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A FEASIBILITY STUDY AND POSSIBLE METHODOLOGY FOR INCREASING  
THE CATTLE PRODUCTION POTENTIAL IN MOROCCO

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RABAT, MOROCCO

APRIL 1966

This report is the result of my observations of cattle raising practices in Morocco and visits and discussions with officials of both the Government of Morocco and USAID during April and May of 1966.

The opinions expressed are my own, but not necessarily original, and do not always reflect the only method of accomplishing a particular job. I have kept all of my recommendations consistent with the December 1965 World Bank Report.

I am very appreciative of the cooperation and assistance that I received from officials of both governments in preparing this report. My heartfelt thanks to each of you involved.

Dr. D. W. Butchart

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#### ANNEX

Tentative Project Agreement

A FEASIBILITY STUDY AND POSSIBLE METHODOLOGY FOR INCREASING  
THE CATTLE PRODUCTION POTENTIAL IN MOROCCO

By: D. W. Butchart, B.S., M.P.H., D.V.M.

I. Purpose of This Report

The purpose of this report is to study the livestock production program in Morocco and to determine the feasibility of a complementary artificial insemination program to assist in carrying out the USAID assisted goals of the overall livestock improvement program.

This is a wide and far reaching program which meets with difficulties in its achievement. The professional veterinary staff of the Ministry of Agriculture in Morocco is faced with changing the traditional habits of the farmers and requires long and arduous training efforts, as well as considerable technical and social knowledge.

A plan for developing livestock improvement is very important in this development effort and, to be realistic, it must conform to the overall production objectives. The livestock program has already been started by improvement of forage production and now should definitely move toward a national livestock breeding campaign directed to improving the local cattle by crossing with purebred bulls.

## II. Background Information

### A. The Setting

Morocco reattained its full sovereignty in 1956 with the termination of the 44-year Spanish and French protectorates over the former northern and southern zones of the country. Tangier and the southernmost province, Tarfaya, were integrated into the Kingdom later. An old country in tradition and culture, Morocco is confronted with difficulties in consolidating its independent status.

There is a dual economy in agriculture in Morocco and the two sectors exist alongside each other throughout most of the countryside. They differ in size of farm units, in equipment and techniques, quality of livestock raised, crops and yields. The "modern sector", which originally included mostly Europeans, is mechanized and often irrigated, uses selected animals, plants, and seeds and studies its market. Modern sector farmers experiment with new species and learn quickly about the modern methods of cultivation. Finally, their operations are rounded out by facilities for storage, trucking to port, dock warehousing, and transport to Europe, which makes a unified commercial system.

Traditional agriculture, on the other hand, is that of the simple wooden plow which just scratches the surface of the soil -- and perhaps much of the problem begins right there. It is dependent completely on adequate and propitious rainfall which is seldom available, and it is devoid of scientific calculations of any kind. The donkey is

the universal helper and carrier, and tools are rare and rudimentary. Holdings are small; where the average "modern sector" farm in Morocco is more than 70 hectares, the normal "traditional" holding is about 5 hectares of cultivatable land.

With such contrasting backgrounds, yields naturally vary. The "modern sector" farmers hold better land normally and, where they do, yields tend to run from three to four times that of traditional farmers; but even where they share the same kind of soil, their technical superiority and know-how brings in about double the traditional harvest.

This report will deal only with the possibilities of increased productivity of livestock raising in Morocco and especially beef cattle production potential. Special emphasis will be given to regions where USAID agricultural programs are concentrated.

The last great refuge of traditional agriculture is livestock raising. This sector possesses most of the cattle, sheep, goats, camels and horses. But it provides a precarious livelihood. The owner is at the mercy of a dry climate, badgered by frequent droughts and restriction on pastures, and condemned by his own nomadic habits. The ordinary Maghribi stock raiser feels that his prosperity and prestige are determined by the size of his herd, which is, therefore, often oversized while individual animals may be undernourished. Then a drought arrives and the lack of storage fodder or facilities for speedy large-scale slaughtering and preservation, condemn him to sudden massive losses.

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There is also a demoralized market at such times, naturally.

Livestock in Morocco directly concerns 70 percent of the population, has a value of about two billion dirhams and constitutes at least 50 percent of the agricultural income. The available statistics place cattle numbers at 2.8 million head. It has been estimated by the Government of Morocco that the annual increase in cattle numbers by reproduction is not much over 30 percent of the total, while the annual reduction through butchering and death is about equal to the increase. The number of cattle and the amount of meat produced has thus remained about static for a number of years while the human population of Morocco has grown at the rate of about 3 percent per year.

There are relatively few veterinarians (65 - including 14 nationals). The research and vaccine producing laboratories are under-equipped in material and technicians. Modern veterinary medicine remains almost unknown in the country and up to this time, the impact of up-to-date livestock production methods have not touched upon the traditional sector of agriculture.

In this sector of agriculture in Morocco, it appears that the animals are inferior in body form, low in production, and low in efficient utilization of feed. There is need for improvement in each of the five major fields of animal production: (1) feeding, (2) breeding, (3) disease control, (4) care and management, and (5) marketing.

It is the opinion of the author that any program directed at

Improved cattle production must not neglect any one of these five major fields if the overall program is to be successful.

It appears that the distribution of livestock by species in Morocco is mainly dependent on the type of soil, the geographical relief, and the rainfall. It can be said that nearly all the cattle are to be found in an area northwest of a diagonal running from Goulimine to the lower Moulouya, on the coastal plains of the west, and in the Riff; that goats are essentially animals of forestland and dry mountains; whereas sheep can be considered essentially in more humid mountain areas, plains of cultivation and high plateaus. Horses are most abundant in that part of Morocco which stretches north of the Central and West High Atlas, and west of the secondary folds of the Northern Middle Atlas. The dromedaries are found mostly in two distinct zones, the eastern and pre-Sahara area, which is the reproduction area, and in the central west zone where their numbers have been decreasing in recent years.

The 2.8 million cattle of Morocco can be divided into two distinct groups: on one hand, and by far the most numerous are the cattle of aboriginal race, and on the other hand, a small but important number of imported cattle.

The local breeds of cattle can be divided into two breeds: -- the Brun Atlas -- with fawn colored hides, and black mucous membranes. It is an animal of inferior body form and slow maturing and I feel

sure that feeding trials would prove it to be low in production of both meat and milk and low in efficient utilization of food; and -- the Culmes -- also with fawn colored hides but with pink mucous membranes and of heavier build. They appear to be a little better quality cattle than the "Brun Atlas". These two basic types have been intermixed and have given birth to a variety of intermediary types, none of which could be called good, whether one considers them either from the beef production, milk production, or dual-purpose view point.

There are perhaps 10,000 dairy cattle of European origin in Morocco, situated around the larger cities, especially Casablanca. These are mostly of Holstein breeding and, to a lesser extent, Tarantais, Montebelliard and Brown Swiss. There are also a small number of imported European beef breeds in Morocco, primarily Charalais and Limousin. Only recently the Government of Morocco has done some crossbreeding of local cows with Holstein, Charalait and with Limousin bulls. The resulting offspring appear to show a marked improvement in both early maturation and meat yield over the native cattle but no controlled feeding trials have been done.

There are approximately ten million acres of rangeland in Morocco -- most of which are badly overgrazed. The northern quarter of Morocco (approximately 25 million acres excluding the Riff Mountain range) has fair to very good soil and sufficient rainfall, usually, to produce cereals and winter growing forages such as Barseem clover, oats, vetch and peas. Corn and grain sorghum are grown along the Atlantic

coast. Alfalfa, with supplemental irrigation in the summer, is said to grow all year with the exception of December.

Both annual and native grasses begin their growth following the fall rains; and generally speaking, these pasture grasses completely disappear by the month of June when livestock are turned into cereal stubble fields. Here they remain until August or September after which a real crisis in livestock feeding prevails until the fall rains begin and pasture grasses begin to revive.

B. The USAID Assisted Livestock and Forage Program

As a result of a serious drought in 1961, an emergency livestock feeding program was supported by a grant of 90,000 metric tons of United States' grains. The Government of Morocco asked USAID in the spring of 1962 for assistance in carrying out a five-year program for livestock and poultry development. The USAID livestock project began in 1964. The King has shown personal interest in this program and many Government of Morocco officials regard it as a key step toward the transition of the masses of farmers from "traditional" to "modern" agricultural practices.

A U.S. Livestock Advisor arrived in 1961 to assist in the distribution of barley during the drought emergency and later to collaborate with the Government of Morocco in developing a long-range livestock improvement program. The grain donated under the U.S. Food for Peace Program is used as incentive payments to encourage farmers to adopt better practices. Thus far, emphasis has been on forage production

and feeding of same in conjunction with U.S. donated corn. The Government of Morocco has envisaged a five-year demonstration program. Allocations to individual farmers who participate is limited to two years.

In addition to the grain, USAID has granted \$40,000 worth of improved seed for forage plantings and rangeland grasses plus \$30,000 of equipment for poultry hatching and brooding. Seven Moroccan participants in forage production were sent to the U.S. in 1961 and four Moroccan participants in poultry to Tunisia for observation studies in 1963. It is planned that additional participants in livestock improvement be scheduled to study in the United States in fiscal year 1967.

The forage and rangeland phase of this activity, projected over a period of five years, is intended to demonstrate, through cooperating farmers, that the improved practices being advocated are economically profitable and should be permanently introduced. In 1964 a forage production program was carried out in 15 provinces including 8,000 cooperating farmers and 15,800 hectares. The summary to date (May 1966) is 39,000 hectares in forage production. Several range areas were inspected and studied in 1963 and 1964, but for various reasons the range improvement program has not been launched.

To match the U.S. aid of grain, seed, and technical assistance, the Government of Morocco is providing technicians, forage seed, interior transportation and storage of the grain and seed. Besides their labor, the farmers provide fertilizers, trench silos and storage of forage. In many instances Moroccan stockmen are buying and mixing other grains with

the U.S. donated corn to make a more complete ration.

The poultry phase was to begin in late 1964 but encountered some delays. The U.S. contribution of equipment and grain has been matched by a Government of Morocco contribution of buildings, additional incubators, brooders, and feed supplements for the U.S. grain. A U.S. Poultry Advisor arrived in Morocco in May 1965, and the poultry phase is now progressing.

The cattle phase of breed improvement and particularly artificial insemination, was made a part of the "Project Agreement" signed June 25, 1963 with the Government of Morocco. A small amount of artificial insemination equipment was purchased to supplement existing GCM equipment in order to launch the program, but this phase of the Project Agreement was not realized in 1963, nor to date.

Verbal discussions on the subject were held between USAID/M officials and the Director of the Government of Morocco Livestock Service, Dr. Ahmed Laaberki. Following these discussions, the USAID/M requested AID/Washington to send an American Veterinarian to Morocco for two-months TDY to study the feasibility and possible implementation of an artificial insemination program and to prepare an analytical report on the subject. The American Veterinarian TDY arrived in Morocco on April 17, 1966 and this report is the result of his study of the possibility of implementing this phase of the program.

A vital aspect of all USAID activities is to train Moroccan

planners, administrators, and technicians in improved methods and technology. This training ranges from the daily contacts between Americans and their Moroccan counterparts through a wide scope of in-service short courses, pre-service schooling, and participant training in the United States through short courses, observations, and extended studies for academic degrees.

A long-term program is envisioned, including training of Moroccan personnel who will be able to take over and carry on this task of livestock upgrading.

It will only be possible to overcome the many difficulties involved in upgrading the cattle of Morocco when a nation-wide breeding plan is established. This program may take different forms, considering the characteristics of the various provinces.

Traditionally a cattle improvement breeding program is organized in either of two ways:

- (1) In the form of a number of area purebred sire breeding stations, or
- (2) in the form of an artificial insemination center and A.I. area stations.

The purebred sire breeding station implies the construction of a building to shelter the bulls that will remain there. The cows to be bred are brought into the station and bred naturally there.

This type of operation also implies the existence of qualified

veterinary personnel at each station, otherwise the operation would be carried out under the control of persons who are not technically qualified to diagnose the presence of disease in the cows being bred. This results in exposure of the purebred bulls to disease which could ruin them very quickly.

A more practical program is the creation of an artificial insemination center, because:

(a) It is less expensive as there is no distribution of bulls to the various local stations, only the distribution of semen.

(b) One bull may furnish enough semen for a much larger number of cows and the bull has no contact with cows, so contamination from diseased cows is avoided.

(c) The local stations require personnel much less technically qualified. An artificial insemination center must be under the direction of a professional veterinarian. The area A.I. stations, however, require only technicians trained in artificial insemination and castration.

### III. Possible Contribution of Artificial Insemination to the Total Livestock Program

The artificial insemination phase of the USAID assisted Livestock Improvement Program is intended to eventually reach both the modern and traditional livestock farmers, and it is anticipated that improved animals resulting from artificial insemination will result in a substantial increase in meat, milk and other animal products. This

phase of the program would be directed at improving or upgrading the native cattle through crossbreeding with imported purebred sires, resulting in: (1) improved body conformation (a higher ratio of carcass meat to bone), (2) increased birth weights, weaning weights, market weights and more rapid maturation, and (3) more efficient utilization of feed. This should result in a better agricultural economy among the livestock farmers and better nutrition in general for the consuming population of Morocco. An important place in the USAID sponsored Livestock Improvement Program therefore seems reserved to artificial insemination, which will have to be integrated with the forage production and range improvement phases of the overall program.

A. Factors Involved in Planning an Artificial Insemination Project

Before stating the possibilities for the introduction of an artificial insemination project in the different areas visited, it is necessary to point out some characteristics of cattle raising in Morocco which must be considered in tailoring a project to their needs.

There are about 2,800,000 bovine animals according to GOM, Ministry of Agriculture, 1964 estimates. These are found in the various regions as follows:

Cujda	33,000
Fez-Taza	281,000
Meknes	202,000
Rharb-Cuezzane	250,000
Rabat	217,000

Chaouia	263,000
Tadla	184,000
Doukkala	266,000
Marrakech	629,000
Agadir	218,000
Northern zone (Tetouan-Tangier)	337,000
	<hr/>
Total	2,880,000

The cattle population is scattered among many small owners, in what may be termed "micro-herds".

Cattle herds with three animals or less represent 50-75 percent of the total cattle population, while herds with 20 or more head only account for about 20 percent of the bovines, according to GOM statistics.

Generally speaking, the grazing of cattle is on collective lands or on grain stubble. The animals are watched by children or adult herders who take them out to pasture in the morning and bring them back to the village (douars) in the evening. Thus, many of the cattle numbers do not represent livestock farming in the strict sense but rather a collection of bovine animals representing capital, or a kind of reserve.

On the whole, except for the USAID sponsored forage production areas, there are few food reserves for cattle and there is a very limited cultivation of forage. The animal subsists on what the soil happens

to produce.

As regards feeding, which is still a big part of the problem in most areas, it is essential that the farmer or the village produce the necessary forage. This must be done, not only on a day-to-day basis, but should provide reserve allowances for drought years.

The Moroccan fellah does not appear to have a real sense of livestock breeding. This may be due to the fact that up till now cattle have merely been intended to produce a little milk for the owner and to constitute a capital reserve allowing owners to satisfy their seasonal needs for cash.

The Moroccan farmer, in general, seems to have no idea of spending more to earn more, perhaps partly because there has never been a reliable or predictable market. Milk is sold mainly for use in large towns or cities and it is an advantage to be situated in an adjacent area to be able to take advantage of this dairy market.

The purpose of livestock improvement must therefore be defined in order to make people think in terms of selection.

At the present time the Moroccan livestock owners' process of selection appears to be very crude, if it is practiced at all. An appeal to his interest must definitely be geared to a promise of immediate cash returns. This could derive from more milk for those who live near towns, and larger carcasses more quickly obtained for farmers in general. The requirements for selection, at the farm level,

are not generally understood and it is obvious that a whole program embracing the various aspects of cattle improvement must be studied:

(1) Selection of breeds, the characteristics of which are best suited to the aims of the area in question; (2) a choice of production, either meat or milk best suited to that area; (3) a selection of forage production which the area can provide and which can insure the desired type of animal production; (4) a choice of the best methods for attaining the desired production, either by selection from the local breeds or by crossing with improved imported breeds.

The improvement of bovine stock without considering the above four points could lead to failure. It would be unwise in this writer's opinion to attempt to follow a different sequence in the task of improving the cattle production potential in Morocco.

## E. What is Artificial Insemination?

Artificial insemination cannot be thought of in complete isolation. It is merely a tool, a means of action which cannot on its own solve all the problems of poor production efficiency in cattle raising. It can only follow other improvements and be complementary to a total program. A knowledge of artificial insemination will prove this to be true.

Artificial insemination is a method of producing fertilization of the ovum by the manual introduction of semen into the genital tract of the female. The procedure has been accomplished in all domestic animals. The primary advantage of artificial insemination is the

possibility of making extensive and widespread use of sires that will transmit desirable characteristics to their offspring. Economy, safety, and disease control are other advantages. Under improper supervision, the assets could become liabilities and disease and poor genetic characteristics would be disseminated. While artificial insemination is practiced to a limited extent with other species of animals for various reasons, the cattle industry has utilized this type of breeding most extensively. The following description of artificial insemination procedures applies to cattle.

(1) Collection of Semen

The semen is collected in an artificial vagina, which consists of a stiff rubber cylinder about 3 inches in diameter and 15 to 20 inches long, enclosing a thin rubber sleeve of approximately the same dimensions. The outer and inner tubes are sealed together at each end so that warm water may be placed between them, thus collapsing the inner liner and simulating the natural vagina. A soft rubber cone is attached to one end to direct the semen into a glass vial. A lubricant is applied to the inner surface and the temperature adjusted to 105° to 115° F. Most bulls will ejaculate into this apparatus during the process of mounting either a cow or a bull or a specially constructed dummy. The artificial vagina should be just long enough so that the ejaculation occurs in the terminal rubber cone, thus ensuring the collection of a clean semen sample. It should not be surrounded by any rubber bands, as these may be accidentally transferred to the bull's penis.

(2) Examination of Semen for Quality

The average volume of the ejaculate should be 4 to 8 cc. A rough estimate of the concentration of sperm is made by observing the color. A normal semen specimen is opaque and milk white, the opacity being due almost entirely to the spermatozoa. In contrast, an aspermic ejaculate is an almost clear white-tinged fluid. A closer estimation of concentration is obtained by microscopic examination of a fresh semen sample or by photometric determination of opacity. Normal bull semen averages about 1,000,000 spermatozoa per cubic millimeter. Mobility is determined by low-power microscopic examination of a fresh preparation. There should be mass movement, with the formation of swirls similar to those produced by the movement of a school of fish. Under magnification of 400 diameters and with the semen diluted with 10 parts of physiological salt solution, 80 to 90 percent of the spermatozoa should be actively motile. Fertility is satisfactory where motility is 60 percent or more, but it should be emphasized that fertility is closely related to mortality. Longevity of the spermatozoa is checked by storing semen at 40° F. and checking periodically for motility. Morphology of the spermatozoa is checked in a stained preparation when infertility occurs. Eighty percent or more of the sperm should be morphologically normal in a good semen specimen.

(3) Dilution of Semen

When the specimen is determined to be satisfactory, it is diluted or "extended". Egg yolk phosphate diluter, egg yolk citrate

diluter, and heat-treated cow's milk are all satisfactory, but the egg yolk citrate diluter enjoys the greatest popularity. Dilution of the semen is done as soon as possible after collection, and care should be taken to see that the diluter and semen are approximately the same temperature. The ratio of dilution may vary up to 1:200, but the maximum dilution is such that each cubic centimeter of diluted semen should contain 15,000,000 live sperm. The diluter is essential because it increases the volume so that one ejaculate can be used to inseminate many cows, provides a buffered nutrient environment, helps avoid temperature shock, and prolongs the life of sperm in storage. A dye may be added to dilute semen to identify the breed.

#### (4) Storage of Semen

The diluted semen is cooled at the rate of  $10^{\circ}$  F. per hour to  $40^{\circ}$  F. and may be held at this temperature for three days without loss of efficiency. It is important that temperature variations be held to a minimum during storage. The semen is obtained from the refrigerated supply as needed for insemination. Semen can be frozen without destroying its fertilizing capacity. Normally it is frozen by using dry ice (solid carbon dioxide) or liquid nitrogen and in the frozen state it has been reportedly stored for up to several years and still maintained its viability. Frozen semen may be thawed quickly, but must be used immediately.

#### (5) Insemination

Insemination of the cow is done in the United States by

the rectovaginal method. The external genitalia are cleaned with soap and water. One hand of the inseminator is introduced into the rectum. The other hand introduces a pipette 6 mm, in diameter and 40 cm. long filled with 1 cc. of diluted semen into the vagina, through the cervix and into the body of the uterus where the semen is discharged. The hand within the rectum manipulates the cervix so that the passage of the pipette is facilitated. A vaginal speculum may be used instead of rectal palpation, but this does not allow deep penetration of the inseminating tube and the conception rate is lower. The breeding efficiency of artificial insemination (the first service conception rate) compares favorably with that of natural service when attention is given to all the details of the process.

C. Disease Control in Relation to Artificial Insemination

Livestock improvement requires attention not only to the inheritance of desirable characteristics but to those environmental factors which have a bearing on their expression. Of these, none is more important than disease. The present-day science of livestock improvement has become increasingly aware of the part disease plays in the success or failure of a cattle raising enterprise. It is obvious, therefore, that the extent to which artificial insemination prevents the transmission of disease will influence the use made of it.

Present experience indicates that breeding artificially can be of assistance in limiting the spread of disease by preventing sexual contact, by encouraging the maintenance of self-contained units, and

by bringing the reproductive function of a cattle herd under the scrutiny of a trained veterinarian. The fulfillment of these potential benefits, however, is dependent upon adequate precautions being taken in sire selection. Males used must be free from infection and technicians in charge of an artificial insemination center must be thoroughly versed in the symptoms of disease and principles of sanitation. Negligence or ignorance in this connection can do more than nullify the hygienic benefits of artificial insemination; they can open up a new and disastrous avenue of direct transmission.

From the standpoint of disease control, the advantage provided by artificial insemination is that it substitutes a mechanical process under human control for sexual contact with its attendant risks. It can, therefore, break the chain of infection in venereal transmitted diseases of cattle.

A list of diseases spread entirely, or in part, by bovine sexual contact follows:

(1) Trichomoniasis is a venereal disease of cattle caused by a protozoan parasite, Trichomonas foetus, and characterized by abortion and general breeding difficulties.

Transmission is accomplished almost entirely by the act of service. A bull acquires the infection from diseased cows; it becomes established in his genital tract, and he may infect a high percentage of the clean cows that he serves thereafter.

Although treatment of bulls is seldom successful, cows

are often freed of the infection spontaneously with sexual rest.

When trichomoniasis becomes established in an area where herds are small, cattle density is high and the usual method of obtaining bull service is to patronize any local bull available, it rapidly becomes a serious community problem. It is difficult to see how such a situation can be brought under control without the use of artificial insemination.

(2) Brucellosis of cattle (Bangs Disease). The principle features of this world-wide disease of cattle are so well known that they require no detailed description here. It is caused by the organism Brucella abortus, and its dominant symptom is abortion with retained placentas, usually occurring after the second trimester of pregnancy. Most frequently the disease gains entrance to the body by way of the mouth, so that artificial insemination can only play a minor part in its control. Occasionally the organism localizes in the genital tract of the bull, creating a potential danger at the time of service. Thus, artificial insemination can be considered a minor aid in its control.

(3) Vibrionic abortion. This disease is characterized by abortion at around four or five months in the gestation period. There is evidence to indicate that this disease is transmitted from male to female, and possibly in the reverse direction, at the time of service. Artificial insemination, using males known to be free of infection, would appear to have a useful place in a control program.

(4) Vaginitis of cattle. This disease does not necessarily

cause complete sterility, but breeding efficiency is lowered in infected groups. The disease is characterized by the formation of small reddish nodules or pustules involving the mucous membrane of the vagina and vulva of cows. Bulls frequently show lesions on their genital organs and are thought to be the principle spreaders of the infection. In some outbreaks, a streptococcus has been isolated from affected mucous membrane; on other occasions, a virus has been incriminated. It is probable that similar lesions can be caused by a variety of organisms.

To the extent that bulls are responsible for its transmission, artificial insemination from clean bulls should be an effective control measure.

(5) Coital Vesicular Exanthema is a highly contagious vesicular eruption of the external genital organs of both cattle and horses. It is caused by a virus and characterized by swelling of the affected parts, ulcer formation, and a purulent discharge. Combined with treatment of affected animals and general sanitary measures, artificial insemination should be useful in its control.

Essentially, artificial insemination is only a means of reproduction. The technique of collecting, diluting, preserving and distributing semen allows: (1) a very large number of cows to be inseminated by one superior sire, (2) control of certain genital diseases (for example Trichomoniasis, which is said to have a high prevalence in Morocco) that can be spread among cows through copulation with the bull. It thus prevents the exposure of a healthy bull to disease and prevents

transfer from cow to cow of those diseases, (3) the feed and labor expended on keeping a bull can be spent on an extra cow, (4) it makes possible the development of superior animals within a particular district and eventually throughout the country.

In the United States, on the average, one superior bull can be used to artificially inseminate 2,000 cows per year, whereas under natural conditions a bull can only be used for 80-100.

It has been established that the most common duration of heat in cows is seventeen hours, that their average time of ovulation is twelve hours after the end of heat, that the average time for sperm to reach the upper tube is five and one-half hours, and that the sperm retain their fertilizing ability in the tubes for about six hours. This means that insemination can only be practiced on cows in heat and for twenty-four hours after the animal has actually commenced her heat period. It is, therefore, essential to have access to rapid information and be in position to intervene in time.

There must be a system of checking the progeny, knowing the sire, origin of the semen used and the results which can be attributed to a given sire. A sire must be evaluated over time by the progeny he produces. Some sires are much more prepotent in transmitting desirable characteristics to their offspring than are others.

An exacting and rigorous administrative organization must, therefore, accompany an artificial insemination project. There must be

an established system of data on collection of semen: Insemination sheets are needed to show identification by ear-tag numbers of inseminated females, and to record the results of the insemination by bull, by inseminator and by month. These records will reveal failure of the cow to come into heat again and expected date of calving.

Another indispensable condition is the castration of all males in areas where artificial insemination is to be adopted. This means that the farmer will be obliged to follow rules of the organization if such a project is to be successful. He will have to be convinced that he is running no risk of his cows not being settled. Castration is the only measure which will successfully prevent the farmer from having his cow mounted by the local bull, before or after insemination, which would negate the value of the technical or zootechnical data recorded by the center and lead to hopeless confusion.

A successful artificial insemination program in Morocco will require the setting up of a "reproduction section" within the framework of the GCM, Veterinary and Livestock Service. This is the logical framework as most of the professionally trained veterinarians in Morocco are employed within this structural division of the GCM, Ministry of Agriculture. Without professional veterinary administration, direction, and planning, this phase of the Livestock Improvement Program cannot possibly succeed.

This "reproduction section" would serve to create, organize and control the artificial insemination center and stations with all

its technical advantages (biological, physiological and pathological), and would represent one of the most important elements for the adoption of a program which most Moroccan zoo-technicians appear to want to see applied. This section would have no other duties and would be able to concentrate full time on this particular effort.

At the same time such a section would act as a means of spreading knowledge and having employees maintaining daily contact with the livestock farmers.

This will be the very mechanism of an artificial insemination center. The inseminators and the center officers will be constantly in the villages ("douars"). They will follow, ear tag, supervise, educate, control and in a word get to "know" the cattle and their progeny and also the environment in which the National Ministry Office will circulate its directives.

All these possibilities should be exploited if such a project comes into being, as they are a condition of success and will help to concentrate action.

#### D. Current Status of Artificial Insemination in Morocco

Artificial insemination has already made a beginning in Morocco since the following veterinary stations have small artificial insemination sections in their operation and are at the disposal of the livestock farmers:

Oujda

Fes

Khemisset

Tetouan

Marrakech

Sale

These veterinary stations are provided with purebred imported sires, provided and looked after by the GOM, Veterinary and Livestock Service as follows:

- the stations at Fes and Sale have one Tarentais bull and one Holstein.
- Tetouan has one Holstein bull.
- Khemisset has one Tarentais bull, one Holstein, one Montebellaird, and one Limousin.
- Marrakech has one Tarentais bull and one Holstein.
- Oujda has two Holsteins and one Montebelliard.

Artificial insemination is carried out by the staff of the GOM, Veterinary and Livestock Service (Service de l'Elevage) and all these operations are paid for out of their budget without any sum being demanded of the cattle owner.

The system employed is like that of an American artificial insemination station:

- A telephone call from the owner of the cow.
- Arrival by car of a technician within 12 to 24 hours from

receipt of the call.

Although no charge is made, these stations, some of which have been going on for nine years, have carried out very few inseminations.

Khemisset carries out an average of 200-300 inseminations per ~~month~~ <sup>YEAR</sup>, Marrakech 20-30 per month and Fes 25-30 per month, and the results are very irregular.

It would appear that the reasons for this disappointing performance are as follows:

- (1) There is no complete, structured organization aiming at artificial insemination and adapted to local conditions.
- (2) The stations have failed to reach the livestock farmer through lack of resources.
- (3) Artificial insemination presents a certain difficulty as compared with the availability of local bulls.
- (4) Lack of initiative on the part of the cattle-raiser, who should watch for cows coming into heat. It is a mistake to wait for the farmer to take the initiative since he will only do so when taught. It is contrary to his mentality.
- (5) Communication difficulties.
- (6) Artificial insemination has not been integrated in a wider cattle-breeding program and there has been a tendency to use it for itself.

- (7) The limited number of professional people have not devoted themselves to the A. I. program because of too many other responsibilities.
- (8) There are no professional groups among the livestock farmers set up with a view to improve cattle production which might serve as a basis for cooperative and concerted action to help spread knowledge.
- (9) There is often not enough large concentration of animals at the family or even village "douar" level.

The previous station attempts at artificial insemination have had the demonstrative value of experiments. They should enable future project planning to define aims and procedures so as not to fall into the same errors.

#### IV. Conditions Required for the Organization of a Successful Artificial Insemination Program

Conditions which will enable the Government of Morocco to set up a successful National Artificial Insemination Center are:

- (1) A cattle raising area with a fairly high density of cattle -- a minimum of 30,000 cows over a 50 kilometer radius and especially an area holding at least 4,000 to 6,000 cows over a 15 to 20 mile radius.
- (2) An area having good communication facilities with other areas where an extension to artificial insemination stations eventually will be made.

- (3) An area where the type of production and environment will be conducive to improvement of cattle.
- (4) An area possessing a market which will be a ready outlet for improved cattle.
- (5) An area with communications which will make it possible to readily reach farmers in the surrounding villages.
- (6) An area where artificial insemination will not be hampered by clandestine rating, and the castration phase will be acceptable.
- (7) A devoted, enthusiastic, professionally qualified and well paid staff is available.
- (8) An adequate operating budget is provided.
- (9) High quality purebred sires can be obtained.

The selection of the site must be made in terms of the objectives of the overall livestock improvement program. It is obvious from the experience so far that the scattered positioning of small artificial insemination units in a loosely controlled system can certainly not lead to large-scale advances in cattle improvement.

#### V. The Organization of an Artificial Insemination Program

The dominant element here is the creation and equipping of a National Artificial Insemination Center. This is where the bulls are kept and cared for, where the staff collects the semen, dilutes it, preserves it, and dispatches it. It is therefore the basic production unit. The artificial insemination stations as they are integrated into the program will have no bulls. They will receive the semen dispatched

by the National Artificial Insemination Center every other day by the quickest and the most suitable transportation. These stations will consist merely of artificial insemination-castration technicians, the buildings and simple equipment required by their activities. Each inseminator-castrator will have an automobile at his disposal.

As the program expands, the artificial insemination sections of the area veterinary stations now in existence would be integrated into the program and also become regular stations.

This writer has become convinced during his study of the subject in Morocco that the logical place to begin an artificial insemination program is with the creation and equipping of a National Artificial Insemination Center in Casablanca. The Casablanca area appears to best meet the conditions required for the organization of artificial insemination. This is the most highly populated province in Morocco with some 2.4 million people and a good potential for a livestock market.

Casablanca Province has a bovine population of about 500,000 head, unevenly distributed over the various districts. The most concentrated cattle populations are those of the North Chaouia around Casablanca city, the Azemmour area and El Jadida.

The distribution of the cattle in Casablanca Province as estimated by the Moroccan Ministry of Agriculture in 1964 is:

North Chaouia	-	46,920 of which 29,000 are immediately around the city of Casablanca and 15,000 at Benslimane.
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Central Chaouia	-	54,344
South Chaouia	-	61,927
Ben Ahmed	-	41,000
Oued Zem	-	30,000
Khouritga	-	9,647
El Jadia	-	112,997
Azemmour	-	32,078
Sidi Bennour	-	82,046
Zemzama	-	37,263
		<hr/>
		508,964

The area around Casablanca shows essentially the characteristics required for the creation of an artificial insemination center.

In this area an effort is already being made toward selection which will make the initial effort to establish an artificial insemination project easier and offers a better chance of success.

The USAID assisted Forage Production Program has been quite successful in the Casablanca area and there has been an increase in demand for improved feeder cattle as a result of this program. The market and needs for more beef is present which should help establish the need for artificial insemination. This area is also the dairy zone worked by the central dairy cooperative in Casablanca. This cooperative processes 40,000 to 50,000 liters of milk daily.

The dairy business of the cooperative is represented by about

10,000 cows, of which 4,000 are either purebred animals or crossbred animals developed by crossing native cattle with imported breeds.

A very favorable characteristic of this region is the presence of some large herds (100 to 200 head), the owners of which seem anxious to improve their cattle with sires of superior breeding.

These herds are all accessible and have better care and management than most cattle raising areas in Morocco. This is an encouraging factor which ensures contact and allows the spread of ideas on improved production.

Finally, for some years a few larger dairy operators in the area have been importing purebred Holstein cows, which they know must be mated to the best purebred bulls available, so they are preventing the mounting of their cows by local scrub bulls. The castration phase will begin easily here.

For these reasons, it appears that the Casablanca area is the logical place to create a National Artificial Insemination Center. It would immediately begin to serve the region and prepare the way for the extension of the program into other regions by way of establishing an expanding ring of artificial insemination stations. Ultimately such stations would be established in other centers of cattle population, beginning with Chaouia South, the El Jadida area and Sidi Bennour.

Sires should be outstanding purebred members of the breeds which are selected for development in the area. In the Casablanca area, I

would suggest the best Holstein, Tarentais and Charalait bulls that the GCM Veterinary and Livestock Service (Service de l'Elevage) now owns, and use them according to the individual farmer's primary aims, whether it be milk or meat. The sires before being used in the planned program should be thoroughly examined, both from the biological point of view (quality of the semen) and from the health point of view (especially reproductive ailments). They would then be examined frequently while in service and, of course, a record system set up to evaluate each bull's progeny. The program soon after starting would, if properly conducted, require three sires of each breed whose semen would be collected and prepared every day in rotation. With a successful program underway, it would be possible to amortize a bull in three years, which would then result in the replacement of one sire per breed every year. It is possible in an optimum program in the United States to utilize one sire annually to inseminate about 2,000 cows, but this will take quite some time in Morocco.

If a USAID veterinarian is assigned to assist in such a program as this, it will be important for him not to attempt to transfer in toto U.S. standards of progress, as the situation is somewhat different in Morocco and ideas will have to be tailored to conditions and problems as encountered.

This program must be adapted to the requirements of the area. The inseminator must not wait for the farmer to call him. On the contrary, the farmer will have to be taught. Therefore, I feel that daily routes must be organized for the inseminators and the route stops must be the

larger cattle farmers in the area. These farmers should enter into an agreement with the GCM whereby they would assume the following responsibilities:

- 1) Agree to have all cows bred artificially by the GCM technicians.
- 2) Agree to keep no bulls on the premises, and to castrate all crossbred male calves born.
- 3) Agree to an ear tagging or other type of positive cow identification.
- 4) Agree to allow his farm to become the route stop and local educational point for himself and surrounding farmers to be taught about artificial insemination.

When a nearby farmer becomes sold on the program and wishes to take part in it, he will enter into an agreement also. His farm will then also become a route stop if he owns a sufficient number of cattle to justify this. However, if he owns only a few animals, he will be taught by the inseminator to detect heat periods in the cows at the route stop. This small farmer will then come to the nearest route stop whenever he has a cow to be inseminated or when he has a bull calf to be castrated. The artificial insemination-castration technicians will make each route stop at approximately the same time each day. As the number of route stops grows, new technicians will be trained to handle the increased work load but gradually less and less time will have to be spent at the original route stops doing teaching about the artificial insemination program and detecting heat periods in the cows.

This method would allow for continual contact, greatest possible simplicity, and it would create a structure making it possible for education of the farmers about artificial insemination and castration.

In addition to this method of daily route stops, the usual method by which the farmer telephones to ask for action will gradually come into being in the Casablanca area, and some of the more advanced areas where telephones are prevalent. The technicians who work at the National Artificial Insemination Center in semen collection, dilution, preservation, and dispatching will also do standby duty in artificial insemination and castration to take care of these telephone requests for service; this will be small at first but will grow with the program in the Casablanca area.

Another method, other than telephones for communication between the farmers and the National Artificial Insemination Center, is to use the milk collectors. They could be organized and perhaps carry messages from farmers along their milk collection routes to the National Artificial Insemination Center. They would telephone the center giving the messages when they reached the cooperative creamery to deliver their milk collection. A small bonus payment for providing this service would have to be provided, possibly on a basis of the successful insemination of a cow which they reported to be in heat.

Of course, many more ideas on solving the problems of communication will develop as the program progresses. Perhaps in some areas, where stations will be developed later, the use of homing pigeons will offer

a means of communication between the farmer and the technician. In my long-term thinking of the artificial insemination project, another advantage of the Casablanca area is that there is a liquid gas plant situated there which will be able to supply the National Artificial Insemination Center with liquid nitrogen, used to keep semen frozen at  $-196^{\circ}$  C. This modern method of semen storage which is used in the United States extensively will make possible the importation of semen from other parts of the world. When the program is well underway and extended into other areas, this will become important because, as has already been mentioned, there must be trials and selection of breeds, the characteristics of which are best suited to the aims of the area in question. This will eventually result in frozen semen being imported. The presence of the liquid gas in Casablanca is not a negligible consideration.

Thus, taking into account the "indispensable conditions" which I have stated in the section on artificial insemination, the Casablanca area is the logical place for a national artificial insemination center.

#### A. Personnel

As was mentioned earlier, this program should be conducted by a specially created "reproduction section" structured within the framework and under the direct administration of the Director of the GOM, Veterinary and Livestock Service (Service de l'Élevage), but this must be at the policy-making level and delegation of authority must be practiced. The Reproduction Section Chief must be a professional veterinarian. The resident chief of the National Artificial Insemination

Center must be a professionally trained Moroccan veterinarian preferably with practical experience in addition to his advanced education.

Apart from technical knowledge, he must adapt himself to the program he is asked to implement and have clear-sighted ideas on organization and administration. He must be delegated enough authority from above to make all decisions at the operational level and have adequate budget at his disposal, and authority to use it, to enable him to act on his own initiation.

In addition to his administrative duties and duty to guide, direct and encourage his staff, he will be responsible for extremely valuable animals which it is essential to keep in good condition and in good health.

Finally, on his shoulders will rest the responsibility for the spread of knowledge from the center and thus ultimately the responsibility for the success or failure of the program. He must not be hamstrung from above by lack of authority or budget.

The insemination-castration technician in this program has an important job as an educator. On him will depend both rate of inseminations and the rate of conception, in so far as he applies himself seriously to the job. Much of the increase in artificial insemination will depend on the confidence he gains among the livestock farmers, by reason of the results he achieves and his information sessions with the farmers.

He must be above all competent but he must also be enthusiastic about the part he has to play in improvement of livestock and have faith in his work and his job.

It is hoped that men with agricultural school training will be obtained to fill these positions, as the insemination-castration technicians knowledge must go beyond acquaintance with the technique of artificial insemination. He is a teacher of stock-breeding and should be familiar with the problems of selection, feeding and hygiene, at least at basic levels.

I feel that a particular status should be considered for this important position, in which there can be no office hours, no fixed holidays and where personal action is preponderant. His status should involve special pay-rates which should constitute a genuine reward for his efforts and his results. His fixed monthly salary should be augmented by a system of bonuses for each cow inseminated and settled, and be calculated in accordance with increased activity.

These men will be trained in artificial insemination and castration by the cooperative effort of the professional veterinary staff and the USAID veterinarian at the theoretical and practical level but it is hoped that in the future some of the key people developed will receive additional training in the United States.

The junior staff at the National Artificial Insemination Center will have to include people in charge of operational maintenance, men to look after the animals, laboratory assistants to be trained to

prepare materials, look after instruments and generally do odd jobs in the lab and of course the indispensable secretarial staff to take care of documents, communications and filing.

B. Equipment

The list of equipment needed at the National Artificial Insemination Center for collection and preservation of semen and the insemination of cows must be drawn up by the Director, who is responsible, but should include most of the following:

Equipment for examining and testing bull semen for quality:

1. A good quality microscope with sterile glass slides and cover slips.
2. A Fuchs-Rosenthal Hemocytometer for spermatozoa counts.
3. Methylene Blue Semen test kit.
4. A Comparator Test Kit which uses so-called opacity standards.
5. Methylene Blue or Rose Bengal stains to make slides for checking semen for abnormal spermatozoa.

Equipment for Collection, Dilution and Storage of Semen:

1. Artificial vaginas.
2. Lubricant for preparation of artificial vagina.
3. Thermometer for taking the temperature of the artificial vagina.
4. Sterile test tubes, some graduated for semen collection.
5. Beakers, some graduated 100 cc. and 500 cc. sizes for preparing solutions.

6. Semen Diluters, preferably egg yolk citrate will be used.
7. Gummed labels for marking tubes and vials.
8. Semen dyes to identify breed by color.
9. Rubber stoppers for test tubes and vials.
10. Refrigerator.
11. Ice making machine.
12. Test tube racks.
13. A good Detergent product for washing equipment.
14. Physiological saline solution.
15. Distilled water.
16. Enamelled pans approximately 12 x 18 x 3-1/2 inches, some for washing equipment and holding it afterward, and others for use in making the semen quality test with methylene blue.
17. Forceps for removing equipment from boiling water or oven.
18. An electric water heater.
19. An electric drying oven.

Since spermatozoa are quickly killed or weakened by toxic substances, it is very important that all equipment be scrupulously cleaned, sterilized and kept sterile until needed.

In the longer-term thinking, the possibility of using frozen semen must be considered. Receptacles holding ten liters of liquid nitrogen and able to preserve 200 doses of semen, consuming one liter per day of nitrogen, are available in the United States. This type of equipment stores semen at  $-196^{\circ}$  C and the semen can be stored for several

years as long as this low temperature is maintained. This, as was mentioned before, only requires keeping the receptacles recharged with liquid nitrogen which can be done in Casablanca.

Equipment for the artificial insemination-castration technicians:

1. Syringes and inseminating pipettes (plastic disposable).
2. Equipment carrying case.
3. Plastic disposable gloves and sleeves.
4. Talcum powder in shaker can.
5. Rolls of absorbent cotton and paper towels.
6. Flashlights.
7. Coveralls and rubber boots.
8. Pail large enough to enable washing and disinfecting boots between farms or herds.
9. Ball-point pens for making out insemination forms.
10. Bardizzo castration clamps.
11. Obviously, all necessary transport vehicles should be included in equipment.

C. The Physical Facilities

The GCM, Veterinary and Livestock Service (Service de l' Elevage) already owns a farm of 147 hectares in the Casablanca area which would be ideal for the National Artificial Insemination Center.

It already possesses a physical plant designed and built by the French Government for artificial insemination just before Morocco gained independence. It has never been used and has been abandoned since its completion. It will require some modifications but is an ideal place for the creation and equipping of a National Artificial Insemination Center.

It consists of a mounting or collection room next to the space designed for the laboratory. Two rooms connect with the laboratory, one of which was probably designed as a storage and semen dispatch room and the other as an administrative section room.

There are a number of auxiliary buildings nearby including stables and buildings which could be put to use as feed storage, etc.

The availability of a physical plant for the start of an artificial insemination center thus appears ideal, as the branch of government which owns the property is also the logical branch to administrate the program.

#### D. Establishing a Record System

The records and reports kept by the National Artificial Insemination Center must allow the staff to register, control, and evaluate the activity of the Center and all its operations. It will be necessary to have the following forms:

- (1) Form for recording the collection of semen, with a registry of each bull; this form recorded on a daily basis will show all the information concerning the characteristics of the semen collected from any given bull on that day.
- (2) Semen dispatch form. This form shows the movement between the artificial insemination center and the various artificial insemination-castration technicians. It should bear reference to both the insemination form

which is to be mentioned next and to the previous document.

- (3) Insemination form. This form should make it possible to control all the activities of the artificial insemination-castration technicians. It should positively identify the cow which was inseminated by ear-tag number, owner, location, description by breed, color, etc. It should also positively identify which bull semen was used to inseminate the animal. It should be made out in duplicate and a copy given to the owner with instructions that the cow should be watched for signs of heat in 17 to 21 days thereafter. If she comes back to heat, she of course has not conceived and must be inseminated again.
- (4) Castration form. This form describes the animal castrated by an ear-tag number and is of course another source of data to control and evaluate both the technician and the program.
- (5) Monthly report form. This form should make it possible to establish month by month, bull and technician data showing results of conception by bull and by technician. This record is extremely important. It represents a graph of the activity and efficiency of the enterprise. It is on the basis of this information that the work of the bulls, of the inseminators and of the Center itself will be judged.

It is obvious that I have only mentioned the key documents which are absolutely essential. Other forms will, of course, be involved in reports, check slips, milage sheets, accounting, and inventory forms for materials, etc. required by any organization.

#### VI. Conclusions

Provided that it is used as a tool towards the implementation of an overall scientific program within the framework of a detailed and concerted action for the improvement of cattle raising, artificial insemination is a basic method for the application of the USAID assisted agricultural program in Morocco and has an excellent chance of permeating the countryside in the concentrated cattle areas in Morocco.

Not only is it an action with technical aims, but it is also one of the best methods of shaking hidebound traditions. From the point of view of farming methods, the growing of forage does the same and this program would complement the USAID assisted forage production program.

Artificial insemination should, therefore, be applied wherever it is likely to be welcome. However, we should not set our sights too high as regards rapid development. In fact, everything depends on the authority of those who are to implement the program, the coordination of different complementary programs and adoption of methods to local conditions.

There are three essential conditions for the use of artificial insemination in Morocco which cannot be stated too strongly:

- (i) Integration of the artificial insemination program with the

operation of the forage production program.

- (2) Implementation of a program for the castration of <sup>All</sup> ~~male~~ bulls.
- (3) Administration, planning, directing and implementing of the program must be done by professionally trained Doctors of Veterinary Medicine.

A reproduction section should definitely be established within the GCM, Veterinary and Livestock Service (Service de l'Elevage) which has no other duties except the artificial insemination program and its immediate ramifications.

During 1966 and 1967 it should be possible to perfect the organization, train the men, adapt working methods and organize channels of communication, all with a view to the effective creation and equipping of the National Artificial Insemination Center.

Obviously, success also depends on financial backing. In the present state of cattle raising, the financial situation and mentality of the Moroccan fellah, we cannot expect financial backing from the latter. The Government of Morocco with USAID assistance will, therefore, have to undertake all the financing of the artificial insemination program if it is to be successful. Funds will have to be earmarked in the budget for modification of the buildings at the proposed National Artificial Insemination Center at Casablanca, equipping it, working expenses, payment of personnel, training, traveling expenses of the staff, cost of publicity, etc., all of which will be required for the program recommended.

The consuming population and livestock producers of Morocco will eventually be greatly benefited by such a program, as there is no doubt that yields of meat, milk and other animal products will be considerably increased. Public health authorities have reported a group of two million people in Morocco who are said to be half-starved and suffering from a lack of calories and other nutrients. There has not been an ICNND nutritional survey done in Morocco and baseline nutritional data regarding the population is not available. There are no accurate food availability tables. However poor the public health statistics are in Morocco, it is fairly obvious that there are many mothers and children not getting sufficient nutrients.

## VII. Recommendations

### A. General

The organization and implementation of this plan will require the cooperation and coordination of activities of all branches of the GOM, Ministry of Agriculture if it is to be really successful. Since this plan if adopted will result in a veritable public reproduction service with all that the expression "public service" means, taking into account regularity of operations, constant activity and security for the user. A real overall artificial insemination program can only be thought of in these terms if it is to make a genuine contribution to the livestock farmer in return for the confidence we expect him to give us. It would be anticipated that careful planning will ensure this when the National Artificial Insemination Center is working.

In a country which is trying to organize itself and where cattle

selection is only beginning, regularity of bovine conception, and hence the regularity of calving, is more important economically than any other excessively zoo-technical consideration.

It would be anticipated that when the National Artificial Insemination Center is operating well and the staff have been trained, an initial spread of artificial insemination outside the Casablanca area may be accomplished merely by investing in personnel, transportation, and the setting up of small artificial insemination stations.

The methods which are adopted in this project will involve essentially technical and financial problems. Technical know-how must be exploited to the maximum. The methodology must be adapted first rationally to the area of the National Artificial Insemination Center and then extended to other areas on the basis of the sum of experience gained in the initial endeavor. The financial expenditures which the establishment of artificial insemination will demand must not be burdened at the outset by lack of coordination and programming.

The bulk of the funds made available must be concentrated on a single coherent and well-controlled line of action which is certain of survival.

The sense of responsibility of the professional veterinarian leaders who are to ensure the success of artificial insemination must be integrated with the responsibilities of those whose task it is to actually inseminate cows and castrate males.

In the training of personnel, there must be the communication of a high ideal of service, of enthusiasm and uniformity, so that there is a unity of viewpoint and ideas.

B. Choice of Method of Insemination

In all artificial insemination programs in the United States, the insemination of the cow is done by the rectovaginal method. The external genitalia are cleaned with soap and water. One hand of the inseminator is introduced into the rectum and grasps the cervix through the floor of the rectum. The other hand introduces a plastic disposable pipette 6 mm. in diameter and 40 cm. long into the vagina, through the cervix and into the body of the uterus where the semen is discharged. The hand within the rectum manipulates the cervix so the passage of the pipette is facilitated. The breeding efficiency of artificial insemination by this method compares favorably with that of natural service when attention is given to all the details of the process.

In Morocco much of the artificial insemination that has been done has been accomplished using the vaginal speculum method instead of rectal palpation; this does not allow deep penetration of the inseminating tube and the conception rate is consequently lower with this method. For this reason, I would strongly recommend that the rectovaginal method be used exclusively in this planned program.

It is obvious that artificial insemination must be carried out on cows which are properly restrained; this is one thing that will

not be a problem in Morocco as the cattle are very placid, due to the tremendous amount of human attention they receive from the time they are calves.

Castration of male calves would preferably be done by the bloodless castration "Burdizzo" method.

C. Spread of Knowledge

When it comes to artificial insemination, as in fact in all cases of knowledge, it is not enough to know, but to communicate what one knows.

All possible methods must therefore be used to disseminate the knowledge of livestock improvement using artificial insemination to those people who are in need of this enlightenment.

Publicity should be carried by direct contact, by leaflets, agricultural journals, lectures, radio talks, etc.

Information must be carried to the livestock farmer with every contact. There should be artificial insemination personnel scheduling as many meetings among cattle farmers as is possible to spread a better understanding of the artificial insemination program, how it works and what it can accomplish. The real grass-roots education will begin at the route stops where cows in heat, the artificial insemination technique, castration technique, etc. will actually be demonstrated on a daily basis.

Recruitment and training of promising young people should be a means of ensuring permanent contacts and of working toward further development as the artificial insemination program progresses.

The livestock farmer participants should be encouraged to raise better cattle by means of prizes or bonuses given in competitions for those who make the best use of artificial insemination in the initial stages and later prizes and awards for the best progeny of artificial insemination (both heifers and steers) at fairs, etc.

In the next few years, the greatest agricultural income in Morocco will undoubtedly continue to derive from grain and livestock. Morocco has good possibilities for increasing its cattle industry fairly soon. Animal production could expand at a much faster rate than is currently observed. Considerable capital is already invested in the nation's herds and flocks. A relatively small additional investment for improved cattle breeding practices, in conjunction with the forage improvement program already well underway, could yield rapid returns both in livestock fattening and dairying.