e.g., twins and breeding more than once a year), but for the present the latter does not appear to be a practical objective, with the possible exception of one or two potentially self-contained schemes (e.g. AVA).

**Crossbreeding and selection** The objective of large lamb and small ewe can be met by a crossbreeding programme (large breed of ram, small breed of ewe).

Crossbreeding can also be used to provide the larger type of ewe required in other circumstances.

Size, however, especially adult size, is a quite highly heritable trait (unlike milk yield, or fertility) and is readily observed in the individual. Selection will therefore be recommended both on "pure" local breeds and from a crossbred foundation.

**Framework of scheme** The following breeding procedures in three overlapping phases are considered appropriate to the aims outlined earlier. With variations and omissions the scheme applies to each of the stations expected to participate in sheep breeding improvement. Some additional stations may be used, or needed, purely for testing sheep produced elsewhere.

1. **Selection for larger size of ewe and weaning weight of lamb within a "local" Ethiopian breed.**

2. **Crossing a local Ethiopian breed with a large Ethiopian breed followed by selection from among the F₁ and F₂ generations (mainly on weaning weight of lamb and size of ewe) to create a self-reproducing "new improved" Ethiopian breed.**

3. **Crossbreeding with rams chosen from a large number of exotic breeds from the Near East, Europe and elsewhere on:**

   (a) the "local" Ethiopian breed  
   (b) the selected (local) Ethiopian breed  
   (c) the new improved Ethiopian breed

   (Phase 1)  
   (Phase 2)  
   (Phase 2)

It is assumed that the ranking of merit of the exotic breeds in these crossing trials will be the same in crosses with the local and the selected Ethiopian breed, although the average performance of crosses from the latter
should be better. The crossbreeding phase with exotic rams cannot wait until the completion of the selection and improvement programme of the Ethiopian ewes and must therefore commence with the available stock.

4. In each case, the crosses with exotic rams (3, a/b/c) will be assessed for their merit as:

(i) animals for slaughter and, after discarding the worst, as

(ii) a type of ewe suitable for the production of lambs for slaughter by further mating them:

- to exotic rams to produce 3-way crosses for slaughter
- to rams of their own cross to produce $F_2$ crosses for slaughter.

5. Depending on merits of the crossbred ewes with exotic blood (assessed in 4(ii) above) the "final" stage could be the development of new breeds by selection among the $F_1$, $F_2$ and later generations of inter-se matings. However, the relative advantages of selecting to produce new breeds, or of continually producing the crossbred types of ewe anew, as part of a stratified system of sheep production, will depend in large part on reproductive and mortality rates, the size of the offtake, and the economic assessments of the systems.

It cannot be stressed too strongly that any progressive scheme will be quite useless unless good records are kept and continually utilized, since every stage depends on full assessment of the preceding stage. Fullest cooperation and coordination should therefore exist among the stations participating in the programme and it is assumed that the staff at the Institute of Agricultural Research will be involved, in particular the proposed coordinator of livestock breeding research, the sheep production specialist, the animal geneticist, the statistician, the records officer, and their staffs.

Diagramatically the scheme looks as follows (ETH - Ethiopian):

<table>
<thead>
<tr>
<th>FEMALE</th>
<th>MALE</th>
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<tbody>
<tr>
<td><strong>1st Phase</strong></td>
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<tr>
<td>(1) Local ETH x Local ETH SELECTION $\rightarrow$ selected (local) ETH</td>
<td></td>
</tr>
<tr>
<td>(2) Local ETH x LARGE ETH CROSSING &amp; SELECTION $\rightarrow$ new improved ETH</td>
<td></td>
</tr>
<tr>
<td>(3a) Local ETH x EXOTIC breeds CROSSING $\rightarrow$ crosses for slaughter</td>
<td></td>
</tr>
</tbody>
</table>
2nd Phase

(3b) selected (local ETH) \( \rightarrow \) EXOTIC breeds

(3c) new improved ETH \( \rightarrow \) CROSSING

3rd Phase

(4) crosses

(from 3b/c) \( \times \) EXOTIC breeds* \( \rightarrow \) CROSSING

x same cross INTER-SE

\( \rightarrow \) 3-way crosses for slaughter

(5) crosses

(from 3b/c) \( \times \) same cross SELECTION \( \rightarrow \) new breeds (part exotic)

*NOTE: Exotic breeds of ram should be tested in "batches" of 4 to 6 breeds at a time, discarding, at fairly frequent intervals (after 2 lamb crops) the least successful half (2 or 3 of the breeds) and introducing new breeds to be compared with the more successful breeds which are retained. This procedure is continued until a sufficient number of appropriate breeds have been tested or no further worthwhile improvement obtained.

Ram-breed testing A possible scheme for testing the exotic ram breeds can be depicted diagramatically as shown below. With, for example, four breeds tested at a time, the worst two are discarded after a two-year test on the basis of the growth of their crossbred progeny and are replaced by two new breeds which are tested against the better two of the original four.

Lamb growth rate between weaning (at 4 months) and 8 or 12 months old is preferred for the first screening test as reflecting more that breed's own contribution to growth than weaning weight, which is much influenced by maternal performance. For example (breeds of ram are given letters):

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<tr>
<th>Test of growth of cross</th>
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<tr>
<td>A ( \rightarrow ) discard</td>
<td>C ( \rightarrow ) ( \rightarrow )</td>
<td>C ( \rightarrow )</td>
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<td>B ( \rightarrow ) discard</td>
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ETC.
The "successful" breed crosses continue for as long as they compete successfully against newcomers. Such crosses are also tested for their maternal performance (as crossbred mothers) on the weight of lambs weaned. However, a cross which, on growth, fails to succeed at the next round has this test of maternal performance foreshortened and only the crosses which continue to succeed against newcomers have a more prolonged test of maternal performance (e.g. the crosses from ram breed "C" in the above diagram).

The purpose of this scheme is to proceed with a testing programme as quickly as possible and to prevent the build-up of numbers of unwanted breeds and crosses (hence the need to assess performance from the records as the trials proceed).

Cautionary note A ceiling must be set on the ultimate size of any breed or cross proposed for use as breeding ewes because if they are potentially too large for the nutritional level which can be made available they will suffer and reproduce badly.

Common management principle Whatever management system is adopted at any one station, the sheep of the various groups being compared MUST be treated alike (given equality of opportunity), lamb over the same period of time and run together (except for purpose of mating). Any sub-division of the flock for purposes of grazing or other considerations should be done by taking some sheep from each breed or cross being compared.

Coordinated breed comparisons It may be necessary to test certain breeds or crosses at more than one station or in more than one physical environment and management system to see whether the relative ranking differs with the treatment. At the same time several stations can be used to test a large number of breeds over a shorter period of time than any single station alone.

The scheme, as for cattle, involves an "overlap" between stations, but since sheep are less capital intensive than cattle the greater advantages of as much overlap as possible should be more readily achieved. However, the breeding problems are also seen, in the first instance, in
relation to the four "environments" for sheep outlined earlier (highland extensive and intensive, lowland extensive and intensive) accordingly a minimum scheme for testing (without including one single "universal" breed for all conditions) would be for three stations and six breeds as follows:

<table>
<thead>
<tr>
<th>Station</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
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<td></td>
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<td>B</td>
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<tr>
<td>H</td>
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</tbody>
</table>

which

This scheme would test specific breeds at specific stations and give an overall indication of the importance of interactions, would not obviate the need to try any breeds finally chosen (it is assumed there will be several) from being tested in more than one environment. The best in each environment should at the very least be tested in alternative conditions.

Implementation Implementation of an enlarged sheep breeding development programme is urgent. But any scheme at any one station, and overall, must be tailored to the facilities than can be made available.

A detailed plan of operation must be worked out for each station so as to optimize the statistical efficiency of the trials in terms of the number of groups, the numbers per group, the degree of overlap required, etc. To begin with, some of the facts needed to optimize efficiency will not be known, such as the amount of variation within breed groups (although early analysis of detailed records at Debre Berhan and CADU, and data collected during weighing surveys in different regions of Ethiopia, will help). Additional facts obtained during the trials will be used to improve statistical efficiency.

The foregoing is a framework to meet the objectives set forth. It is not the only possible framework. It does not obviate the need for further discussion of details and a detailed plan of operation. It should, however, remove the temptation for further procrastination on the principles or for delaying action.
Appendix 4 deals with programmes for specific stations.

Recording keeping and utilization

Collecting  The importance has been stressed elsewhere of having a clear-cut plan of operation for every trial and development scheme based on a design which is statistically sound. This is essential if the intentions of the work are to be fulfilled.

The execution of the trials requires keeping accurate records of the prescribed observations. The Records Officer and his staff, proposed as part of the livestock team of a strengthened Institute of Agricultural Research, can be expected to provide advice on recording systems and undertake the collection and checking of records that have been taken in the field and cooperate in the process of data analysis. Occasionally the records section will be able to assist in taking records on stations. For the most part, however, recording will be the responsibility of staff at the locations of the trials.

It is emphasized that such work is skilled and responsible and at least the senior person of any such group should have an adequate educational level and vocational training to understand and carry out what is expected. In many cases graduates of the Agricultural Institutes would be the most appropriate and the money should be made available to employ this calibre of staff.

Utilizing  The greatest single deficiency of past work on livestock has been inadequate utilization, or absence of any utilization, of data collected in the course of trials.

Many of the programmes outlined in this report require, for their execution and progress, the simultaneous collection and utilization of data. Decisions, for example in a selection programme have to be made prior to every mating.

Correct interpretation of the results requires good experimental design and sound statistical analysis. The methods of statistical analysis in livestock experimentation are specialized and sophisticated and go far beyond the calculation of averages, ranges and standard deviations. Accordingly the right type of statistician is required, and of a high calibre at that.

To facilitate the rapid utilization of records in the right way urgent consideration should be given to mechanization of the system by the use of (IBM-type) punched cards and the appropriate equipment. Computer use seems appropriate to the most efficient development of a livestock improvement policy. This does not necessarily require more than arrangements for time on an appropriate machine for which suitable statistical programmes are already written. Some programming specific to the data collected is always required and staff will need to be trained for this purpose.
(Members of the Recording and Statistical Sections proposed for the IAR). Bit computer programming of complex statistical procedures (from scratch) for machines not used for such purposes at present is not practical or justifiable in terms of the persons and skills required, or the costs and the time it takes.

As stated in the introduction, proper design of trials, record keeping, adequate, rapid analysis of the observations and correct interpretation are essential to the success of any livestock improvement scheme. This applies equally to the components of improvement: breeding, nutrition, management and health.

Information exchange

Consideration should be given to producing, once a year, a report summarizing all activities with livestock trials in Ethiopia and including, from Government Departments and specialized agencies as well as from the teaching, research and development institutions, summaries of surveys, development proposals and other aspects of forward planning in the livestock sector. Foreknowledge of such proposals would assist in making research relevant to developments needs.

In summaries of work in progress, the following information is the minimum that needs to be given: type(s) of animal, numbers, treatments, and methods, objectives and summary of results.

The report should be distributed approximately two months prior to at least one annual meeting of the National Livestock Research Committee, so as to provide a background for its discussions.
V. RECOMMENDATIONS FOR INDIVIDUAL INSTITUTIONS

What follows is essentially a summary of the involvement in the foregoing schemes by each of the physically separated Institutions considered, and a cross-reference to the specific items, in terms of investigation and development, where they are mentioned in the report. The opportunity has, however, been taken to supplement this section with a number of items in respect of which there was no earlier opportunity to make suggestions. With minor exceptions, no cross-reference is made to the general sections and recommendations which apply to all Institutions and form part of the general framework and recommendations.

Institute of Agricultural Research

This is seen as having a central role in the development of livestock production work in Ethiopia by coordinating an investigational framework for the development. This would be achieved through a team of specialists to promote the work and supervise its execution, by participating in some of the relevant investigations and undertaking others within its own facilities and by taking a leading part in the collection, utilization and interpretation of data collected.

Specific proposals for investigational work include:

1. Participation in coordinated comparisons of cattle breeds and crosses (p. 35)

2. Cross-breeding work with sheep with particular reference to nutritional and pasture management studies (p. 55)

The first of these, with the scheme discussed in some detail with Institute staff, visualizes herds of approximately 120 breeding cows, a total (including 'followers') of approximately 250 cattle, at each of the three stations, Holetta, Melka Werer and Adame Tulu, and that number plus an additional 150 breeding cows at Bako. These last 150 are not primarily for investigational purposes at the station itself but for the provision of Boran x Friesian cross heifers to each of the stations, in the interests of coordinated comparisons. These numbers represent a relatively modest increase for Holetta and an approximate doubling at Melka Werer and Adame Tulu. In terms of actual breeding cows the increase is much greater but some of the stock currently carried (much of it at Melka Werer) has no particular actual or foreseeable function (e.g. surplus males) in terms of the investigations proposed and should not add to the management problems in the future. Cattle work at Bako is in its infancy and the numbers proposed are well within its expected capacity.

Sheep work is proposed in terms of a modest start and the development of a crossbred flock of 200 breeding females, which would provide a sufficient number for a reasonable amount of sub-division, in the interests of pasture management and nutritional studies superimposed on some breed comparisons. Integrated work and a joint approach would provide essential information on the relative performance of the different classes of sheep (big and small) given very different treatments. No recommendation is made as to the location of this particular flock.

The possible involvement of the IAR in sheep development in the Jijiga region is mentioned on page 49.
Animal Production Division of the Ministry of Agriculture

This Division clearly plays a central part in the formulation of a policy for livestock production development. In the context of this report, the Division can do much to foster the spirit of cooperation required among the various organizations, for which the Minister of Agriculture has an overall responsibility, and to facilitate the coordination of activities.

The Division is, however, directly involved in development and investigation work with cattle at Adame Tulu and sheep at Debre Berhan and newly developing stations.

Specific recommendations are made in respect of the sheep work (p. 45) and a change in direction of the current programme. The Boran breeding work at Adame Tulu is referred to specifically only in the review of past work (p. 12). The major need for this station, and the future of this work, is the effective utilization of the records kept and a more efficient use of these records to promote the current breeding work, i.e. as an aid in selection, not merely in retrospect. Logically this involves the production of data on punched cards and their utilization by computer.

This is not a need peculiar to the Animal Production Division but applies elsewhere. The Division should, as a matter of urgency, imitate the provision of computer facilities or of time on computers.

Chimalo Agricultural Development Unit (CADU)

This project, though concerned with the problems and agricultural development of a geographically restricted area, is providing information of concern to wider Ethiopian needs. An expansion of work of this wider relevance should be encouraged particularly since the unit possesses both facilities and specialist staff to carry out investigations. Coordinated work with other organizations should be the means of achieving this aim. Specific involvements are referred to in respect of cattle (p. 36) and sheep (p. 54).

The livestock sector within the Unit should be strengthened in relation to the total investment for the general reasons given in this report.

Since the reports of Swedish consultants advising the livestock sector of the project were not available, the arguments in favour of specific aspects including choice of breeds and design of trials are not known. However, it appears that the statistical planning and design of the cattle breeding work could be greatly improved and future sheep work, where it intends to compare breeds and crosses, should ensure that the animals are representative of their breeds and crosses.

In the wider national interest the sheep work in particular should be increased in numbers and scope. The specific recommendations (p. 54) deal only with the current involvement with sheep, which has only just started, and not with the expansion that is desirable within the wider framework outlined in this report.
Haile Selassie I University, College of Agriculture

Involvement of the Animal Science Department of the College is suggested in respect of coordinated comparisons of cattle breeds and crosses (p. 36).

This could be readily achieved by the introduction of additional crosses or breeds into the present dairy herd. This would make the results from the College herd more readily comparable with results from elsewhere and would provide much more information of the relevance of the herd management system at the College for a wider set of circumstances. This should be done even at the cost of some reduction in the high average yield of this herd because of the probable introduction of some types inferior in milk yield to the present Holstein-Friesian herd.

A comment on beef work proposed by the College appears on p. 21.

The possible involvement of the College in sheep development in the Jijiga region is mentioned on p. 49.

Ambo and Jimma Agricultural Institutes

A properly designed breed comparison, or comparison of crosses, within the relatively small cattle herds at these institutions would provide useful information within the framework of the coordinated comparisons (p. 35) and would, in the opinion of the consultant, provide a positive aid and stimulus to demonstration and teaching and to the development of the critical faculties of students.

Dairy Development Agency

Two schemes are recommended for implementation by the Agency (p. 38 and p. 42). These are of relevance to the breeding problems in the development of the Addis Ababa dairy development project but as importantly would provide information necessary for the extension of such development to other areas of Ethiopia.

In general, the Agency is the organization most appropriate for collecting the information needed for its own future effectiveness, as in many other countries with equivalent organisations. Assistance from the livestock team proposed for the IAR, and from the statistical and recording sections in particular, is visualized in the utilization of the records obtained.

Livestock and Meat Board

The Board is involved in development proposals for sheep production in the Jijiga region. It therefore appears to be the agency most closely concerned with ensuring that the sheep marketed from this region are of the type required, particularly for export. The Board should ensure therefore that the proposals on p. 49 for improvement of the local sheep are executed and developed.

In principle, the approach suggested is applicable with modifications to any other region where similar developments are contemplated.
Avraah Valley Authority

Comparisons of breeds and crosses of cattle (p. 20, p. 21) and of sheep (p. 56) are considered appropriate to the Authority even at this stage of its project in order to provide a basis for decision in the future as to the most appropriate genetic types to utilize the pastures in this highly intensive production system.

Within the framework of the coordinated trials, the information obtained would have applicability to intensive rearing situations elsewhere in Ethiopia and would ensure that particular breeds or crosses are assessed under both intensive and extensive conditions since it is important to know whether they rank differently, or the same, in their merit.

Assistance from the IAR might be sought with weighing or recording of animals. Proximity to Melka Werer makes this a feasibility.

Beef from Molasses project

Proposals are made (p. 20) for the inclusion of comparisons of breeds and crosses into the preliminary feeding trials and developmental phases in order to provide information on the relative efficiency of different breeds and crosses for this system.

Commercial herds

Within the framework of coordinated trials selected individual farms can provide useful information (as shown in the Spåth report) on the performance of different breeds and crosses particularly if encouragement can be given to include breed comparisons or exploit those already present. Assistance from the IAR would be expected.

Other development units

Although only CADU was visited, the principle of coordinated trials should be incorporated in the livestock programme of other units (e.g. HADDU).
Appendix 1

COORDINATED COMPARISONS OF CATTLE BREEDS AND CROSSES

The comparisons are to be made primarily in respect of growth rate, final size and milk production and secondarily in respect of 'total dairy merit' and acceptability for draught purposes. 'Total dairy merit' includes milk yield, reproductive efficiency, viability and disease resistance. It is not thought less important than single lactation milk yields, but takes longer to investigate. The trial has two breeding phases.

The questions to be asked in the first phase are, primarily:

- are there differences in merit among exotic breeds of sire?
- are there differences in merit among Zebu breeds of dam?
- are there differences among stations?

secondarily (and incompletely):

- do breeds rank differently in their merit at different stations?

thirdly (and only as a 'hint' from the first breeding phase):

- do specific breed combinations have particular merit?

The second breeding phase will answer the primary question: What are the relative merits of $F_1$, $F_2$ and $3/4$-bred animals? Since this will depend on the levels of hybrid vigour manifested by each cross it will contribute to an understanding of whether specific breed combinations should be further investigated.

The second phase will reinforce the information on all the main questions for which answers were obtained in phase 1.

Breeds - Exotic: Friesian, Jersey, Simmental, Ayrshire;
Zebu: Boran, Horro, Barka, Arussi, and possibly Pogera, as the named types in current use.

The choice of the Friesian as the main crossing breed in the dairy development project is justified (in the first instance) by the evidence of its combined milk and meat production elsewhere. Other breeds may, however, have special merits as crossing sires:

Jersey - Since a small breed (or cross) is at an advantage relative to a large breed when nutrition is limiting. Jerseys may also have special advantages for hotter regions, and the yellow pigmentation of their milk may have a special consumer acceptability.

Simmental - It is alleged to be superior to Friesian for the production of draught animals (as the 'male' by-product) and is likely to be superior in growth and possibly carcass attributes.
Ayshire — May compete favourably in 'total dairy merit' including resistance to udder troubles.

The case for using different Zebu breeds as dams of crossbreds is more open to question since less is known of their relative performance as purebreds than in the case of the exotics. The Boran is larger and likely to grow faster than all the others. In terms of milk yield alone it might be acceptable on statistical grounds to ignore any small differences among Zebus as mothers of crossbreds used for milk production, Differences in 'dairy temperament' reflected in willingness to let down milk, however, may become apparent and require consideration.

The experimental design should attempt to establish as statistically significant only average differences in excess of 200 litres per lactation.

Stations — Institute of Agricultural Research: Holetta
Bako
Melka Werer
Adame Tulu

Chilalo Agricultural Development Unit
HSTU College of Agriculture
Others as soon as may be arranged

Design — The Boran x Friesian cross should be used as the baseline against which other crosses are compared (since it will be the most widely available of the crosses supplied by the DDA).

A second cross should be in common to at least any two stations in order to estimate, although incompletely, breed x station interactions. Schematically 4 breeds (A, B, C, D) might be distributed among 3 stations (1, 2, 3) as follows to meet the minimum requirements:

```
1   2   3
A   A   A
B   B   C
C   D   D
```

In practice the situation is more complicated because of the use of several Zebu breeds as dams, although not in all combinations, and the need for more stations.

The exact number of animals per sub-class will have to be considered in the light of the final design but is unlikely to be much less than 15 contemporaries. Sub-division in later generations will require larger numbers at the start.

1st Phase: The comparison of first crosses \( (F_1) \) of different breed compositions.

2nd Phase: The continuing comparison of \( F_2 \) crosses simultaneously with the contemporary comparison of \( F_2 \) (i.e. \( F_1 \times F_1 \)) and \( 3/4 \) bred (i.e. \( F_1 \times \text{exotic} \)).
For the Institute of Agricultural Research there would be a PRELIMINARY PHASE of comparing pure Zebu breeds, with at least two types at each of any two stations, whilst the \( F_1 \) crosses are being produced.

For any one Zebu and exotic breed the schematic representation is as follows:

<table>
<thead>
<tr>
<th>Preliminary Phase</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{Zebu mated to} )</td>
<td>( \text{Exotic} \rightarrow F_1 )</td>
<td>( F_1 \rightarrow F_2 )</td>
</tr>
<tr>
<td>( \text{Zebu} \rightarrow \text{Zebu} )</td>
<td>( \text{Exotic} \rightarrow \frac{3}{4} )</td>
<td>( \text{Exotic}</td>
</tr>
</tbody>
</table><p>ightarrow F_1 ) |</p>

The \( F_1 \) : Zebu comparison in Phase 1 in the scheme above is incidental to the further production of \( F_2 \) crosses for use in Phase 2. In situations such as that of CADU, where continuous commercial production of \( F_2 \) animals is contemplated, the availability of \( F_1 \) would be provided for without the need to use 'experimental space' to include the Zebu in Phase 1, although this is essentially what has happened at CADU until now - but also, of course, it provides additional, though less essential, information.

Statistical Considerations - These impinge on the design and affect the ultimate analysis. They are concerned with more than total numbers. The importance of full consultation with competent statisticians familiar with non-orthogonal designs is stressed.

Duration - With the simplifying assumptions of a first calf crop at 3 years old followed by three lactations at annual intervals, the total duration would be 11 years, starting with the first calving of pure Zebu cows to produce \( F_1 \) calves and ending with the third lactation of the last of the animals born in phase 2.

General Rules - Whatever system of management is considered appropriate to each station must be applied to all classes of stock.

No animals or their records must be excluded (for example on account of short lactations, poor growth, etc.).

Many exotic bulls of each breed must be used and they should be distributed among all the stations. Frozen semen and artificial insemination will be required to operate the scheme.

Measures to ensure heat detection will need to be taken to avoid unnecessarily low conception rates.

The Zebu cows of any one type at different stations should, if possible, come from a common pool.

The Boran x Friesian crosses kept at each station as a test stock should be genetically equivalent to each other, preferably from the same pool.
Appendix 2

TESTING THE RELATIVE MERIT OF VARIOUS GRADES OF ZEBU x FRIESIAN CROSSES WITH A VIEW TO DETERMINING THE MOST SUITABLE BREEDING POLICY FOR THE ETHIOPIAN DAIRY INDUSTRY

Background - The dairy development project for the Addis Ababa region envisages the widespread use of F₁ (Boran x Friesian) heifers. Milk-yield improvement schemes in less developed areas of Ethiopia are likely to rely even more heavily on the use of cows with 50 percent (or with 25 percent) exotic blood. There is a widespread belief and some supporting evidence that 50 percent exotic blood may be the optimum proportion in the foreseeable future, given the levels of management, nutrition and disease control which it is realistic to expect. There is, moreover, some evidence (e.g. Katpatal, 1971; Mason, 1965; Rendel, 1968; Wijeratne, 1970) and inference from unpublished observations, suggesting that the level of performance of first cross (F₁) cows is markedly above the half-way level between the two parent breeds, under conditions such as those prevailing in Ethiopia (that is to say, hybrid vigour is shown, or is thought, to be important).

If hybrid vigour is NOT important (and in respect of milk yield alone that is evidence from Europe) the simplest way of maintaining 50 percent exotic blood in the population is to mate F₁ cows to F₁ bulls to produce F₂ females. The F₂ generation might look a little more variable than the F₁, but in terms of its milk production and other performance traits the very small theoretical increase in variability is likely to be negligible or undetectable in practice. Average performance should remain unchanged.

F₂ cows could continue to be mated to F₁ or F₂ bulls, or a selection programme could be applied and the new 'intermediate' type fixed. Further 'grading-up' to increase the proportion of exotic (e.g. Friesian) blood could be done at any time this was thought desirable.

If, however, hybrid vigour is an important component of F₁ performance, F₂ performance will, on average, be worse than F₁ performance to the extent of half the hybrid vigour: (that is ½ the yield by which the F₁ exceeds the average of the yields of the two parent breeds). Thus, although the F₂ performance is still expected to be better than the hypothetical 'half-way' between the parent breeds it may be worse, to a lesser or greater extent, than the F₁. Under these circumstances, however, further 'grading-up' with exotic blood will not give further proportionate improvements in production. There are a number of published reports which show that ¾-bred animals gave little or no more milk than the F₁.

It should be remembered that milk yield is only one aspect of the total dairy merit of a cow. Ability to grow to the required size for mating at the youngest possible age, regularity of breeding and fertility, freedom from udder and foot troubles, from disease in general, and so on, contribute markedly to life-time milk production and profitability. Heterosis (hybrid vigour) in respect of any of these traits would contribute to the advantage of crosses compared with purebreds. The report by Dr. H. R. Späth - September 1971 - based on a study of production characteristics of exotic and first-cross dairy cattle in commercially run dairy farms, mostly in the Addis Ababa region, shows that the generation interval was shorter by 23 days in the exotic x Zebu cows than in the pure exotic on the only two farms in this survey where both types were in fact kept together and separately recorded - both farms enjoy a high standard of management.
Some facts will therefore need to be gathered before the most appropriate breeding policy can be recommended. The options are to organize a systematic crossbreeding programme, to form a new breed, or to grade-up towards the exotic breed (\(\frac{5}{4}, \frac{3}{4}, \frac{7}{8}, \frac{15}{16}\) etc.). The relative ease of arranging the latter should not detract from the probability that it may be undesirable. The options must be kept open. It would be poor service to Ethiopian farmers to commit them to one breeding system only, so that later it may be hard to get another scheme adopted. At the very least, the idea that 'crossbred animals may turn out to be the most profitable, even if not always the highest yielding' should be part of the educational and extension programme.

Comparisons needed — A contemporary comparison is required under commercial dairying conditions in the Addis Ababa region of \(\frac{1}{4}\)-bred, \(F_1\), \(F_2\) (i.e. \(F_1 \times F_1\)) and \(\frac{3}{4}\)-bred cows. Subject to further calculations, as Ethiopian figures begin to accrue on variation in yield under commercial conditions, it is probable that records from 100 lactating animals per group should make it possible to confirm an average difference of 200 litres in milk production as statistically significant provided animals are distributed among farms in an efficient manner (in the statistical sense).

Procedure — A 'contemporary comparison' means having animals of the different types and of approximately the same age, milking in the same herd at the same time. This implies a minimum of two such animals (e.g. a \(\frac{3}{4}\)-bred and an \(F_1\)) in any one herd, but preferably one or more of each of the four types (this would increase statistical efficiency greatly).

The most practical procedure would be for DDA, through the breeding ranches for \(F_1\) heifers, to provide \(F_1\) heifers already in calf with the appropriate type. Thus \(F_1\) (Boran mother \(\times\) Friesian father) heifers would be mated:

(a) to Friesian bulls to produce \(\frac{3}{4}\) Friesian calves;
(b) to \(F_1\) bulls to produce \(F_2\) calves;
(c) to Boran bulls to produce \(\frac{1}{4}\) Friesian calves;

(alternatively \(F_1\) bulls could be mated to Boran cows to produce the \(\frac{1}{4}\) Friesian animal — this procedure is considered the more practical by DDA officials, because the \(\frac{1}{4}\)-breds would be born on the breeding ranches instead of on the dairy farms, although it puts greater pressure on the resources of the breeding ranches).

At the same time:

(d) Boran cows mated to Friesian bulls would continue to produce contemporary \(F_1\) calves.

Since herd size, on most of the farms within the DDA orbit of influence, will be fairly small it would be difficult to ensure a sufficient number of contemporary heifer lactations representative of the four types (or even of two types) in each herd. It is proposed therefore that the appropriate female calves be purchased by DDA from the farmer, reared by DDA (or on the private breeding ranches) up to breeding age and then sold to farmers in the appropriate combinations. The \(\frac{74}{14}\) Friesian \(\frac{3}{4}\) Boran) heifers may need to be sold at a slightly lower price than \(F_1\), \(F_2\) and \(\frac{3}{4}\)-bred because not only will their Zebu status be more obvious, but yield expectations are slightly lower.
Note pertaining to the $\frac{1}{4}$-bred — There is an expectation that the average yield of $\frac{1}{4}$ Friesian $\frac{3}{4}$ Zebu cows will be substantially above the average level of Zebu cows. DDA officials believe that, within their present scheme for the Addis Ababa region, such cows would not provide a sufficient incentive for improving dairy management in this developing industry. This might well be true, but DDA also have a national responsibility. Future improvements in milk production, particularly in rural areas where management levels are more primitive, may well depend on providing such cows. (They can be cheaply and easily produced by supplying $F_1$ bulls to be mated to local Zebu cattle.) DDA should therefore provide the information on the yield of such cows relative to that of higher grades even though further work may be needed to translate these results for application to more primitive conditions.

Complications — Under the scheme outlined above, $\frac{1}{4}$-bred, $F_2$ and $\frac{3}{4}$-bred animals would be born on commercial dairy farms and reared there, artificially, until weaning (thereafter on the breeding ranches). $F_1$ heifers, on the other hand, would be born and reared by single-suckling of their Boran mothers at the breeding ranches. This would invalidate any direct comparison between the $F_1$ group and other groups in terms of early growth rate, calf mortality, etc. It is assumed, however, that it would not invalidate comparisons in respect of first and later lactation milk yields, since the carry-over effects attributable to the first 6-8 months of life are likely to be small at 3-4 years of age. However, a nagging doubt would remain and an attempt should be made to find out whether $F_1$ calves could also be produced on the same farms where the other types will be born, so that rearing, by whatever method, is in common.

Bulls used for breeding — $F_1$, and $\frac{3}{4}$-bred calves will be produced, in the main, by use of pure Friesian bulls on Zebu or $F_1$ cows. For this purpose semen should be used from the young bulls taking part in the proposed progeny-testing scheme outlined in Appendix 3. The female progeny would then be part of that progeny test. The $F_2$ and the $\frac{1}{4}$-bred generations will be produced by the use of $F_1$ bulls or, in the case of the latter, by the alternative of Boran bulls. In either case an adequate number of bulls ($6-10$) must be used to be representative of their type.

Records to be kept —

| Identity number of animal | Type of animal ($F_1$ etc.) |
| Identity number of sire | Breed of sire |
| Identity number of dam | Breed of dam; age or parity of dam |
| Birth date of animal | |
| Sex of animal | |
| Where born (name of farm or breeding ranch) | |
| Method of rearing | |
| Diseases (if any, with dates) | |
| Date and cause of death (if applicable) | |
| Date of transfer to breeding ranch (if born on commercial farm) | |
| Name of breeding ranch | |
| Body weight at 1 year old | |
| Body weight at 2 years old | |
| Body weight at time of sale to dairy farm | |
| Dates of service (at breeding ranch) | |
| Date of calving (at farm) | Name of farm |
| 1st lactation milk yield (1 day's production each month) with dates | |
| Service dates (at farm) | AI or natural |
Date dried-off
(Next) calving date
Disease record (with dates) (incl. udder troubles)
Death or disposal date (say which, if applicable) and cause

REPEAT FOR A 2ND LACTATION IF POSSIBLE.
Appendix 3

TESTING THE SUITABILITY AND MERIT OF FRIESIAN BULLS FOR ETHIOPIAN CONDITIONS

In connection with the DDA project it is proposed to use Friesian bulls in the Addis Ababa region, but also elsewhere in Ethiopia:

1. On the existing or anticipated 'pure' or 'grade' Friesian population.

2. On local breeds and on crosses for 'grading-up' to Friesian (3/4, 7/8, 15/16, etc.).

3. For the production, possibly on a large scale and for many years, of first cross (F₁) heifers (Zebu x Friesian) for use as the main milk producing animal on many farms where this proportion of Friesian blood may turn out to be the most profitable.

To provide information on what bulls it would be best to use and what breeding policy to adopt for the future - at least that part of it which involves the use of pure-bred exotic bulls - it is necessary to find out whether bulls ranked according to merit on the basis of progeny testing in their country of origin (e.g. in Europe or U.S.A. or Israel) will:

(a) have the same (or similar) ranking when used in Ethiopia;
(b) show no appreciable difference;
(c) rank quite differently.

(b) and (c) are sufficiently strong possibilities to require a test, as proposed, because: (i) Ethiopian conditions of dairying represent a different environment (including management, nutrition, disease exposure, etc.) from the European conditions (under which the bulls are assessed). The possibility of significant genotype x environment interactions cannot be ruled out. (ii) There is some evidence that hybrid vigour may be an important component of the performance level of crossbred (but especially first-cross, i.e. F₁) cows. (Friesian bulls - as all other breeds - are normally progeny tested on pure-bred progeny which may not reflect their merit as fathers of crossbred progeny if hybrid vigour is very marked).

If the answer, following the proposed trial, is (a) (same ranking) future importations of bulls or bull semen can usefully take into account the progeny test information supplied for 'proven' bulls if these are desired (although the extra cost of 'proven' bull semen may not be warranted by the expected returns).

If the answer, following the proposed trial, is (b), it would indicate either that the variation among the bulls tested is unimportant under Ethiopian conditions (unlike, for example, the average difference between Friesian and Zebu milk production) and that paying extra for relatively small differences in progeny-test ranking would be a waste of money, or that the situation under (c) is beginning to operate.

If the answer, following the proposed trial, is (c), assessment of actual results obtained would indicate whether (i) (European) progeny-test information
should be ignored and the expected average performance of all the bulls combined is probably more important than the relatively minor variations among them or (ii) a special testing scheme for Ethiopian conditions (i.e. including the production of crossbred cows) should be considered. It should not be assumed, however, that even if the answer of the trial is of type (c), that either the size of the Ethiopian specialized dairy population, or the costs of testing, would make an Ethiopian testing programme desirable. This would need to be separately worked out.

A scheme for the trial — Twenty young Friesian bulls under test in their country of origin should be tested simultaneously in Ethiopia (by use of frozen semen) most particularly as fathers of F₁ progeny, but also, if possible, with progeny resulting from matings to pure or high-grade Friesian cows in Ethiopia.

The method used would be that of contemporary comparison whereby at least one offspring from each of two bulls are compared (on the basis of their milk yield) in any one herd over the same period of time. The offspring of more than two bulls and more than one offspring per bull in each herd would be preferable. However, the test is intended to be made under practical dairying conditions and is intended to be spread over many herds. Between 20 and 40 first lactations are likely to be required per bull, i.e. a total of 400-800 heifers. This, in turn, will require the birth of a minimum of three times that number of calves (on average only \( \frac{1}{3} \) the calves born will be females and some allowance must be made for losses) and in all probability 2-3 inseminations per conception. This suggests a requirement of between 2,500 and 8,000 doses of semen. Only a small loss of calves between birth and completion of a first lactation is assumed because most of the inseminations and calf rearing will be made on farms and breeding ranches under direct DDA control, or DDA supervision, and because it is assumed that all cows in the scheme will be milk recorded at least once a month.

The aim should be to complete the necessary inseminations over a 3-year period; the trial should then have provided complete information on 1st lactations after 7 years, though preliminary information will accrue from year 4 after the start. Follow-up information would be obtained from second and later lactations, but this is not a pre-requisite of the scheme.

It is proposed that semen from 6-8 young bulls at a time should be used on the breeding ranches operated by or on behalf of the DDA for the production of F₁ heifers (out of Boran cows). The current DDA plan is to sell in-calf F₁ heifers to dairy farmers in the scheme. The progeny-test trial requires that such heifers be placed out at least in pairs (with one offspring from each of two bulls) as described earlier, with a larger number desirable.

The main emphasis of the trial should be the production of records from F₁ heifers; there should be at least 20 of these per bull; if the scheme is extended to include a test of pure-bred progeny bred, most likely, on larger commercial dairy farms, a greater number of inseminations must be made per required heifer lactation, since there will be less control over the number of female calves which will be retained by the farmers, or which will eventually produce a lactation alongside a contemporary offspring of another bull.

It is proposed that the scheme should be operated in collaboration with the English Milk Marketing Board because:
(a) They operate a progeny-testing scheme which lends itself to the proposed comparison.

(b) Senior staff of the Board, as individuals, have expressed an interest in the questions to be answered and can therefore be expected:

(i) to undertake the necessary statistical calculations (which are complicated and require computer facilities) and

(ii) /press for the provision of the semen on favourable terms.

(c) The semen provided would be from bulls of highly acceptable merit under British conditions.

N.B. The young bulls (from which semen would be supplied for the test in Ethiopia at the same time as these same bulls are used in England) are themselves the sons of selected proven bulls and the best available cows. Their average genetic merit is likely to be at or a little above the average genetic merit of the selected proven bulls still in use. Young, as yet untested, bulls are, however, required for the scheme outlined since they are expected to produce (at least under British conditions) a wider range of variation in yield than a restricted range of 'proven' old bulls. It should be added that even the daughters of the bulls which are below the average of their group are likely to yield a highly acceptable amount of milk and probably little less than those of the above-average half.

NOTE (1) Coordinated trials involving comparisons of various breeds and crosses

These are proposed elsewhere in this report and call for a 'tester' stock of 15 Boran x Friesians (F.) heifers to be distributed to each centre involved in breed or crossbred comparisons for investigational purposes. These are likely to take place at four to eight such centres (including the stations of the IAR). These crossbreds, even if produced outside the orbit of the DDA scheme, should be produced using the semen from the young bulls described above. By ensuring that each of the centres in the coordinated trials receives offspring from about five bulls each (three progeny per bull) the centres can usefully contribute to the progeny-test information.

NOTE (2) Details of the precise plan of operation of the above scheme, including the number of lactation records required, the manner of distributing heifers among farms (whether in pairs or larger numbers at a time), the form of record required, etc., would need to be settled bilaterally between the DDA and the cooperating semen-supplying agency (e.g. the English Milk Marketing Board). The consultant making these proposals is willing to be involved as a 'go-between' on technical matters.
SHEEP IMPROVEMENT PROGRAMMES FOR SPECIFIC STATIONS

(These should be read in conjunction with the framework of the scheme on pages 24-28)

(a) Debre Berfaan Sheep Station

This highland station is administered by the Animal Production Division of the Ministry of Agriculture. It is seen as having a key role in the development of improved sheep breeding in Ethiopia and in particular for the Gimba–Mehal Meda Highland Sheep Development Scheme. This station is ideally suited to new breed development and breed comparisons within the framework outlined.

Preliminary steps –

(a) sell all Merino and Merino-cross sheep for slaughter;
(b) sell all castrated males as soon as fit for sale without imposing arbitrary weight limits;
(c) sell all females not essential as flock replacements within the prescribed breeding programme.

These steps would clear the way for more relevant work, reduce the overgrazing, and remove the legacy of the unwanted Merinos. The earliest possible sale of surplus stock (male and female) should be routine practice to avoid overgrazing and encourage good management.

Any temporary under-utilization of the land as a result of the sales proposed should be welcomed as giving the land a temporary respite while numbers in the new project build up.

The Corriedale, Romney and Hampshire crosses should be retained only so long as they can demonstrate their superiority over other breed combinations as outlined earlier. As pointed out in Mr. Allathan's report, the design of the breeding trial at Debre Berhan at present makes it difficult to make the required breed comparisons since to do so requires that the groups compared should be contemporary and treated alike (both these aspects are deficient). Summaries by Allathan and for a different year by Ato Hailu Kassa suggest, however, that the performance of the Corriedale is not impressive particularly in first crosses with Ethiopian ewes. Since the Corriedale is itself a Merino derivative it is in any event no longer an obvious choice for Ethiopian conditions. The number of Corriedale matings and the use of their crosses should be reduced to the numbers needed for comparisons of breeds and crosses only.

Romney and Hampshire cross females bred on the station should not again be mated to the three rams of each breed on the station, which are their fathers. There seems no case, anyway, for the production of 3/4 bred Corriedale, Romney and Hampshire sheep at this station. There are better alternatives.

Objectives and intermediate targets –

(a) to produce a larger sheep of traditional type (weighing 40-45 kg);
(b) to produce a ewe which will be a good mother of lambs (to wean single lambs of 25 kg at 120 days);
(c) to produce lambs of adequate live weight (40 kg) for slaughter before 1 year of age.

These targets can be revised to meet future needs and improvements. Even within these targets there may be great differences among breeds and crosses in the ease and efficiency with which they reach the targets and in the potential they offer for further improvements. It is ESSENTIAL, however, that the female sheep kept for breeding should not be so large that they cannot adapt to the Highland conditions.

Breeding groups - Since a number of crossbred females produced by mating local Ethiopian ewes to Corriedale, Hampshire and Romney are already on the station they should be incorporated in the trials but in a manner to make comparisons valid.

The report by Allathan suggests an ultimate carrying capacity for the station of 1,100 breeding ewes following substantial improvements in grazing and the provision of conserved feed. Subject to some early improvements in that direction a starting figure of 800 breeding ewes is assumed.

No selection of the local Ethiopian ewe is being recommended for the present in the absence of the basic information needed.

An immediate start, however, should be made with items (2) and (3) of the framework outlined earlier.

**Development of New Improved Ethiopian breed(s) (approx. 400 ewes)**

- 200 local Ethiopian ewes (from the Debra Berhan region) to be mated to a large Ethiopian breed referred to as the 'Kaffa'.
- 200 local Ethiopian ewes to be mated to a large Ethiopian breed called the 'Horro'.

10 rams are required of each type (20 ewes per ram). Individual pedigree records must be kept for each mating so that the actual sire and dam of every lamb born is known. It is not enough merely to record breed of ram as before. This is a necessary requirement to facilitate selection and minimize in-breeding.

Facilities required are small mating paddocks or pens and additional recording staff of high calibre.

Selection procedure to be followed to optimize progress whilst avoiding in-breeding will depend on the relative variation among the 10 sire progeny groups compared with the variation within groups (selection primarily on post weaning gain).

If variation between the sires used (as judged by their progeny) is small and variation within sire groups (half sibs) large the best procedure might be to pick the one best male lamb judged on his own growth from each of the 10 sire groups. If variation among sire groups is large compared with that among the offspring of any one sire it would be preferable to keep more male lambs (the best) from the best of the sires. It will NEVER be possible to keep male lambs from only one sire without running into immediate and close in-breeding problems.
Mating of the chosen $F_1$ rams should be to the $F_1$ females (among which selection will not be practicable except to discard obviously defective animals). Matings of half-sibs must be avoided. The process is repeated with the $F_2$ generation, etc., until the target is reached with the desired type.

A parallel process would be taking place with Kaffa and Horro rams. It is not known whether Kaffa and the Horro represent genetically different types or whether they are basically the same type in different districts. The two types should be compared in terms of their merits. If one is clearly preferable to the other and there is no particular adaptive reason for maintaining both types, the poorer should be discarded and the better developed on a numerically bigger scale. If there is little to choose between the types the two might be mixed at a later stage but in a controlled manner.

Introduction of additional Kaffa and Horro rams, after the initial 10 of each, may be required to avoid in-breeding or replace rams discarded because of the poor performance of their progeny.

If Kaffa and/or Horro seem likely to be highly acceptable to the conditions of Debre Berhan and the Highland area it serves, and not too big (the larger the sheep the more its nutritional demands), half the $F_1$ or $F_2$ generation of crossbred females could be mated back to the appropriate ram breed to produce $3/4$ bred (Kaffa or Horro) for comparative purposes with the possibility of then 'fixing' the $3/4$ bred type or continuing even with further 'grading-up'.

Crossbreeding studies with exotic breeds of ram

- 50 local Ethiopian ewes x Corriedale rams
- 50 local Ethiopian ewes x Hampshire rams
- 50 local Ethiopian ewes x Romney rams
- 100 local Ethiopian ewes x Dorset Horn rams

The first 3 named breeds are chosen only because they are already available. Three rams of each breed (5 of Dorset Horn) should be used and in the following year the same number of entirely new rams of each of the 4 breeds should be used. The inequality of ewe numbers is suggested only because crossbred females of the first 3 types are already on the station – see below – which will provide a ranking of merit among these three. The Dorset Horn is thus allowed some extra numbers to provide for a more accurate assessment.

As for the selection programme, individual mating records must be kept if subsequent development of a crossbred ewe for use as a mother of lambs for fattening (Phase 2 of framework) is contemplated.

Assessment is on the post weaning growth rate of the crossbred progeny.

When the two poorest-performing of these four ram breeds are discarded the next in line for crossing (to be tested against the two better-performing breeds) should be:

- The White Karaman (Turkey);
- The Wiltshire Horn (a virtually wool-less English mutton breed with high growth rate and mothering qualities in its native environment).
and subsequently other breeds to be determined after further consultation. The consultant disagrees with the Allathan recommendation of the North Country Cheriot as an early or obvious choice in a testing scheme. It carries too much wool (of medium quality) and as a purebred showed relatively poor adaptation in its breeding cycle to the changed day-length pattern of equatorial compared to northern latitudes (Beaty and Williams, 1970) (although in these trials the Border Leicester was the only outright failure). In view of the need not to produce too large a sheep for use as a breeding ewe some 'smaller' ram breeds are included in the choice of breeds which may yet meet the targets with the available feed.

Comparisons of crossbred types of ewe – Since three types are already available they should be tested as follows:

50 (Corriedale x Ethiopian) females
50 (Hampshire x Ethiopian) females
50 (Romney x Ethiopian) females

and when they become available, Dorset Horn x Ethiopian females should be added to the comparison by which time the poorest of the first three tried should be in the process of being eliminated.

Each crossbred type of ewe should be mated to the same ram breed or breeds.

The Hampshire, because it is available, is an obvious choice but new extra rams are needed to avoid in-breeding when mating to the Hampshire x Ethiopian ewes (or a proportion of them).

The Wiltshire, because it promises well and is next in line for introduction.

The Suffolk, because it is a commonly used breed to produce 3-way crosses and has done well in temperate climates and reasonably well even in hot.

It is proposed that two only of these three breeds be chosen initially and that half the crossbred ewes of each type be mated to each of the two ram breeds (there should be at least three rams of each ram breed for this purpose). No individual pedigree need be kept on the ram side (ram breed is enough in this instance unlike in the situations described earlier).

The three-way cross lambs so produced will almost certainly require supplementary feeding after weaning (at 120 days) if they are to reach slaughter weight and conditions quickly and efficiently.

Further Developments

These would proceed within the framework outlined but subject to the detailed design which is a prerequisite and the detailed assessments of progress which are essential. These assessments might profitably include consultation with outside specialists particularly in the earlier phases of development.

If additional land can be made available, or a sub-station, the consultant believes that a parallel trial to that proposed for the Jijiga region should be tried on a relatively small scale using the:

Blackhead Somali ewes mated to (a) Blackhead Somali rams;
(b) Dorset Horn rams.
Approx. 100 ewes with 50 mated to each breed of ram would establish, in the course of a five-year period, whether the pure breed would adapt well to highland conditions and whether the cross (equivalent to the Dorper) is preferable. Since the Somali Blackhead has many alleged virtues, this is a trial which should be attempted in view of its good potentialities for further development if early results are promising.

(b) Jijiga Region

The Livestock and Meat Board (LMB) have a particular interest in sheep development in this region where the predominant sheep is the SOMALI BLACKHEAD. The region and its hinterland is in fact, or potentially, one of the major supply areas of live sheep of a desired type for export to the Arabian peninsula. At present much of this trade is presumed to go via Somalia and remains unrecorded in terms of Ethiopian export statistics. The intention of the LMB is to make the flow through Ethiopian outlets more attractive and developments in that direction are taking place. The political considerations do not however alter the animal requirement which is for a bigger sheep than that marketed at present although not necessarily of a different type. Most of the sheep herding is in the hands of nomads but from reports they appear not inexperienced in the needs of sheep keeping and can be expected to benefit from and accept improved methods and stock.

The LMB should initiate a sheep breeding station for the area with an initial programme of the type outlined below. The technical supervision of such a project requires immediate consideration since there is no existing base for it. It is suggested that the HSTU College of Agriculture of Alemaya be approached with the necessary finance to staff and service the project. The ownership, distribution and returns from the sheep might be separately considered. The members of the Animal Science Department of the College have expressed themselves as most eager to participate in developments of this nature (although this particular one was not discussed at the time of the consultant's visit, the ideas emerged afterwards). The main obstacle to such participation is lack of funds. The sheep project proposed seems to be more easily realizable than the ambitious cattle project proposed by the College for the Dakata Valley although the motivation of the two are basically different (since the latter is intended to serve as a means of ultimately providing money for the College). It should be stressed that the sheep project is not intended as an academic exercise but, superimposed on the general framework, it could provide much of interest to animal science research. An alternative would be to provide the Institute of Agricultural Research (IAR) with the necessary finance for the project.

In the wider interests of the aims of this work the specialists proposed for appointment at the IAR to assist in livestock developments should be involved in any event. This is particularly so since the Jijiga region and this project in particular offer opportunities for the pasture and range management and the nutrition sections of the IAR, in collaboration with the breeding work.

The Somali Blackhead Sheep in the Region - Part of the study by Allathan, already referred to, was concerned with weighing lambs and adult sheep of various ages (as judged by dentition). The results pertain to several hundred sheep and are presented as group averages by flocks and ages. The average weights for groups of
lambs at 2½-3 months of age range from about 10 to nearly 15 kg. Group averages for full-mouthed females range from 27 to 37 kg and for 2-tooth rams or castrate males from 23 to 34 kg (but the male groups are very small including many ones and twos). The individual weights were not available to the consultant, but the inference is drawn from the data on group averages that there must be some sheep, even under the present system of management, which achieve or exceed the desired target of 40 kg liveweight for the export trade. This is relevant to the scheme proposed. The weights recorded by Allathan are similar to those published by Trail and Sacker (1966) for 'East African Blackheaded' ewes at a Ministry of Animal Industry Farm in Uganda, but appear to be lower than the 'Somali' averages quoted by Mason and Maule (1960).

The Proposed Schemes

1. To investigate whether improved nutrition through controlled grazing and/or some supplementary feeding will markedly increase growth rate and ultimate size. The improvements in feeding and management should be restricted to levels which are both realizable and economic in practice.

2. Selection for larger size within the Somali Blackhead breed.

3. Crossbreeding of Somali Blackhead ewes - initially with rams of the Dorper breed.

1. Environmental improvement

If improved management and nutrition at the level suggested produce a marked response in the sheep in respect of growth, ultimate size, and reproductive performance, it must be assumed that this was the main limiting factor for the sheep at present. If so, there would be little to gain and perhaps something to lose by introducing a genetically larger sheep to those areas where no improvements in management or nutrition can be achieved - unless the provision of improved animals (if the 'improvement' can be demonstrated) itself encourages improved husbandry. However, for those parts of the region where rainfall is slightly higher and where settlement might allow for the provision of some conserved fodder, a genetically larger animal, produced by selection or crossbreeding, should still pay dividends provided the 'potential' size of the sheep is not wildly ahead of that achievable by improved management. These considerations have little bearing on the operation of the proposed selection and crossing scheme but they affect the application of the results.

2. Selection

- A flock of 400 Somali Blackhead ewes, preferably young, should be established.

- Twenty young rams (one year old) should be purchased. Only one ram should be obtained per flock, preferably from the larger flocks, and care should be taken to distribute the purchases over a wide area so as to minimize the possibility of buying related rams. Each should be chosen as being the single best (biggest) ram of that age from among his contemporaries in the flock. To obtain the right rams a good incentive price will need to be paid, but since a proportion of the rams will be used for only one year and few for more than two or three, they could be returned to their original owners if desired.
- Pedigrees of individual matings will need to be kept (as explained in the scheme for Debre Berhan).

- Weaning of lambs should be at four months old and lambs should be allowed to suck their mothers in full.

- Weaning weight (birth weight if possible) and weight at three months post-weaning (seven month weight) should be recorded as a means of assessing the merits of the (purchased) sires by the growth rate of their progeny.

- On the basis of this progeny assessment the worst ten of the original 20 rams should be discarded and the best ten retained for a second year of mating. The number of rams used in the second year is again made up to 20 by the purchase of ten new young rams in the manner described above.

- Selection of ram lambs born in the flock is on the basis of their own weight at one year old. This includes an intended component of 'maternal performance' as represented by weaning weight. Analysis of the first 2-3 years of records will show whether selection on post-weaning growth of ram lambs would be more efficient in this improvement scheme.

- Twenty rams (one year old) are chosen, but whether to choose the best ram lamb within each of the 20 sire progeny groups or more than one from the groups with the better averages (discarding choices from the worst groups) depends as explained earlier (in the Section on Debre Berhan) on the relative amount of variation between and within groups. The precise procedure must await the data required.

- Since inbreeding must be avoided it is impossible to concentrate breeding in the flock on only the 'best' one or two rams since this would sacrifice future progress for the possibility of an immediate gain.

- As selection proceeds, the likelihood of being able to introduce outside blood which will compete favourably with that already within the flock becomes less and less. Hence reliance on 'outside blood' to rescue the scheme from ill effects of inbreeding should be only a last resort.

- Female progeny born in the flock are kept for breeding and replace the purchased ewes, to keep the total number of the breeding flock within the prescribed limits (unless these can be expanded to meet developmental needs without detriment to grazing, management and record keeping).

- Some selection on growth rate among female stock will become feasible only later in the scheme (obviously defective animals should be culled).

- As the scheme progresses, if selection is successful, the balance of advantage may move slightly in favour of testing more rams on fewer progeny each thus increasing the total number of rams used, BUT at each mating newly introduced rams are tested against the most successful of the previous year's. At the second mating this is achieved by introducing new purchased rams (as explained above). Thereafter home-bred performance-tested rams (if necessary from the best families) are tested alongside the best of the previous year's fathers selected on progeny test.

Diagramatically the scheme may be presented as follows:
DIAGRAM OF SELECTION SCHEME (number of rams subject to revision - See text)

MALE LINE

Year 1
mating
20 P

Year 2
lambing
progeny(H1)
select 10
10 best (P)
10 new (P)

select 20 (H1)

Year 3
lambing
progeny (H2)
select 10
10 best (P)
20 (H1)

select 15 (H2)

Year 4
lambing
progeny (H3)
select best 15
15 from H1
15 H2

Year 5
lambing
progeny (H4)
select (H3)
select (H3)
selected on progeny test
selected on performance (H3)
remainder of purchased plus H1, H2, H3 ♀♀

Year 6

P = Purchased  H = Homebred, year 1,2,3, etc.

FEMALES

purchased

purchased (less culls) plus H1, ♀♀
purchased (less culls) plus H1, H2 ♀♀

homebred ♀♀ only
3. **Crossbreeding**

This should be started on a limited scale alongside the selection programme to test both the relative rate of change obtained with crossbreeding and the acceptability of a somewhat altered end product. A 25 percent introduction of 'outside' (exotic) blood achieved through the use of F\(_1\) (first cross) rams should be adequate to meet the needs and would be simple to operate in practice. F\(_1\) rams could be produced in large numbers relatively cheaply by mating rams of the exotic breed chosen to females of the Somali Blackhead breed. Thus few exotic rams are needed to provide all necessary F\(_1\) rams for distribution (subject to avoiding inbreeding by changing the exotic rams periodically and replacing the ewes by regular culling of ages).

The scheme should be started with 200 Blackhead Somali ewes (in addition to the 400 in the selection flock) to be mated to 10 imported Dorper rams (from Kenya or South Africa). The Dorper breed is itself derived from a first cross of Blackhead Persian females (an improved breed originally deriving from the Somali Blackhead) and Dorset Horn rams. In a sense, therefore, the 'F cross' (though 'fixed' as a breed) can be purchased ready-made thus saving time and avoiding the necessity of importing Dorset Horn rams until proven desirable.

**Procedure**

1. **Year 1** - mate 10 Dorper rams to 200 Somali Blackhead ewes.
   2. - lambing - approx. 160 \(\frac{1}{2}\)-Dorper lambs.
   3. - mating - repeat previous mating with surviving ewes.
   4. - lambing - approx. 150 \(\frac{1}{2}\)-Dorper lambs.
   5. - mating - approx. 60 \(\frac{1}{2}\)-Dorper females (born year 2).
   6. - approx. 140 Somali Blackhead ewes.
   7. - lambing - offspring of \(\frac{1}{2}\)-Dorper females - for slaughter.
   8. - approx. 120 \(\frac{1}{2}\)-Dorper lambs.
   9. - mating - approx. 55 \(\frac{1}{2}\)-Dorper females (born year 2).
   10. - approx. 55 \(\frac{1}{2}\)-Dorper females (born year 3).
   11. - approx. 55 \(\frac{1}{2}\)-Dorper females.
   12. - approx. 90 Somali Blackhead ewes, etc.

(The numbers in the above model make some allowance for wastage.)

The male lambs born are tested for growth up to 1 year old as in the selection scheme.

The female lambs are kept for breeding to assess whether the \(\frac{1}{2}\)-Dorper female (\(\frac{1}{4}\) Dorset Horn, \(\frac{3}{4}\) Blackhead) offers advantages as a mother over pure Somali Blackhead.

Mating is entirely to purchased Dorper rams which must be changed every 2 years to prevent mating them to their daughters.

On this scheme there is no need to record individual pedigrees.

Trail and Sacker (1966), referred to earlier, found that at one year old Dorset Horn x Blackhead crosses (F\(_1\)) were 80 percent heavier than contemporary pure Blackhead, out of the same type of mother. This is not the difference expected in the present trial which involves only \(\frac{1}{4}\) Dorset Horn blood but gives an indication that half or even less than half of this improvement is worth aiming for.
Further developments - Subsequent, or contemporary, developments could make use of further crossing breeds including:

- Improved Awassi (from Israel) particularly to create a more productive type of ewe.
- Barbary (from Tunisia or Libya).
- White and Red Karaman (Turkey).
- Wiltshire Horn (England).
- Barki and Ossimi (Egypt).
- Sudanese Desert (Sudan).

All except the Wiltshire Horn and Sudanese may introduce an unwanted amount of wool, of carpet type.

(c) CADU

The scheme just started with the objective of crossing local sheep with rams of various breeds is commendable and should be continued except that several rams of each breed should be used and not one as at present. Even if it makes management at mating time more difficult the use of several rams per breed is essential for valid interpretation of the results in terms of the effects of breeds rather than the effects of individual rams. This is particularly important when the ram breed differences are not very large in relation to the differences among rams within breeds.

The choice of ram breeds used so far at CADU was based on availability rather than preference. The intention to use the Kaffa (as recommended for Debre Berhan) is excellent. The use of the Hampshire x Merino cross ram is unfortunate on account of the Merino component. The use of local rams for comparative purposes is obvious and should be continued. New breed crosses should be introduced and coordination would be assisted by an overlap with other stations in terms of breeds used.

Unfortunately the reasons for importing two Bleue du Maine rams from France on the advice of the Swedish breeding consultant to the project are not known to the FAO consultant. On the face of it the choice does not accord with the needs as suggested in this report.

The interests and work at CADU would lend themselves particularly well to testing breeds and breed crosses, each under more than one level of nutrition and grazing management. Such work should be encouraged (the point is elaborated somewhat in the next section on the IAR).
At present, the Institute is not involved with sheep. The range and pasture management work at the Institute, by common consent with the FAO expert on this work, would be most relevantly assessed in terms of animal output. The same can be said for comparing the practical value of different fodders and feeding stuffs given at different levels. Sheep are particularly well suited to much of this work especially that associated with grazing trials. They are much cheaper to use than cattle and, for a given investment, allow better experimental designs.

In terms of comparing the usefulness of different breeds and crosses one of the main questions requiring an answer is whether a large breed requires extra nutrients (or grazing) in proportion to its extra size compared with a small breed, and what that proportion is. Put crudely, for example, if 4 ha of a particular pasture support 20 small sheep, when a sheep of double the weight is used could the same pasture support only 10, or is the number nearer 18?

Questions of this type are essential to the improvement of animal production in Ethiopia since the desired increases in size of individual animals for marketing purposes will require improved nutrition and, overall, a probable reduction in total numbers.

Possible breed differences in efficiency of feed and pasture utilization may need to be investigated at some future time but are likely to be relatively small and of importance only in highly intensive systems. For the moment these are of no more than a second order of importance relative to the cruder differences associated with sheer size.

It is proposed therefore that the IAR should collaborate in coordinated comparisons of sheep breeds and crosses with the Ministry of Agriculture, the LMB and CADU by parallel breeding and testing of breeds and crosses. In addition, however, each breed or cross should be tested on more than one treatment.

Initially the need might be met simply by obtaining small (local Ethiopian) and relatively larger (Hampshire x Ethiopian) sheep from Debre Berhan. However, this would be a short-term expedient. A more sensible trial would involve.

<table>
<thead>
<tr>
<th>Sheep Type</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Ethiopian</td>
<td>Small</td>
</tr>
<tr>
<td>Somali Blackhead</td>
<td>Relatively small</td>
</tr>
<tr>
<td>and each mated to Dorset Horn</td>
<td>Larger</td>
</tr>
</tbody>
</table>

This would produce the 4 classes of sheep to be tried at Debre Berhan (local Ethiopian x Dorset Horn) and in the Jijiga region, if proposals are accepted.

The Institute's flock would thus act as a 'link' between the two as proposed for coordinated trials in general and provide the much needed comparison of local Ethiopian sheep with Blackhead Somali.

Other breed combinations should be tried in later phases.
(e) Awash Valley Authority

The livestock production component is geared to the utilization of irrigated pasture which incorporates a high proportion of lucerne (alfalfa). The growth rates and yields from the animals (sheep and cattle) expected in the models for the most profitable systems (Lines, 1972, Development of the Awash Valley, Phase II Livestock Development Programme) are well in advance of those likely to be achieved by the animals available in the vicinity. This suggests that animals would either need to be 'imported' from a distance, or bred specifically for the purpose. Special breeding is contemplated in the programme in any event to provide a reliable and regular supply of animals.

It is necessary, therefore, even at this stage in the development of the project, to ascertain which breeds or crosses are likely to do best under this intensive system in a tropical region, at least by testing on a limited scale the various breeds and crosses proposed for production elsewhere - say 20 male castrates of each of two or three breeds and crosses at a time, ensuring that at least one of the types is in common to successive fattening trials. Subsequent work should aim at finding the most suitable type of breeding ewe to produce the lambs for fattening. Something capable of producing and rearing more than one lamb at a time seems called for here. Since 'genes' of the right type cannot be introduced at the drop of a hat when the time comes to exploit greater potential, the testing and development work is needed now.
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