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Genetic Improvement in Cattle Through Artificial Insemination and Artificial Insemination at Fixed Time

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Abstract

The livestock sector seeks to improve the productivity of meat, milk and rusticity, through crosses, which has led to deterioration of racial lines, impact on the decline in quality and quantity of production, and directly influencing profitability. Currently the biotechnological advances propose to improve the production levels of a cattle company, based on the practice of Artificial Insemination (IA) and Artificial Insemination at Fixed Time (IATF) managing and introducing genetic improvement, practices that increase the productive and reproductive value of cattle to compete in the local, national and international market. The IA and the IATF, have the time of the process of insemination, the IA, is managed to detect zeal and the IATF must be taken into account the hours of the application of the hormones for the insemination in exact times, these two methods are handled with the use of a proven and proven semen of highly productive animals for meat and / or milk. For IATF protocols have been available for estrous synchronization based on: "those using combinations of GnRH and prostaglandin F2α (PGF), called Ovsynch protocols and those using devices with known progesterone (P4) and estradiol as the control of follicular development" division raised by Saldarriaga [1] In this review, we intend to recognize the importance of the application of IA-IATF biotechnologies in livestock production systems to contribute to the genetic improvement of the bovine breeds.

Keywords: Artificial insemination; Artificial insemination at fixed time; Genetic improvement

Abbreviations: IA: Artificial Insemination; IATF: Artificial Insemination at Fixed Time; IEP: Intervals Between Deliveries; GMP: Good Livestock Practices; PEGA: Plan of the Colombian Livestock; DEL: Days of Lactation; DP: Dual Purpose

Introduction

Biotechnologies such as Artificial Insemination (AI) and Fixed Time Artificial Insemination (IATF) have been designed for its applicability in the livestock sector, mainly for genetic improvement. Over time the genetic and racial identity of cattle has been lost thanks to the crossings between animals, in search of greater benefits for the sector, in terms of productivity, rusticity and adaptability for different regions, reaching to form multiracial animals, which has been designated as a mestizo race, in which deteriorated the productive characteristics mainly of milk.

AI, through the use of semen from highly productive bulls, highlights the characteristics of the father, which have been evaluated in several generations, whether in milk production and/or meat production [2]. The introduction of this semen in the reproductive system of the female, with racial characteristics already lost and with an average productive level, concludes in a gestation that will be developed with the best characteristics of its parents, which will be reflected in time with new crossing and providing greater productivity.

The practice of AI, is handled directly with the detection of heat and with the AM-PM and PM-AM system, the cows that are seen in estrus in the morning, must be inseminated during the afternoon of the same day, and the cows seen in heat in the afternoon, should be inseminated after dawn the next day [3], which does not accurately determine a pregnancy since variations in the estrous cycle of each female, the environment and management may occur.

The technique of AI, according to the experiences have been improved over time, to avoid economic losses and decrease the intervals between deliveries (IEP) in the herds, through the IATF method, which consists of the synchronization of the estrus of the female with the application of hormones, respecting the hours and time of the different protocols. Within the current biotechnological proposals and through this review, we intend to document the importance of the application of biotechnologies IA-IATF, in livestock production systems to contribute to genetic improvement.

Generalities

Definition of the problem: The management of livestock through time has developed in cattle the combination of several breeds among them, thanks to the approach of the crossings between Bos taurus (dairy breeds) and Bos indicus (zebu, as meat producers) in search of a double-purpose production system, of rusticity and adaptation to the environment, losing genetics among racial lines and their productive potentials in terms of meat, milk and hatchlings per year, affecting the livestock producer sector at levels of quality and quantity, which directly influences the profitability and economic losses for farmers by production costs of raising and keeping animals in their livestock enterprises.

Researches by Saldarriaga [1], indicate that "in Colombia the use of artificial insemination is only implemented in 20% of the productive systems dedicated to livestock, the rest of the systems uses the multitool system or also called natural mountain". Currently the practice of IA-IATF is taking place by large producers, mainly by the level of acquisition of biotechnological proposals and commercial and productive demands, which intervenes to ensure the productivity of quality beef and milk from genetic improvement, directly influencing the competitiveness of the sector.

The lack of information and dissemination of these practices to small producers has limited the productive level of the livestock sector, mainly due to ignorance of the cost-benefit relationship, which directly affects the continuity of production and reproduction in a traditional way, leading to the commercialization of low quality products, longer production time and low profitability.

General objective: Document the applicability of biotechnologies such as IA-IATF in livestock production systems to contribute to the genetic improvement of bovine breeds.

Specific objectives:

a. Characterize AI - IATF, as a fundamental component in the genetic improvement of cattle production.

b. Review the IA-IATF techniques for genetic improvement.

c. Provide updated information on the costs of IA-IATF as an investment in genetic improvement.

Justification: The development of reproductive biotechnology involves the genetic improvement to rescue the productive potentials through the AI and the IATF which affects to improve the genetics from the reproduction and its production by means of the management of the estral cycle of the cow, guaranteeing one child per year and thus rescue the productive characteristics over time, from generation to generation with the use of superior reproducers through semen from interracial crosses and genetic selection [4].

Development

Genetic Improvement: Currently, genetic improvement programs have developed biotechnological strategies such as AI and IATF for obtaining dual purpose animals (production of meat and milk) from interracial crosses and genetic selection. Carvajal & Kerr [4], affirm through studies that "the composition of milk is regulated by several factors being one of the most important genetics" and for beef cattle in terms of weight gain through the AI, precise crosses can be made to provide growth and musculature rate to the offspring with the use of the selected semen, generating an animal for the market, produced in a profitable manner.

In genetic studies, it has been established as the main management the identification of the best animals, which should be selected and used as the parents of the next generation, sharing the opinion of Uribe [5] who states "Artificial insemination plays a role preponderant in the dissemination of desirable genes in a population. " It should be noted that genetics and the principle of improvement is based mainly on production: "PRODUCTION = GENOTYPE + ENVIRONMENT" [6], the which should be taken into account for its application and implementation in livestock enterprises according to their production system (meat, milk, dual purpose) to improve and compete in the productive sector.

It is also important to highlight that genetic improvement practices are directly related to management (Good Livestock Practices-BPG), status of females and management tasks through the management of records, which may have a favorable or unfavorable impact at the time of conception after the application of the IA-IATF and the profitability of the results.

Good Livestock Practices (GMP): The BPG constitute a "guide of technical recommendations" applied in the cattle systems in order to guarantee the innocuousness of the production (meat and/or milk). According to the definitions of Gambini [7], categorizes the BPG into three principles or objectives: "hygiene and food safety, care for the environment and ensure the safety and health of people (consumers and workers)", this concept is addressed mainly to the commercialization and profitability of the livestock sector. It should be noted that the management and applicability of these techniques directly contribute to animal welfare and health, improving physiological, metabolic and stress conditions, which have an impact on production and reproduction (Table 1).

Table 1: Correlation between scales 1 to 5 and 1 to 9 for CC.

Scale	Degrees								
1 a 5	1	1.5	2	2.5	3	3.5	4	4.5	5
1 a 9	1	2	3	4	5	6	7	8	9

Source: Bavera and Peñafort [8].

Factors affecting fertility in females

a. Body condition (CC): according to the definitions of Bavera and Peñafort [8] "the corporal condition is assimilated to the one of corporal state, that is to say, to the level of corporal reserves that the animal has to cover the requirements of maintenance and production", indicating the nutritional and health status of the animal, which is measured by scales of 1 to 5 or 1 a 9 according to the definitions of the producer and/

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or veterinarian, these two scales handle the same evaluation criteria in the animal, where 1 is characterized as being too skinny or caquexic and 5 or 9 for being an obese or fat animal. In both levels fertility is nil or limited since its reproductive and endocrine (hormonal) system is not able to manage the estrous cycle, attend to a pregnancy and/or maintain an adequate level of production.

b. Heat stress: "These are the metabolic problems caused by the increase in body temperature of the animal generated by the combination of ambient temperature and relative humidity" [9]. This condition affects consumption, physical activity, milk production, estrous cycle and reproduction in cows. Caraviello [10], states that "an increase in body temperature at the time of insemination leads to low fertilization and high incidence of embryonic death, because the viability of the oocyte, sperm and embryo are compromised."

c. Nutrition: directly affects physiological and reproductive aspects in females mainly in a productive state; "The amount of food ingested, and the source of energy affect the variables of the estrous cycle, such as duration, follicular wave patterns, size of ovarian structures and circulating concentrations of steroid hormones "[11]. Energy and mineral nutrients such as selenium, cobalt, phosphorus, iron, copper and iodine are directly related to the reproductive system and their deficiencies affect the hormonal concentrations involved in the estrous cycle

Records management: The livestock production in these times is determined as a company, in which the producer must manage data and information collected permanently from the production of his livestock, thus allowing a financial analysis to establish the profitability of the investment. According to Donato [12], the livestock company establishes as a production unit land, where it is important to determine what was the production of meat and/or milk per hectare/year to evaluate the profitability of it. The most important information to take into account in a livestock production:

a. Presentation of jealousy.

b. Application of the AI.

c. Births.

d. Milk production.

e. Weight gain.

f. Reproductive indicators and reproductive control (palpations).

The management of records and their evaluation not only demonstrate the state of losses or profits of the livestock company, but also provides criteria to make changes and thus project the future of the operation.

Reproductive indicators: From the reproductive records, the different situations found in each one of the females should be evaluated, which will indicate the selection, application of treatments or discarding of them, such as:

a. Open days (DA): The open days of the cows include the time between the birth and the time when the female becomes pregnant again [12].

b. Interval between delivery (IEP): It is the time that elapses between two births [12].

c. First birth interval estrus/service: It is the number of days that pass between the last birth and the presentation of heat, ideal time for artificial insemination or the first service when it comes to natural mountain [12].

d. Birth rate: Donato [12], conceptualizes the parameter towards the practice of the AI, and establishes it, by dividing the number of births among the total of suitable and synchronized females for reproduction that make up the livestock enterprise.

e. Index of no return: they indicate the percentage of cows that do not repeat estrus or that do not repeat service in a given period [13].

Genetic heritage in Colombia

Developing countries such as Colombia present stagnation at the biotechnological level due to the low investment of the rural sector, high costs of supplies and veterinary medicines, low coverage educational, training and information, access roads in poor condition (tertiary roads), lack of electrification and TIC'S, minimum productive incentives (value of milk and meat), little investment in research compared to countries like the United States, Brazil, Argentina, Chile, Mexico, where the support to the agricultural sector by the government is fundamental for the policies of productive development.

Information in the Strategic Plan of the Colombian Livestock (PEGA) 2019 by Fedegan-FNG [14], reports 23 million bovines of different breeds and crosses, of which 72% corresponds to Bos indicus cattle (cebuinos), 15% to Bos taurus (European breeds) and 13% to those known as criollo breeds and their crosses. At the commercial meat level there are currently indicators in combination between age and slaughter weight, standing at an average of four years with an approximate weight of 400Kg, with a weight gain of 350gr/day, compared to Argentina that handles sacrifice time at three years with weight gain of 550gr/day, factors that directly affect the profitability of production.

On the other hand, the information on milk production in our country ranges around 4.5 liters/cow/day compared to some international benchmarks such as Argentina and Uruguay, which report around 13 liters/cow/day and the United States with 25 liters [14].

Fuentes, presents the figures of bovine insemination at international level: United States 90%, Argentina 80%, Brazil 80% and Peru 15%, in order to raise the levels of genetic improvement and productivity and in studies and analysis

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of Galeano [15], presents to countries such as Mexico, Chile and Argentina, with advances in animal genetic improvement programs focused on the estimation of genetic and phenotypic parameters for the different characteristics of economic interest in meat and milk production systems, indicators for the selection and determination of IA-IATF, in favor of productive development.

Animal health at the reproductive level

The management of these biotechnologies is directly intervening in animal health at the reproductive level, definitively diminishing or cancelling diseases such as brucellosis, leptospirosis, bovine herpesvirus-1, bovine viral diarrhoea, Neospora caninum [16], and others such as trichomoniasis and campylobacteriosis [17], unlike the management of natural mountain where they can transmit this type of diseases, which will directly affect the profitability of the productions, since they cause abortions, infertility, decrease in production, animals they become potential transmitters, mainly by the bull or secretions expelled with bacterial, viral or parasitic load. These diseases not only affect animal health and its production, but also that of man, as some are characterized by being zoonotic, as in the case of brucellosis and leptospirosis.

Results

Artificial insemination method (AI)

The practice of artificial insemination is managed through the introduction of Semen of genetically selected bulls with high productive potential, to which semen has been collected by different methods, which remains preserved until its use.

According to the description of Fuentes, the detection of estrus for the management of artificial insemination is the indicator of success in the field, which depends on the adequate detection of estrus and the ability in insemination. The classical principle for AI is the AM - PM and PM - AM system, the cows that are seen in estrus in the morning, must be inseminated during the afternoon of the same day, and the cows seen in heat in the afternoon, should be inseminated after dawn the next day [3]. All this based on observation, palpation of ovaries and data on services/mounts.

Descriptions of Restrepo [18], indicates the main advantages that the AI has for its acceptance among producers: the low cost of semen and its application and the success that guarantees the process, also the lower cost of the service, lower risks associated with the use of the bull, a greater genetic gain, and pregnancy rates that may be better compared to natural riding.

Artificial insemination method fixed time (IATF)

The IATF, involves that the females must be managed with hormones to synchronize them and modify the behavior of the reproductive system, preparing them for the reception of the semen and thus achieve the gestation. Martínez [19], describes the IATF as: "A protocol used to manipulate the cow hormonally to ovulate the day it is scheduled "and conceptualizes for its management that:" In this protocol it is very important to understand how the reproductive physiology of the cow works, since although there is a great variety of products and protocols, the most appropriate one must be chosen according to the case (heifer, cow, postpartum, meat, milk) ". It is also indicated that for such management it is recommended to select a group of animals, synchronize them and inseminate them on the same day, from the manifestation or detection of jealousy.

Hormones for the IATF protocols

Martínez [19] reference, the hormones to be taken into account when applying the IATF:

a. GnRH: Induces the release of hormones such as FSH and LH, which affect the regulation of follicular development. It is recommended to use it in protocols for pregnant cows postpartum with good body condition.

b. Progestogens: They come in slow release implants, either vaginal or in the ear. The objective of using the implants is to simulate a right-handed to control ovulation until the ovulation is removed.

c. Prostaglandins (PGF): They are used in any protocol, their main function is to destroy the corpus luteum ending with the luteal phase (luteolítico), they are the most used in programs of synchronization of jealousy, since 50 to 70% of the animals treaties will respond with the presentation of estrus and ovulation within 6 days following an application of PGF, whose fertility is equal or superior to spontaneous or natural ovulation [20].

d. Estrogens: In combination with progesterone they create a negative feedback for GnRH, causing the self-destruction of the surrounding follicles, but if they are administered only with the presence of a dominant follicle and in the absence of a corpus luteum, they create heat behavior and intervene in the induction of ovulation.

e. eCG: (Equine chorionic gonadotropin), used in several synchronization protocols seeking to potentiate the LH action, in order to synchronize ovulation and increase the size of the dominant follicle.

Protocols

A study conducted by Saldarriaga [1], proposes the division of the protocols for the IATF in: "those that use combinations of GnRH and prostaglandin F2α (PGF), called Ovsynch protocols and those that use devices with progesterone (P4) and estradiol known as control of follicular development "

Ovsynch protocol: This protocol is widely used for synchronization of cycling cows as it causes ovulation, usually without presentation of heat, for which it is necessary to comply and respect the times to do IATF. In the Ovsynch protocol, GnRH causes the largest follicle to ovulate or return, initiating a new follicular wave; 7 days later, when PGF2α is applied, luteolysis is caused and On day 9 the second injection of GnRH induces the

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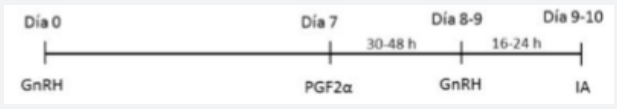
ovulation of the new follicle; Within the next 24 hours insemination must be done [21] (Figure 1).

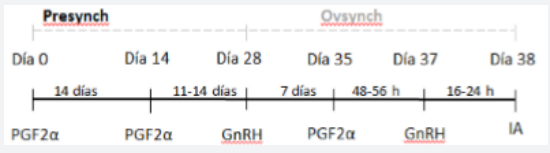


Source: [21].
Figure 1: Ovsynch Protocol.

Studies compiled by Morales & Cavestany [21], have determined that the results with the application of this protocol have been varied from 9% to 37%, which is why other alternatives have been provided from the practice to complement it, such as For example, the Cozynch, which has the addition of progestogens (P4), the administration of P4 for 7 days together with the injection of GnRH improves the pregnancy rates between 50% and 55% compared to cows in anoestrus treated with the Traditional Ovsynch. Among the variations is the advantage of a less handling session in animals, since the IATF is established at the same time as the second application of the GnRH [22] (Figure 2).

Source: [21,22].
Figure 2: Cosynch Protocol.

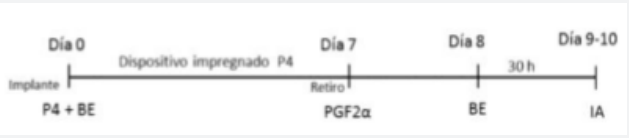
Another of the Ovsynch protocol variants is based on pre-synchronization or Presynch, which consists of 2 applications of PGF2α with 14 days of interval, the second injection must be applied 14 days before OvSynch or CoSynch, if you want Injections are given the same day of the week, or the second injection of PGF2α at 11 or 12 days before OvSynch or CoSynch, if wants to maximize the conception rate [22]. The objective with this protocol is to have the cows in a similar state of estrus when initiating the synchronization protocol for AI, although it is important to emphasize that its use is effective to increase fertility in cyclic cows [21] (Figure 3).



Source: [21].
Figure 3: Presynch Protocol.

Protocols for follicular development control: Collection of information on studies and practices carried out in bovine cattle with anestrus, has led to the creation of treatments that improve this situation, currently in the market efficient devices are offered that release Progesterone (P4) and that are maintained in the vagina by a 7 to 8 days period [1]. Morales & Cavestany [21], highlight the function of this protocol, which consists in imitating a short luteal phase, produced prior to the resumption of postpartum cyclic sexual activity, in order to improve the pregnancy rates in animals artificially inseminated and avoiding the formation of a short-lived corpus luteum, which contributes to the corpus luteum of the next ovulation having a normal activity, allowing the development and maintenance of pregnancy, also suggests, based on previous studies, that the success rate of protocols with progestogens or P4 alone are variable between 50% to 70%, since it depends on the interval of labor to treatment and the cause of anestrus.

Also, studies by Bó et al. [23], indicates that milk producers around the world who have used these protocols have obtained pregnancy rates between 35 and 55%, which were influenced by the body condition, the days in lactation of the synchronized animals and the production of milk from the cows. Likewise, it is possible to infer about the results that are desired to obtain at the time of the application of the IATF, which are related to the selection of the animals to be treated, a fact that highlights the importance of record management and palpation Rectal by qualified personnel.



Source: [1].
Figure 4: Protocol Device impregnated with progesterone together with estradiol.

The protocol with progesterone impregnated device together with estradiol, within its most used treatment consists of administering 2 mg of estradiol benzoate (BE) intramuscularly (IM) together with the implantation of the device on day 0 of the treatment; on day 7 or 8, the implant is removed and prostaglandin PGF2α-IM is applied and 24h after 1mg of BE-IM is administered; the IATF is performed between 52 and 56h after the device is removed [1] (Figure 4).

Treatments are also handled with progesterone, estradiol and equine chorionic gonadotropin (eCG) release devices, indicated for cows with good milk production and presenting postpartum anestrus, which causes an increase in the interval between births and affects negatively Reproductive and productive performance, experiments by Bó et al. [23], report pregnancy rates of 52% in groups treated with P4 + BE + eCG, stating that no significant differences are detected with treatments without eCG that handles a percentage of 51%. In contrast studies by Morales & Cavestany [21], report results with a conception rate of 70% and 64% of pregnancy in cows for meat, by combining P4 + eCG + PGF2α, managing to increase the synchrony and the percentages of conception in the Subsequent insemination, making the IATF more satisfactory and profitable. It is also indicated that the addition of eCG in the protocols of P4 and BE in animals in anoestrus is established as a useful tool to improve fertility in indicus breeds with a high percentage of acyclic cows before 60 days postpartum. Espinosa [24] states that to achieve better pregnancy rates, the protocol of choice P4 + BE is applying a dose of eCG (400 IU) 24

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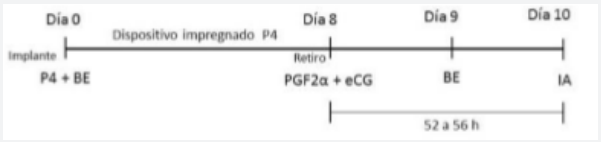
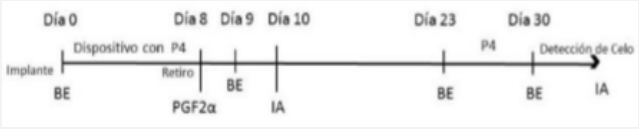
hours after the device is removed, achieving a pregnancy of 62% (Figure 5).



Source: [24].

Figure 5: Protocol P4 + BE + eCG.

Resynchronization protocol: The resynchronization protocol is taken when the cow shows estrus 21 days after the first IATF or with the establishment of systemic inseminations in the animals without the need to detect jealousy, shortening the returns to reach a fertilization of 55% to 75% [21].



Source: [23].

Figure 6: Resynchronization protocol.

Figure 6; Bó et al. [23], express opinion on the advantage of resynchronization where cows are expected to return to estrus in a defined period of time, thus determining that field observations should be made more accurately. Likewise, the disadvantage of the program indicates that it requires continuous hormonal treatments and success depends on the effectiveness of heat detection, which increases production costs.

Cost benefit analysis: IA-IATF programs

Estimates proposed by González [25], with respect to open days (DA), empty days (DV) and interval between deliveries (IEP) for dual purpose (DP) and crossbred herds on days of lactation (DEL), ideal, practical and profitable goal is to obtain one baby per year, in mestizo cows, the rate of pregnant cows with more than 150 DEL varies between 26.4 and 37.8%, currently in the breeding farms there are difficulties to achieve these goals. The management of records evidences these difficulties and directs the solution alternatives.

The increase in LED> 150d shows a low reproductive efficiency for livestock enterprises that will have an impact on productive economic losses. González [25], has related in his study: "that recommends the service of animals from 60-75d DEL, since before 60d is considered a risk for fertility, if 60% of pregnancy occurs between 60 -150d, that means that 40% have DV> 150 DEL and longer lactations. An animal inseminated after 120d postpartum will maintain IEP, DEL and prolonged lactation, which decreases the profitability ". At the administrative level of the livestock company, the aim is to reduce the DV, it is considered that empty cows> 120d in dairy breeds economic losses they are around 15 thousand pesos, while in beef cattle they are around 5 or 7 thousand pesos per day, if the conversion is made in animals of higher production and with more empty days, the profitability of livestock decreases and produce losses for the producer.

The management of AI and the implementation of IATF programs is an economically viable alternative, which produces economic returns, based mainly on the differences of kg obtained at weaning [25], and control in the intervals between births. This difference occurs basically by the incorporation of genetic improvement at the productive and reproductive level, providing profitability in the livestock enterprise, with better productions in terms of quality and quantity (milk) and less time (meat).

Table 2: Difference in weaning weight of male calves born by IATF or natural service.

	Weight at Weaning (Kg)	Adjusted Weight 205d (Kg)
IATF	211,4	201,1
Natural Mountain Service	175,4	184,6
Difference	36	16,5

Source: Cutaia et al. [26].

Table 3: Weight difference at weaning of female calves born by IATF or natural service.

	Weight at Weaning (Kg)	Adjusted Weight 205d (Kg)
IATF	196,8	185,0
Natural Mountain Service	163,6	174,1
Difference	33,2	10,9

Source: Cutaia et al. [26].

Below is a study carried out by Cutaia et al. [26], where the weight gain of calves with IATF is measured and compared with those managed from natural montage, where the genetic value is shown in relation to the weight gain: (Table 2 & 3) Cutaia et al. [26], through this study demonstrate that "it is possible to improve productive indices in a breeding ranch applying an IATF program at the beginning of the service ". With these data, the advantage of genetic improvement since the start of the productive development of cattle in terms of weight gain and meat production is highlighted, which affects time and quality according to the characteristics of the semen of choice for management in the company.

Cost ratio IA-IATF

a. Vitamins and minerals as reproductive adjuvants: in some cows for traditional AI it is recommended to apply vitamins in order that the ovaries have a better cyclic activity and thus achieve that the cows come into heat faster. Based on mineral and vitamin deficiencies within the diet.

b. Straws: in the market you can find variations according to quality, ranging from 15 thousand pesos, to prices higher than 300 thousand pesos in straws of imported semen and sexed semen.

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c. Synchronization: the cost varies according to the protocol of choice by the professional, according to the conditions of each animal and management of the livestock company. The protocol of choice for this analysis is based on P4 + BE + eCG.

d. Labor: The labor of the inseminator for each inseminated animal costs around $20,000 pesos (Table 4) [27].

Table 4: Cost relationship between traditional AI and IATF.

IA vs IATF	Traditional AI	IATF
CalfosvitSe®	$24.200=	
Straw/Animal Value	From 25,000 to 300,000 =	$60.000=
Synchronization/Animal Value		$31.000=
Total Synchronization per Animal		$91.000=
Resynchronization Value		$4.000=
Inseminator Labor	$20.000=	$20.000=
In 10 Cows		$910.000=

Source: Fuentes SD [27].

The costs related previously are not exact, since in the IA-IATF program there are variations due to the conditions and state of the animals, semen management in its application, environmental and sanitary conditions, selection of protocols, among others. The choice of protocol depends on the conditions of the animals, investment budget and criteria of the professional who applies and manages the IA-IATF.

The risk in applying and managing traditional AI in cyclic cows depends on the detection of estrus and calculating the exact time to inseminate, which is why it has been expressed in many experiences that the pregnancy probability is low. Failure in the first AI leads to increase the days open or empty days thus increasing the interval between delivery and impacting losses for the producer. Analyzing the context of the livestock business is more profitable management of the IATF for genetic improvement and maintain good productive and reproductive parameters.

As previously mentioned, an empty day in a production system has a cost between approximately 15 thousand and 7 thousand pesos per day for milk and meat production respectively; The average number of days open in Colombian livestock is >170d according to the PEGA 2019 report [14], reducing this parameter with the application of the IATF would satisfactorily benefit the profitability of the livestock sector.

Conclusion and Recommendations

Conclusion

Affirmations in studies by Van Arendonk [28], states that: "The first reproductive technique that had a great impact on animal husbandry systems was artificial insemination (AI), along with pedigree registration and milk registration" , to obtain exact estimations in highlighting the productive values of the bulls in the systems of production of meat and/or milk; bulls contribute to the diffusion of genetic improvement, inheriting the productive characteristics of their daughters and thus providing an attractive economic alternative for the generation of progress in the livestock sector.

Among the disadvantages that are reported in the application of biotechnologies such as the IA and the IATF, from a genetic point of view, the answer depends on the degree of interaction genotype by environment generating variability of the response or expected results which will be reflected In the long term, and inbreeding [29], which is still the subject of study and estimation within the context of genetic improvement, it is expected that with the importation and use of new generations of foreign semen and record management, a decrease in this risk, which until now has not presented major advances [30].

Recommendations

The investment of the AI guarantees over time to genetically improve livestock, through the crossings between commercial animals from the application and management of biotechnologies, determining the racial percentages of Bos taurus and Bos indicus, for the selection of tested and proven semen towards a racially productive genetics, directly for each system of production of either meat, milk and/or breeding.

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