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DIPLOME D'ETUDES SUPERIEURES SPECIALISEES

PRODUCTIONS ANIMALES EN REGIONS CHAUDES

SYNTHESE BIBLIOGRAPHIQUE

MS

ARTIFICIAL INSEMINATION AND EMBRYO TRANSFER IN CATTLE WITHIN AFRICA

par

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année universitaire 1988-1989

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REVIEW OF RELATED LITERATURE

From historic background, mas has been puting a lot of efforts to improve on the method of reproduction of domesticated animals in different parts of the World. Based on written records (I.E.M.V.T. document on Artificial insemination) it seems as if the Arabs were the first (1332) to put into use the method of artificial insemination in the reproduction of mares. This happened at the begining of the XIV century when they were trying to improve on horse breeding.

In 1725, the biologist JACOBI, succeeded in carrying out the first scientific experiments to fertilise fish eggs through artificial insemination. His experiments were later repeated by his Italian friends Lazaro SPALLANZANI and Von HELZHEIM. During that period, the main reason to embark on artificial insemination was to find a solution to the problem of sterility in certain animals and also irradicate diseases transmitted through sexual intercourse (eg horse-pox and epididymitis vaginatis of mares; genital tuberculose, contagion vulvo-vaginal virosis, trichomonasis of cattle etc.)

As a matter of fact, Elie IVANOV, was the first researcher who applied the method

of artificial insemination to ameliorate certain genetic characters of animals. He based his work on the idea that, from one male ejaculation it is possible to subdivide (or dilute) the content and afterwards inseminate many females. This is due to the fact that a single ejaculat contains a lot of spermatozoa but to fertilise the ovule, a small quantity of sperms is sufficient (5% of the total sperms ejaculated).

In 1907 this same Russian, Elie IVANOV and his school colleagues published some results from their experiments on horses (39 inseminations gave 31 pregnant mares). Due to the communist system, this method of animal breeding got spread rapidly to other areas of U.S.S.R. Within the same year, 1200,000 cows were inseminated in six centres and 14 millions of goats in fourty-one centres respectively. Results from both cases showed more than 90% success. During the course of the tiventy years which followed, evidence of the use of artificial insemination appeared from other advanced countries in animal breeding (eg England, Argentina, Australia, U.S.A., Italy, France ... etc.) The results were so encouraging that other centres of animal

breeding accepted the method in view of improving their flocks and maximising profit.

Based on detailed studies, the french professor LETARD, published some of his experiences on the subject (Le Recueil de Médecine Vétérinaire 1935). He terminated his experiences with complimentary practical demonstrations during the "MAISONS ALFORT DAY" of 1937. Infact, he made emphacies on the use of artificial insemination in animal breeding in the years to come. In France, the application of this method of reproduction is limited to cattle breeding. The purpose is to improve on the beef and diary productions.

On the side of the tropical countries, the application of this method on the reproduction of animals was first realised in 1930 by the English Vétérinary officer, DR. ANDERSON. He carried out his insemination trials at the experimental station in KENYA. His main aim was to fight against genital contagious diseases in cattle. Within a period of six years (1935-'41) 1,500 cows were inseminated and the percentage success was very high (based on I.E.M.V.T. document on artificial insemination 1987).

In the case of Mozambique, the first exercise of artificial insemination was carried out in 1951. The event took place at the Chobela Experimental Station (Pinho MORGADO, 1951) but the method did not stimulate public interest until 1974 when an Animal Insemination Centre was inaugurated by the Government. There were 4,925 beef cattle inseminated and a proper Government controlled programme was put into effect by 1977. Laboratories and technical training fercilities were also re-instated.

For Cameroun, the veterinary inspector, MANSOUR used this method in the reproduction of the imported cattle from France (Montbelliard breed This breed was destined to develop the cattle flock in the ADAMAWA region.

In Indo-china, DR. VOTTOZ also used artificial insemination as a possible solution to fight against sterility in mares (1943-1946). He again used this technique to make-up for the insufficiency of stallions necessary for his breeding purposes.

Within these recent years, studies are being carried out between France (I.E.M.V.T.) and other french overseas territories so as to revive their Animal Breeding Centres. Weekly flights

were even effected to carry semens from France to these breeding centres. The result obtained encouraged the continuation of research in this domain. The good out come serves also as an insight to the progress this method may have in Animal Breeding; especially in the 3rd world countries where its application will be of tremendous benefit in the near future.

INTRODUCTION

Artificial Insemination (A.I.) and Embry Transfer (E.T.) are modern methods in animal reproduction which are relatively new in Africa and so their values and advantages are not yet fully realised. Therefore the application of these methods outside research/experimental stations still requires wide publicity.

The artificial insemination strictly defined, is simply to deposit the sperms into the reproductive tract (womb) of the female by using instruments (without sexual contact with the male). Normally, this brings about fertilization of the ovule and the the gestation of the females. The fusion of the two sexual gametes (sperm + ovule) generally takes place in the fallopian tube ($\frac{1}{3}$ the distance from the uterus

Embryo transplantation is simply the introduction of a normal embryo into the womb (near the uterine horns) of the recipient mother. The transfer is normally done when the embryo is at the BLASTO-CYST stage. The collected embryos should always be transplanted at a physiologic state/age which corresponds to that of the recipients. That is the age of the embryo is approximately the same to that of the estral cycle of the recipient mare

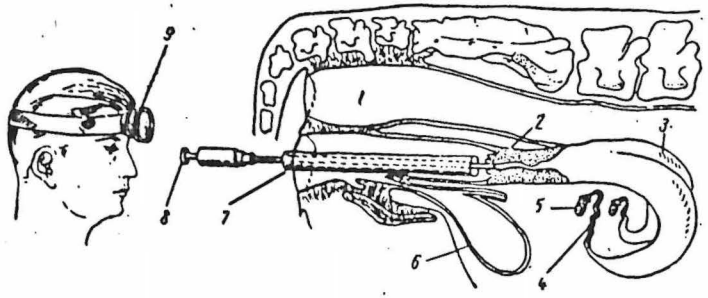
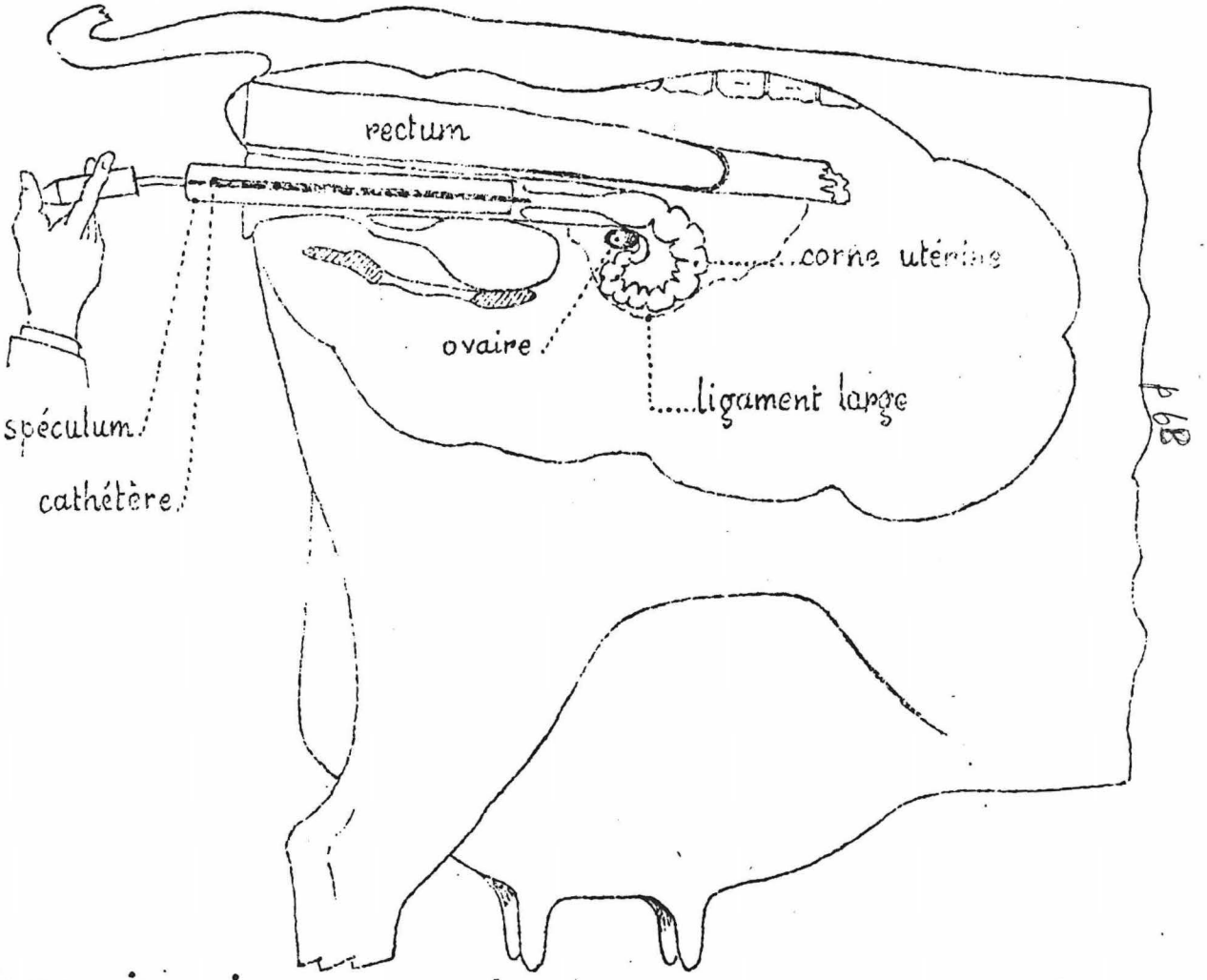


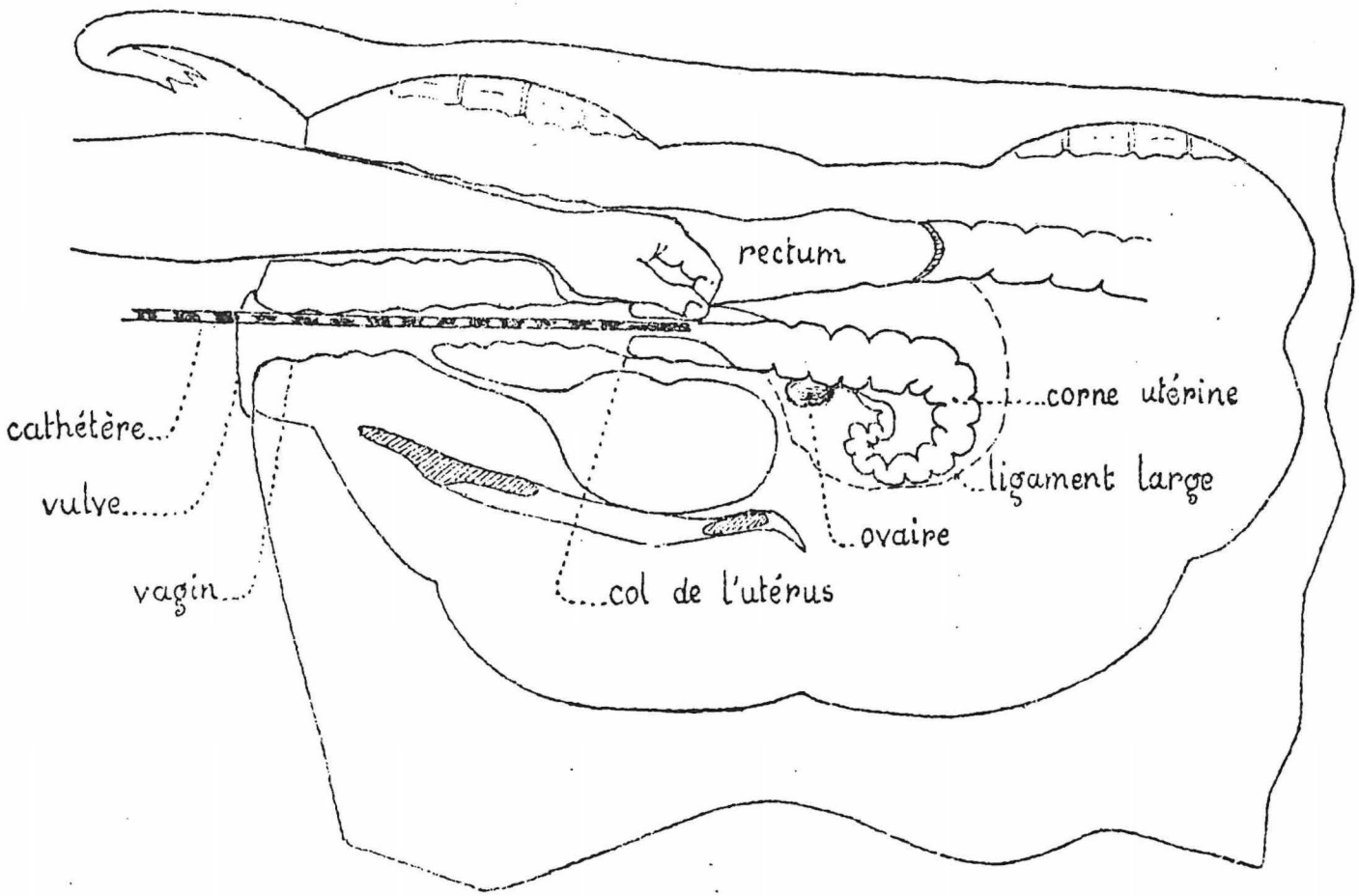
Fig. 97 : L'insémination artificielle chez la vache par méthode avec le speculum.



INSEMINATION CERVICALE _ METHODE CLAIRE

Day zero equals day of estrus. There are different methods of carrying out embryo transfer but the commonly used are either surgical or non-surgical. The surgical method involves an operation where in instruments and surgical knowlege are necessary (eg. mid-line flank approach). The non-surgical method (very recent) consist of sucking-up the embryo through a pasteur pipette (of 1.5mm diametre depending on size of embryo) and its deposition at the space inbetween the uterine horns (womb of the receiving cow).

The normal age to transfer an embryo is between 7 and 16 days after estrus but the most favourable days are located between the ages of 12 and 14 days. For the present time, the application of artificial insemination (in Africa) and embryo transfer is largely limited to cattle production. However, there are few exceptions (in countries along the mediterranean coast or where efforts are being made to preserve rare wildlife).



INSEMINATION UTERINE PROFONDE _ METHODE OBSCURE

The practice of artificial insemination varies according to the time in question, the level of developement of the country and the type of implements available to the breeders. No matter the method chosen for use, the process of insemination should be carried out with care.

There are two methods in use: the one defined as "clear" (ie CERVICAL INSEMINATION) and the other defined as "obscured" (ie DEEP UTERUS INSEMINATION). The process of artificial insemination compose of four aspects:

(i) the sperm collection (there are many ways)
(ii) the examination of the collected sperms
(iii) the dilution (and conservation) of the sperms
(iv) the re-establishment of the physiological temperature (40-42°C) for the actual insemination process.

THE SPERM COLLECTION

There are many ways of collecting the sperms from the male animal. The responses of different animals vary according to the

techniques or method applied during the sperm collection. This document is concerned mainly with the methods used in cattle breedi
The following are the methods commonly in use

(a) the artificial vagina (this instrument is applicable to all mammals).

(b) électro-ejaculation method (application mainly on goats, dogs and poultry birds).

(c) mechanical excitation, massage of the seminal vesicles and the epididymal canals of the bull.

(d) direct puncture method of the testicles.

Among all these methods, the most usual and frequently used is that of the artificial vagina This apparatus was first put into operation by MILOVANOV V. K. (1930–1931).

EXAMINATION OF THE SPERMS

Generally the sperms are found within a slippery liquid called semen and this has an odour characteristic of the dissolved protein substances. The examination is carried out using a microscope and the exercise

demandes precise techniques and biological knowledge. The mobility of the sperms is excellent at body temperature (38°c–40°c) but it reduces as the temperature increases and totally stops at 45°c upwards. On the other hand, the sperms are immobile at a temperature of 0°c downwards. The examination is based on the morphology and physiology of the sperms such that the following parameters can be known:

(a) density of the sperms
(b) sperm speed
(c) the PH of the semen
(d) the sperm count

The formula used to estimate the sperm concentration is similar to that used for white blood cells estimation (haematometric).

$$C = \frac{N \times D \times S \times I}{n}$$

C = concentration

N = number of spermatozoa counted in 80 small squares

n = number of small squares counted

D = dilution

S = area of the small square

I = depth of each square

The sperm concentration of an average bull is eight to ten hundred millions per millimetre (8.0×10^6 to 10×10^8/ml). A diluted ejaculat gives 500 to 1000 insemination doses (of Holstein breed) but 200-400 doses for African breeds (eg N'dama, Baoulé etc).

DILUTION OF THE SPERMS

The dilution is carried out by the addition of nutritive and protective substances conducive to the spermatozoa. The sperms are biological products highly sensitive to external conditions as such it is imperative to exercise maximum care throughout the collection and dilution processes. During the last 30-40 years, scientists have produced different media suitable for dilution and conservation of the sperms. Here are few examples of diluting media:

a) egg-yolk-citrate diluter
b) egg-yolk-gluco-citrate diluter
c) egg-yolk-phosphate diluter
d) fresh milk base diluter

Any of these media can be used to dilut the semen before artificial insemination.

12 The composition of one medium of the sperm diluter for cattle is as follows:

(eg. EGG-YOLK-CITRATE DILUTER)

a) distilled water - - - - - 100ml

b) dihydropenicilline - - - 500 UI/ml (ou 500 to 1000 UI/ml)

c) sodium citrate - - - - 2,9g

d) streptomycine - - - - - 500 UI/ml to 1000 UI/ml

e) fresh egg-yolk - - - 20ml/80 ml saline dilution

f) pH - - - - - - - - - - - - - - - - 6,7 — 6,8

In certain countries, the sperm diluter is chosen according to strict regulations for each species (BANE and BONADONNA, 1963). For instance, in Federal Germany the sperm of the bull can be diluted with a ratio of 1:1 or 1:6, in Sweden 1:2 in U.S.A. from 1:50 up to 1:100. But it is always advisable to dilute 1:1 for the first instance at 37°C. The final dilution could then be carried out twenty to thirty minutes later at the laboratory temperature of 18° — 20°C. The final dilution is made with glycerine poured into the semen 1:1 ratio with regards to the initial dilution. The whole content is now fit for storage

CONSERVATION

There are two possibilities for conservation, be it on short term bases or on long term basis. The sperms can be conserved directly in the diluted liquid form or frozen solid already diluted. The diluted liquid form is usually stored for short periods (2 days, 5 days or 7 days) at temperatures ranging from 16° to 22° (or between 0°c and -5°c). There are specific steps to follow if the semen is to be stored for a long time (frozen). The freezing temperatures can go down on to -50°c or -70°c when the containers of the semen can then be put into the liquid nitrogen (max = -196°c) for long term conservation.

INSEMINATION PROCEDURE

The female on heat period (naturally or by using injections) is contained into a metal palpitation chute. The genital parts are properly cleaned in a hygienic way likewise the implements to be used — syringe, speculum etc. The semen is deposited into the cervix in such a way that

that fertilisation is assured. The insemination can be carried out with a speculum or sometim without a speculum — ie using the Anglo-American style which uses a special pipette fitted with a syring to innoculate the sperms into the womb of the cow (described as recto-cervicale method)

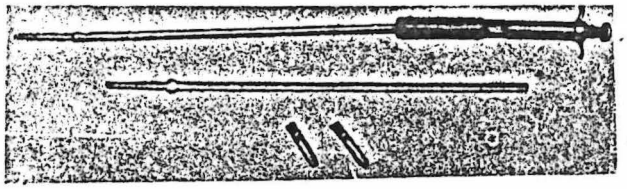


Fig. 89 : Seringue et sa pipette pour l'insémination artificielle de la vache.

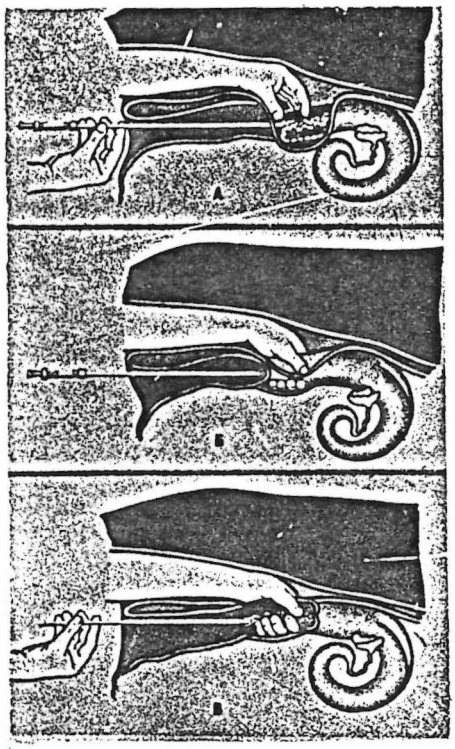


Fig. 96 : L'insémination artificielle par méthode anglo-américaine (recto-cervicale) chez la vache.

It is necessary to be tactful at work. For instance to inseminate when the cow is on heat, to be able to estimate the quantity of spermatozoa viable per dose and which type of technique to use.

15 METHODS OF EMBRYO TRANSFER

The transplantation of the embryo (or transfer of the fertilised ovum) from one cow to the recipient is one of the modern methods of artificial reproduction. This method gained momentum from the early 1970s and has made tremendous progress due to its scientific support and the commercial pressure on Animal Breeders.

Based on K.J. Betteridge et al., the process of embryo transfer involves distinct stages which require a certain level of competence. The stages are (i) superovulation and insemination of the donor animal, (ii) the embryo collection (surgical or non-surgical approaches and (iii) the actual transfer of the embryo into the uterus of the recipient mare (single or twins).

(i) Superovulation and insemination: this stage involves the use of different intramuscular injections administered on the two animals (donor and recipient of the embryo) in specific days of their menstrual cycles. The

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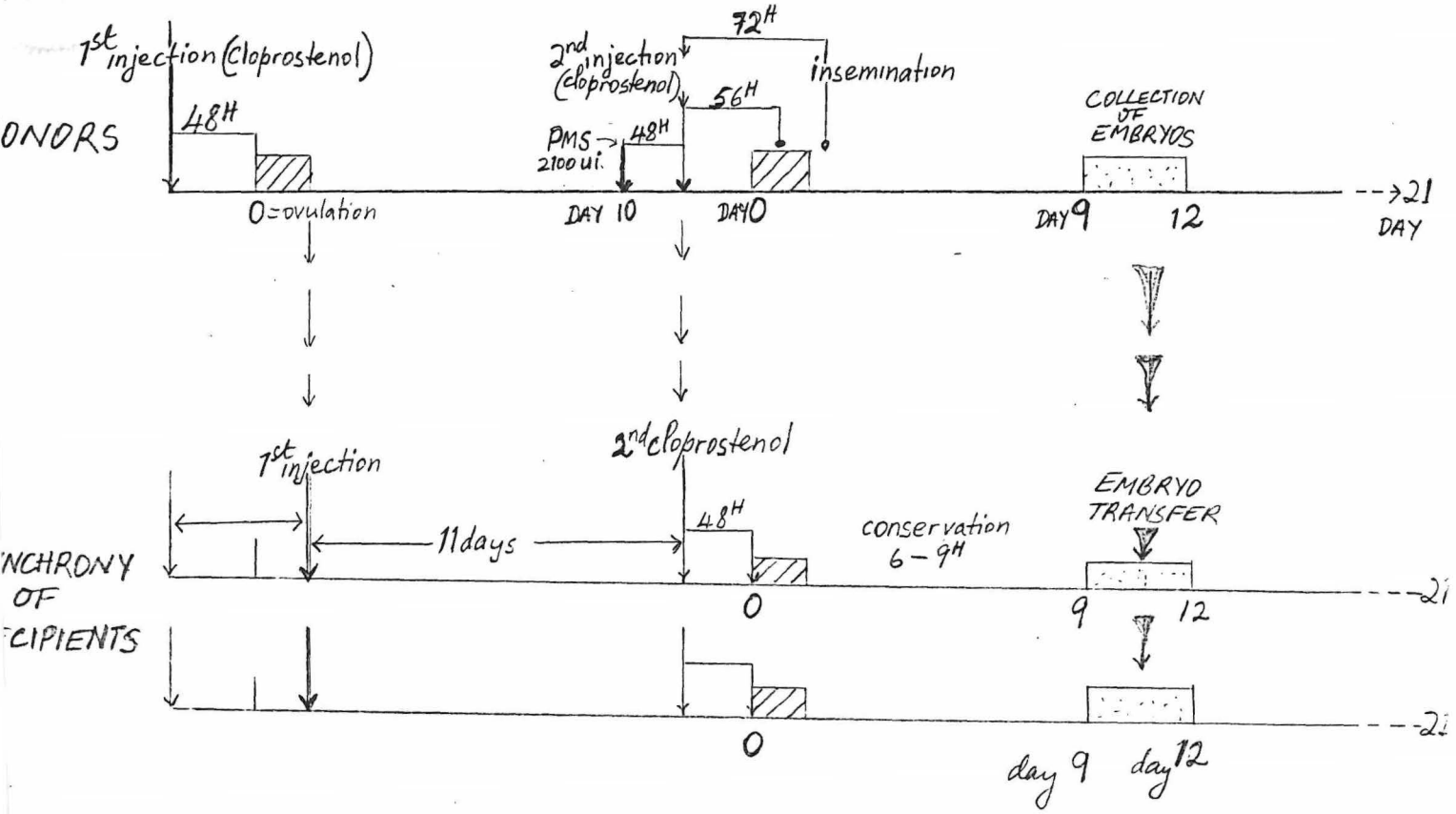
order of the procedure is explained in the table below; knowing that the cow has a menstrual cycle of approximately 21 days.



(Based on the Research center I.N.R.A. of Jouy-en-Josas
Le Progrès de LYON 14-9-77)

(ii) Embryo collection: this stage can be effected by using 3 different methods — by the surgical method; or the non-surgical method (ie flushing method); or by the slaughter house method. The

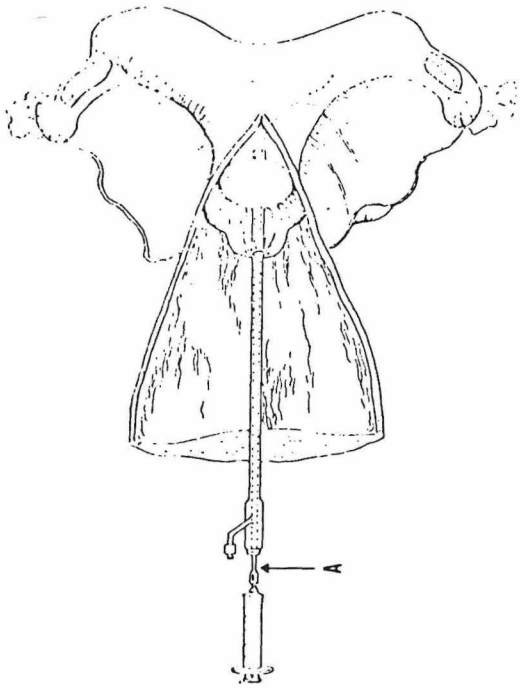


Figure 1. Diagrammatic representation of uterine secretion collection device in position in the uterus. The inner catheter (A) is depicted in the extended position.

J. Anim. Sc Alberta livestock Transplant
(Vol. 47, 1978, p. 673)

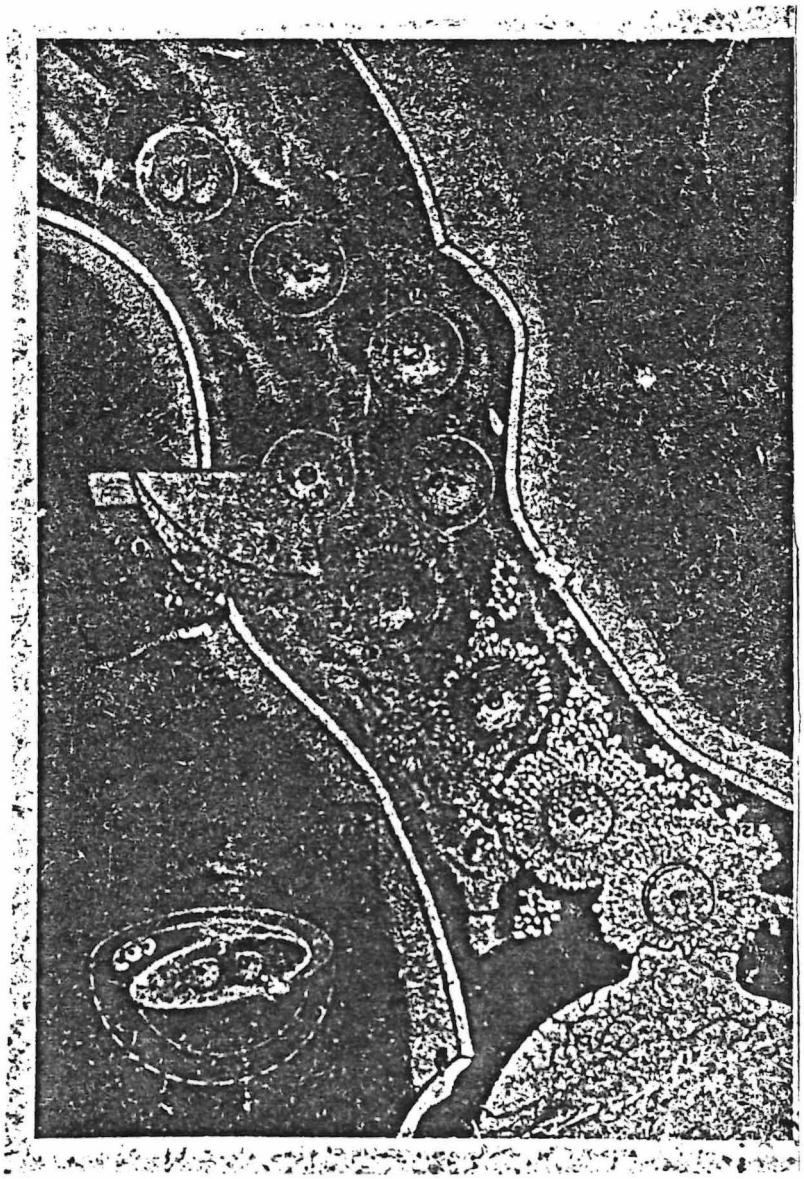


Fig. 51 : Division et la migration de l'oeuf.

1) le stade des 2 blastomères
2) le stade des 4 blastomères
3, 4, 6, 7) les stades des 6; 8, 16 et blastomères
9, 10) la morula
11) le blastocyte
12) le bouton embryonnaire
13) la cavité de blastocyte - blastocoele)
8) l'oeuf avançant dans l'oviducte.

(D'après I.I. SOKOLOVSKAYA, 1971).

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non-surgical method (flushing) uses certain liquids as media. The well known media for embryo collection are: TCM-199, Gibco of Betteridge and Mitchell 1974; PB-1 of Wittingham 1971 etc. The Foley catheter (3-way) is commonly used for the collection but the recent model of Neustandt/ Aïsch (2-way) catheter is prefered by many many (Fed. Rep. Germany). Details of the procedure of flushing are described in the document of INTERNATIONAL EMBRYO MOVEMENT SYMPOSIUM of Montreal 1987.

(iii) <u>Transfer of the embryo into the uterus</u>:- this is done in two ways; the surgical way and the non-surgical way. With the non-surgical way, the transfer is done with the use of a Pasteur pipette (of 1.5mm diameter) and a flushing liquid. Single embryos are transplanted with the use TCM-199 medium and placed in-between the space of the uterin horns inside the womb. Twins, embryos are placed at the base of each horn inside the womb and the PB-1 medium is found to be very suitable.

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The surgical method is carried out with the use of anaesthetics (flank and midline approach, as described by K.J. Betteridge et al.

Majority of the nuniparous species are treated with gonadotrophins (PMSG) and prostagladin (equivalent of cloprostenol or estrumate) to provoke superovulation and increase the quantity of embryos needed. The recipient mare is put into synchrony in accordance with the oestral cycle of the donor. In most cases, embryos with the age of 7 days are frozen for storage because they are more reliable for various micromanipulations (article on 33rd World Vet. Congress, Montreal 1987).

Pregnancies have resulted from embryos transplanted with ages up to 16 days but no pregnancy from embryos of 17 days old. Thus indicating the limit by which an embryo can be transplanted to prevent luteolysis (based on J. Reprod. Fert - 1980)

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THE LIMITS AND INTERESTS OF ARTIFICIAL INSEMINATION AND EMBRYO TRANSPLANTATION IN CATTLE WITHIN AFRICA.

In reality, Africa is such a big and varied continent that it requires different techniques and approaches inorder to cope up with the problems of development; particularly in the agricultural sector. The lives of individuals in any region largely depend on their agric cultural activities and part of these activities come from animal husbandry. Therefore the development of livestock, in all forms, becomes very important. As such the use of modern methods like Artificial Insemination (A.I.) and Embryo Trainsfer (E.T.) have an important role to play in animal production — not only for the commercial benefits to herders but also to the well-being of the general public.

The Real Situation of Cattle Production

This information is to give a general view on the various components of herding

systems in Africa.

The livestock production in Africa with relation to the development of capitalism, cultural practices, terror of disease and government policies; has become an affair complex and difficult to handle. The problems hampering animal breeding are many and in most cases they are characteristic of each region — with regards to their tradition.

The surface area of Africa is 30 millions square kilometres. 12 millions km^2 of this area is a desert; 3 millions km^2 represent the forest and 15 millions km^2 represent the savanna and drakensberg: of which 8 million square kilometers not infested with the trypanosome vectors (glossin fly) holds 140 millions of cattle heads. The remaining area of 7 million square kilometres is infested with glossin flies and so contains just 20 millions of cattle heads.

The sanitary conditions (health) of a large area of the continent, are very

poor or not under proper control as such several efforts have been made to fight cattle diseases eg. the Rinderpest (George TACHER, Afrique Agriculture No 153). Consequently, livestock has not been very profitable to the local individuals.

The animal productivity is low compare to their temperate counterparts. Some traditionalis (as breeders) consider their flocks as a symbol of property or honour, not purely on commercial purposes. Thus the first pregnancy of heifers is usually at the age of 4 years and the intervals between deliveries (caloing) is between 18 and 24 months.

Apart from the zonal and seasonal factors (eg droughts ...etc); the lack of useful information to breeders, strict land tenure systems (grazing land unavailability to foreign tribes) and the desprat need for appropriate drugs in case of diseas out-break, render the situation of cattle breeding very hazardous and discouraging. This explains why majority

of private herders are either transhuman pasturalists or nomads. On the other hand those who are sedentary embark on small-hold cattle.

Project controlled centres and Government Research Stations appear to be the only sites at present, where breeding activities are making some progress. This is because these centres receive the necessary financial support (Govt. or International Agencies like FAO, UNDP IFAAD .. etc.), have the qualified technical staff, essential equipments and these centres can maintain the basic sanitary and nutritional standards.

LIMITING FACTORS

The first limiting factor in the application of A.I. and E.T. is the mastery of the various techniques involved. The success of any programme dipends on good training and pratical experiences of the staff. There are

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very few centres of Insemination or Government Research Stations (in Africa) which have the privilege of employing qualified staff. The staffs cannot serve to their full capabilities due to bureaucratic limits, let alone to satisfy the demands of provincial regions. The personnel who are capable of using this methode of A.I. are not enough so the applicatio is limited just to the centres and their surrounding

The readiness of the Inseminator and the availability of a reliable sperm bank, at all times, is another limiting factor. The Inseminator should be employed at full time and be given basic transport with proper means of carrying quality sperms to the place of insemination. He should be able to do the insemination at the correct time (ie heat period of the mares).

Another factor is the difficulty in detecting the oestrus of certain races of cattle in the tropical regions (eg tropical Zebu; based on experiments of ANDERSON 1944). This means the application of A.I. is

mostly limited to cows with distinct signs of oestrus. Cows with uncertain heat periods give poor insemination results and so this will make the breeders loose confidence on the A.I. method. Once there is no confidence, the A.I. programme will be rejected. So natural application of A.I. cannot be general.

It is also clear that the A.I. and E.T. methods tend to be limited to the over-use (or over-circulation) of the selected races (sperms or embryos) for the breeding purpose. In case of discas-outbreak, this can lead on to catastrophic effects on the new generations (descendant hybrids). Normally, reproduction based on selected character is often complimentary to the absence of certain qualities (genes). Pinho Morgado (1953-54) found out that good meat producing cattle lack the quality of walking long distances per day. Thus the A.I. eliminates the possibility of possessing many qualities per hybride — hence the best bull is selected for its sperms or the best reproductor is selected for calving.

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With the use of A.I. or E.T. methods, there is always the possibility of introducing new diseases (due to operation errors/contermination) or propagating the same anomalies of animals in a region. The general side effects can prevent achieving the objectives of the breeder.

The A.I and E.T. programmes are generally costly (vis-à-vis training, equipments, semen ... etc.) at the initial stage and so not all private breeders are able to use these methods.

INTERESTS

The interests on the application of A.I. and E.T. in Animal Husbandry cover far and wide areas in the development of African livestock. It is clear that majority of the African population is malnurished partly due to the insufficience of certain mineral salts and proteins in the daily meals. These essential nutrients could as well be secured by adequate consumption of meat and milk of domesticated animals (eg. Cattle).

As such the use of A.I. and E.T. in animal

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production will not only be of interest to the breeders but will also supply the nutritional needs of the under-nourished population. Therefore it will be advisable to apply A.I. and E.T. methods at all levels of animal production (rural or research stations).

Abundance of hygienic meat in controlled Butcher's shops will reduce the health risks taken by local people who consume carcasses of wild animals in the forests (death due to diverse factors eg. rodenticides used against agoutic; Capricon-55 use against birds ... etc) because of meat shortage.

Generally a healthy bull could mate with a maximum of 20-30 mares (eg tropical Nilama) but with the A.I. method, the same bull can produce about 200-300 viable doses of sperms for insemination. These two methods (A.I. + E.T.) make it possible for the breeders to be able to determine precisely the quality of breed they want to raise (eg. Animals for Power-traction). Animal breeds for power-traction can easily solve the problems of the expensive tractors in the African communal farms — the machines are very expensive, consume imported fuel, spare

28 about possible reproduction between animals otherwise considered morphologically incompatible. The reproduction potentials of males could now be prolonged considerably, even if they are physically unfit to effect sexual activities (eg. conserved sperms of slaughtered bulls).

The use of A.I. and E.T. in reproduction play a prophylactic role in the fight against disease transmitted through sex.

On the whole, artificial insemination and embryo transplantation are the latest methods in Animal Breeding which any developing country should not afford to neglect because the benefits and advantages are very great.

TABLEAU I. Performances de reproduction de différentes races bovines d'Afrique de l'Ouest

Type d'élevage	Age au premier vêlage (mois)	Intervalle vêlage-vêlage (mois)	Références
N'dama Elevage traditionnel	48	18-24	8
N'dama Elevage amélioré	35-39	14-15	8
Baoulé Elevage traditionnel	48	18-24	8
Baoulé Elevage amélioré	26-35	12-13	8
Zébu peulh Mali Elevage traditionnel	49,5	22	9
Zébu gobra Sénégal Elevage amélioré	36-48	11-17	10

millions de Km^2 où il n'y a pas de glossine mais où les pâturages sont limités et hébergent 140 millions de têtes, soit 17,5 têtes par Km^2; 7 millions de Km^2 à fort potentiel pastoral mais infestés par les glossines, où vivent 20 millions de têtes, soit 2,5 tetes au Km^2 (7). La pathologie n'est pas maîtrisés au niveau du continent, comme le montre, entre autre, le lancement imminent du programme panafricain contre la peste

ANNEXE 1

Situation de l'insémination artificielle chez les vaches dans le monde.

Tableau 23

Pays	Nombre des vaches inséminées	% du cheptel bovin
Union Soviétique	23.000.000	61
Etats-Unis d'Amérique	7.930.000	20
France	7.500.000	63
Pologne	4.000.000	66
R.D.A.	3.500.000	67
R F.A.	3.000.000	47
Angleterre	2.500.000	56
Inde	2.340.000	1
Italie	1.890.000	28
Tchéçoslovaquie	1.880.000	88
Danemark	1.500.000	98
Japon	1.380.000	95
Hollande	1.230.000	62
Roumanie	1.110.000	30
Cuba	1.060.000	50
Canada	1.030.000	19
Australie	1.000.000	15
Finlande	176.000	16,5
Irlande (1954)	178.000	14
Yougoslavie (1954)	70.000	-
Norvège (1955)	70.000	12
Suède (1955)	406.000	28
Suisse (1954)	7.000	0,8
Israël (1954)	-	60
Turquie (1951)	7.276	-
Algérie (1951)	3.049	-
Kenya (1950)	1.333	-
Afrique du Sud (1951)	11.007	-
Argentine (1952/53)	150.000 - 300.000	-
Brésil	25.392	-

D'après MILOVANOV (1962), SOKOLOVSKAYA (1971), BANE et BONADONNA (1963).

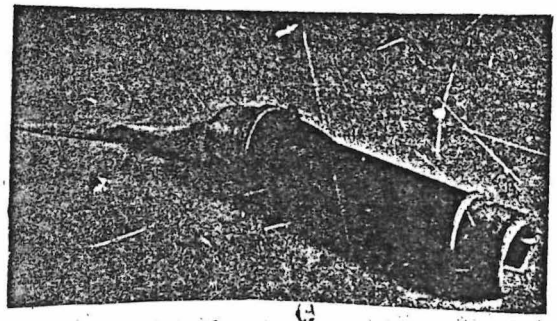


Fig. 74 : Vagin artificiel pour taureau (D'après DERIVEAUX, 1958)

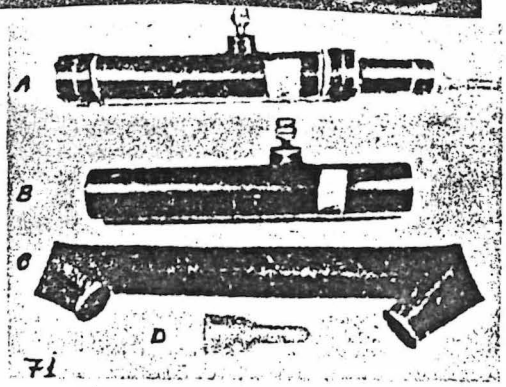
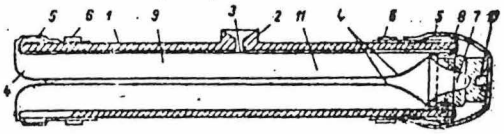


Fig. 71 : Vagin artificiel pour taureau.

A- vagin déjà préparé
B- tube vaginal
C- chemise vaginale
D- collecteur

(D'après BANE et BONADONNA, 1963).



70

Fig. 70 : Section du vagin artificiel pour taureau.

1- tube vaginal; 2- orifice à filet pour introduire l'eau; 3- soupape; 4- chemise vaginale; 5-6- anneau en caoutchouc; 7- collecteur; 8- fixateur du collecteur; 9 et 11- l'eau d'entre le tube et la chemise; 10- l'eau d'entre les parois doubles du collecteur.

Fig. 78 : La position en cours de la récolte du sperme.

A- normale; B- anormale, le taureau présentant l'impotentia coeundi. (D'après BANE, 1954).

ANNEXE

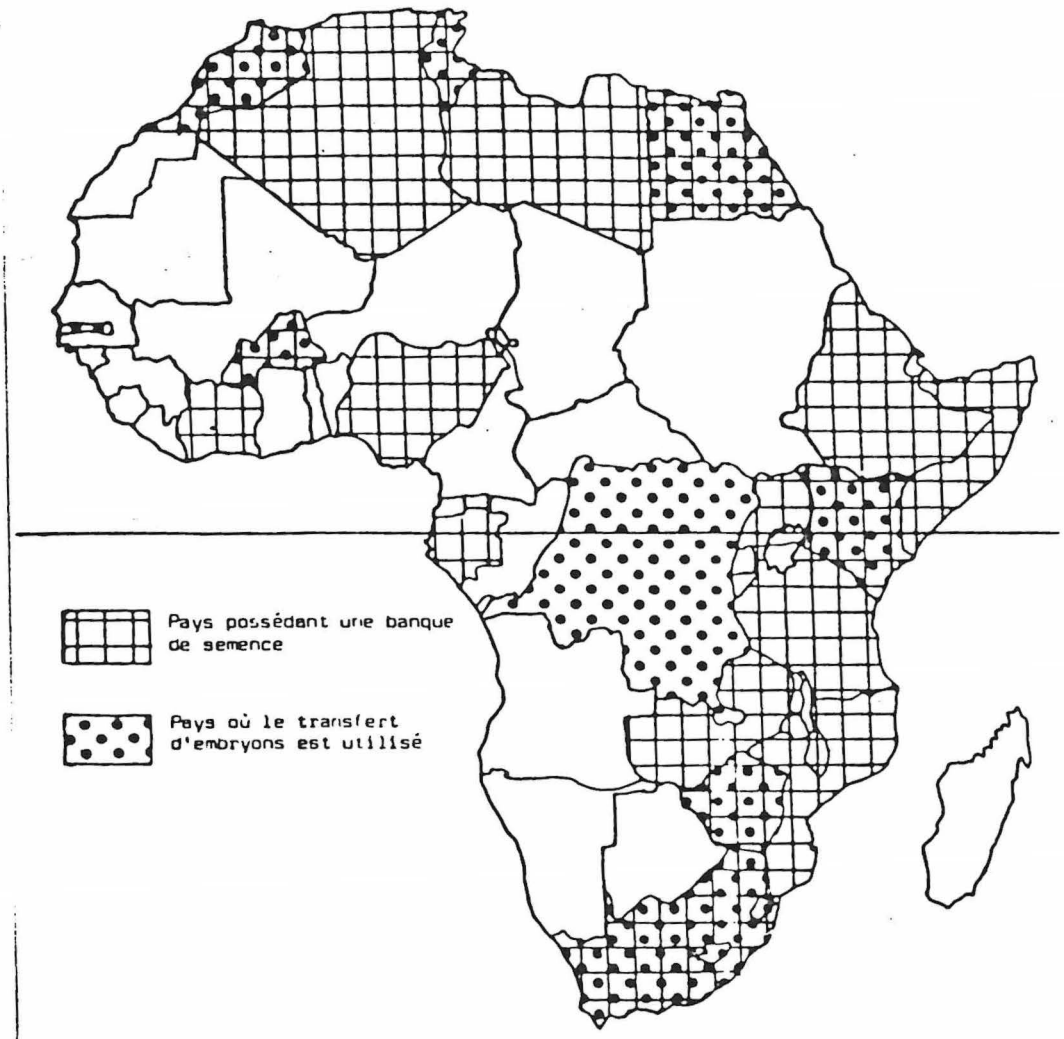


FIGURE 1: Implantation de l'insémination artificielle et du transfert d'embryons en Afrique (3, 4)

ANNEXE

Tableau n°5 - Distribution des bovins N'Dama

Pays/Région	Nombre de bovins N'Dama	Proportion de N'Dama dans le cheptel bovin national (p.100)	Pourcentage par rapport à l'effectif N'Dama total (p.100)
AIRE TRADITIONNELLE DES N'DAMA			
Guinée	1 154 000	95	33,7
Sénégal	746 000	57	21,8
Mali	465 000	26	13,6
Gambie	296 000	100	8,7
Sierra Leone	207 000	100	6,1
Guinée-Bissau	166 000	100	4,9
Côte-d'Ivoire	70 000	14	2,0
Libéria	11 000	41	0,3
Total	3 115 000		91,1
ZONES D'INTRODUCTION ET D'AUGMENTATION MINEURE			
Ghana	17 000		
Nigéria	15 000		
Gabon	2 000		
Cameroun	1 000		
R.C.A.	1 000	2	1,0
Togo	1 000		
Bénin	1 000		
Burkina-Faso	1 000		
ZONES D'INTRODUCTION ET D'AUGMENTATION MAJEURE			
Zaïre	240 000	79	7,0
Congo	33 000	75	0,9
Total	3 427 000		

Source ILCA, 1979

ANNEXE

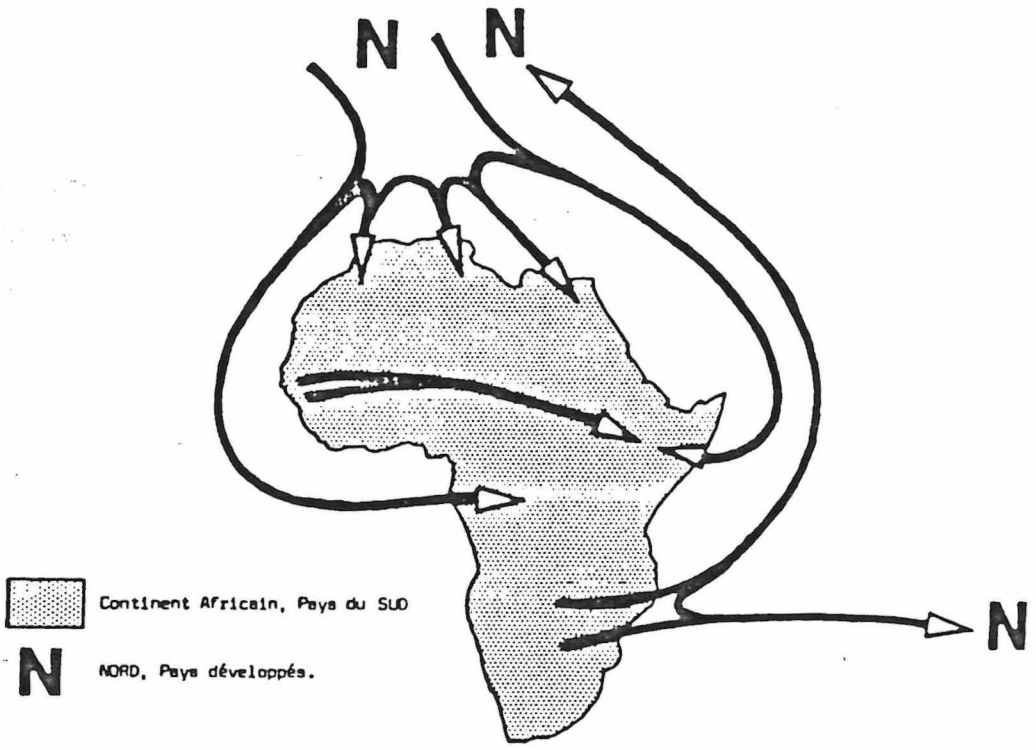


FIGURE 3: Mouvements d'embryons en Afrique (4; 12; Thibier, communication personnelle)

ANNEXE

Le coût de production d'un veau trypanotolerant par T.E. serait de 1500 à 2000 dollars US. (1$ = 300 F CFA) en station alors que l'adulte transporté coûte de 1750 à 2000 dollars U.S.
(D'après même document JAN. 1988).

TABLEAU III. Réponse ovarienne à un traitement de superovulation

Pays	Hormone	Race	Nb. de donneuses	CJ/ donneuse	Références
Tunisie	PMSG	Frisonne	18	4,7	17
Tunisie	FSH	Frisonne	18	8,2	17
Gambie	PMSG	N'dama	14	4,4-4,9	12
Gambie	FSH	N'dama	10	2,0-2,7	12
Burkina Faso	PMSG	Baoulé	17	5,4	11
France	PMSG	Diverses	1129	7,76	18

TABLEAU IV. Taux de collecte et qualité des embryons

Race	Taux de collecte	% non fécondés	% dégénérés	% trans-férables	Références
Frisonne	31	52		48	17
Baoulé	40	33	58	9	11
N'dama	69	52	4	44	12

Son introduction ne présente pas de risque sanitaire (24), ce qui est fondamental pour un pays qui a su obtenir et maintenir un cheptel sain. A ce titre, il peut constituer le seul matériel génétique exportable d'une zone incertaine au point de vue sanitaire.

L'environnement peut être hostile à un individu sélectionné, importé

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