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Buffalos in Argentina

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PREFACE

I became involved with the Buffalo because I am convinced that it is an irreplaceable tool for the development and welfare of the societies that live in the different areas of the earth.

America lived practically at the back of this powerful species.

In the last decades an outstanding change has taken place, It was led by Brazil. This change allowed America to become the continent with the greatest percentage of bubaline population in the world.

It is a significant expansion and Argentina takes part of this event actively through the audacious effort of the producers, who have believed and trust in this animal. Since 1983 they have been part of a Breeders Association, which tries to support and protect them. They have also had the invaluable collaboration of scientists, researchers, university teachers and technicians. I would like to emphasize the untiring work carried out by the National Northeast University, Corrientes, coordinated by Dr. Gustavo Crudeli. Without them, without their scientific product, the bubaline livestock would not have had the knowledge support irreplaceable for every human activity. This preface, tries to be homage to all of them, to the institutions they belong to and especially to whom shed light on this book.

We know that about bovine literature we can fill several classrooms to the ceiling, but as regards specific buffalo literature only the light of William Ross Crockrill's book has shone in the dark during years. Today, this book is another lighthouse of great importance.

We, as cattlemen recognize the effort of all the bubaline breeders of our country and embrace them closely.

José Enrique Bencich

Honorary President

Argentina Buffalo Breeders Association

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CHAPTER 1

THE DOMESTIC BUFFALO

Marco A. Zava

ORIGIN, DISTRIBUTION AND BREEDS

What is the buffalo?

It is a valuable business option for our beef and milk livestock, especially in certain circumstances: tropical severe weather and /or subtropical weather and natural fields with low nutritive value pastures. In these conditions, it has gains in weight that are superior at least in 70% to the bovine cattle in the first two years of life.

It is also a valuable option near the urban centres: with silage, greens and few concentrates it allows excellent milk production that is rich in nutrients, ideal for the very much-wanted Mozzarella buffalo cheese.

Zoological classification

According to the zoological classification, the domestic buffalo belongs to Mammalian class, or to the sub-class Ungulate. It also belongs to the Artiodactyls order; to the sub-order Ruminants; to the family Bovidae; to the subfamily Bovinae; to the Bovine tribe (the other tribes are Ovine, Caprine and Antelopes); to the genus (or group) Bubaline (the other genera are Bovine with 60 chromosomes –that includes the Bos or bovine cattle and the bison; and the Syncerus, i.e. the African or savage buffalo). Finally it belongs to the species *Bubalus bubalis* sp. (according to the scientific denomination of Carlos Linneo or Carolus Linnaeus), what is classified into two types (Mac Gregor, 1938) River Buffalos (*Bubalus bubalis bubalis)* and Swamp Buffalos (*Bubalus bubalis karebau)*, with 50 and 48 chromosomes respectively.

The *Bubalus bubalis* sp. is commonly called Domestic Buffalo, Water Buffalo or Asiatic Buffalo. The crossbreeding between the Swamp Buffalo and the River one has 49 chromosomes and is sterile.

The Word buffalo

The word buffalo appeared after the introduction of species in Italy (near the year 1200 A.C., it comes from the Latin *bubalus* and the Greek *boubalis* that were indicative of animals that lived in the North of Africa.

The Asiatic Buffalo (*Bubalus*) unfortunately was associated by mistake to the bison (*Bison*) or to the African Buffalo (*Syncerus*). The wrongly called Buffalo in the U.S.A. is the American bison. The observation of the *Bison* or the *Syncerus*, both wild animals, truly causes the sensation of terror or ferocity. On the other hand, the Asiatic Buffalo transmits serenity, especially in the dairy farms or rice fields from Asia.

Origin, domestication and spreading

The information about the origin and domestication of the buffalo is a bit lost in the remoteness of time. But according to Shalash (1991) there are archaeological findings about the buffalo domestication since 4000 years ago in the ancient Mesopotamia or Ur region (present Iraq). And in the Indus valley, from the sub Indian continent, they were domesticated 5000 years ago. According to the archaeological findings in the Chekiang province, in China, they were domesticated 7000 years ago. That is, this species in general was domesticated in the middle of the third millennium B.C.

There was no domestic buffalo in the ancient Judea, Greece or Rome and it appears for the first time in pictures or registers in the Jordan Valley in the 723 A.C.

Apparently they arrived in the Middle East and Egypt brought by the Arabs from Mesopotamia and entered Europe first thanks to the advance of Muslims (1500 – 1600A. C.). It is also said that the Arabs brought them to Italy in the VIII century when they invaded the plains of the Sele River.

The truth is that at the beginning of the XII century (1200A. C.) they are found in great numbers in Thracia, Macedonia and Bulgaria (Cockrill, 1974). From this area, they spread towards the other countries of the Valley of Danubian River and to Italy, where they were present in the Pontinos Swamps at the end of the XIII century.

The buffalo was also introduced in the Caucasus region in the ancient Soviet Union (Aleksiev, 2001) and since less than a century, in the South America and Australia.

The Domestic buffalo, since 50 years ago has been revalued thanks to the work done by William Cockrill (1974), from the FAO (Food and Agriculture Organization of the United Nations) and with his book “The husbandry and health domestic buffalo”. It was turned into the topic of technological investigation and enterprise interest due to its fertility, longevity, aptitude to produce beef, milk, and labor and as a sub product a leather of excellent quality. Its efficiency of conversion, its adaptation to severe or impossible conditions for bovine cattle and many other factors are also added.

The buffalo in the world and in the Americas

The World bubaline population is of approximately 182 millions of heads (11% of the world bovine population) and the 96% of the same is found in Asia, where they are destined principally to beef and milk production.

To have an idea of the economic importance, in India the 94 millions of buffalos represent the 27% of the total livestock population and nevertheless its production covers the 65% of the milk consumption and sub products of the country. Nowadays in Italy, it is often an activity of intensive production. It uses technology of the latest generation, having improved noticeably the milk production after 50 years of selecting and controlling it. In the elite herds, there are productions superior to 5,000 liters, in 250 days and two years of milking. Nowadays from Napoli, 3,000 kg of Mozzarella cheese leave towards the United States and Great Britain. In Bulgaria, productions superior to 3,500 liters have been obtained, absorbing massively the Mediterranean local breed towards Murrah.

In the countries of Africa (Egypt principally), of Oceania (Australia) and some of America, they are destined to beef production. In this last continent, Venezuela takes the lead in milk production followed by

Brazil. They are used to transport wood in the Brazilian Amazon, cane in sugar mills in Trinidad and Tobago and African palm fruit in plantations in Colombia (Picture 1).

In the Far East (ancient Indochina, China, Philippines, Indonesia, etc.) they are destined principally to labor: tilling in the rice fields and pulling ("the living tractor of the East", it represents the 90% of the agricultural force in rice cultivation in that area).

After India, the principal populations in the world are in China (22,4 millions of heads), Pakistan (18), Philippines (5), Nepal (3,8), Egypt (3,55), Brazil (3,5) and Indonesia (2,9).

Picture 1: Labor: The buffalo for transport in Alacid Núnes da Silva's fazenda, Marajó Island, Brazil.

The average in milk production in India and Pakistan, in lactations of 300 days, is of 1,500 litres. In the best herds averages of 2,500 liters are reached, with individuals of up to 5,000 litres. In Italy, with the Mediterranean breed the figures are of 6,000 liters but with lactations of 240 – 270 days (to help pregnancy because the calves have more commercial value than in Asia) (Picture 2).

In Venezuela and Brazil, the average values with lactations of 270 days are between 1,200 and 1,500 liters, with herds of first line that reach averages of 2,000 liters and individuals that exceed 3,500 liters.

In Argentina, the Graduated in Economy Javier Gonzalez Fraga produces 22.22 kg of Mozzarella cheese with 100 liters of milk).

The principal products obtained with buffalo milk are: fresh cheese or *criollo* (it is produced by many in Argentina an Venezuela and it is excellent), butter, ricotta, yogurt (of excellent quality being the principal production of Bulgaria), Mozzarella, Provolone, and in India, Cheddar, Carnal, Brick, Surati and *Fundido* (tasty, with soft consistency) cheese.

In India apart from milk to consume (which is dissolved with 33% of water resulting in a composition similar to cow milk), the principal product is the *Ghee* (clarified butter, with 99% of fat that is preserved in tropical conditions and is the only source of animal fat for Hindus).

Picture 2: Italy, milk buffalos eating horticulture sub products.

Buffalos arrived in South America at the end of the XIX century; with animals coming from the so-called Indochina, they were brought to the French Guyana in 1859, to work in sugar cane exploitations. From there they moved to Surinam. They also reached Trinidad and Tobago.

The first introduction of buffalos to Brazil, done in 1890 by Dr Vicente Chermont de Miranda, consisted in buying Carabao or Rosilhos buffalos for Marajó Island from fugitives coming from the French Guyana. In 1895, Mrs. Lopoldina Lobato de Miranda and her children, ranchers of Marajó imported Italian buffalos. Both introductions gave way to the black buffalo of Marajó (Preto Marajoaro), identical to the Italian Mediterranean buffalo, thanks to the absortion of the Carabao by the Mediterranean (Picture 3).

Picture 3: Milk Mediterranean buffalos, called “Preto Marajoara” Marajó Island, Brazil.

In 1919 – 1920 breeders of Minas Gerais State, principally Mr. Antenor Machado de Azevedo, introduce male and female buffalos from Ahmedabad and from Bombay (India); and Francisco Mattarazzo imports various Italian buffalos (Mediterranean). Great part of the bubaline of the central – southern Brazil, principally Mina Gerais and San Pablo estates descends from these reproducers.

In 1962, Celso Garcia Cid, Torres Homen Rodrigues Da Cunha (through their representative Jose Dico Da Silva) and others import buffalos from India (principally Murrah and Jafarabadi, too).

In 1989, Delfino Beck Barbosa (from Porto Alegre), Casimiro de Borbon (from San Pablo) and Ricardo Hegler (from Bahia) import Mediterranean buffalos from Italy.

From all these importations that do not reach 400 heads, in 110 years it is possible to reach to one of the biggest bubaline populations in the world. Nowadays it has an annual increase of 12.7 % and can reach in 2020 to 15 millions of heads (or even more, according to other estimations).

In Venezuela, the first buffalos entered during the 30s brought by the dictator general Juan Vicente Gomez (no more than 25).

During the 60s, thanks to the efforts of Abelardo Ferrer among others many importations were done from Trinidad and Tobago (*Trinitario* Buffalos, creation of Steve Bennett).During the 70s and 80s pioneer breeders as the Reggeti Gomez (descendants of the general above mentioned), the Moser and the Coirán import Murrah from Bulgaria and Mediterranean from Italy massively. They revolt the Venezuelan livestock (of beef and milk) that was anemic with the bovine cattle.

Nowadays, at the beginning of the XXI century, in the Americas, there are 3,800,000 buffalos; from which there are 3,500,000 in Brazil; 150,000 in Venezuela; 60,000 in Argentina; 35,000 in Colombia; 30,000 in Cuba; 20,000 in Peru and 10,000 in Trinidad and Tobago.

There are other populations, which are less significant: 5,000 in United States, 3,500 in Paraguay, 3,000 in Central America, the same as in Bolivia and the Guyana, and lastly 1,000 in Ecuador and 500 in Uruguay.

In Brazil, country with tropical and sub tropical climate in almost all its territory, the genetic potential of bovines was improved through the crossing of European and Indian breeds, but obtaining discrete results.

With the advance in knowledge about the buffalo potentialities, it was evident that a new alternative livestock industry was available in Brazil, principally for flooded areas or poor soils, located in the Amazonian, in the *Pantanal*, in the banks of the rivers and litoral, where the bovines do not have a satisfactory behavior.

With the current knowledge, it can be affirmed, in general, that the indexes of bubaline productivity referring to beef, milk and labor are excellent in the Brazilian conditions in all its territory.

Miranda (1986), studying the distribution of bubaline in the five Brazilian physiographic regions estimated it in the following way:

- 50% in the North,
- 14% in the Northeast,
- 15% in the Southwest,
- 9 % in the South, and
- 12% in the el Central- West.

Brazil, a country of more than 8 millions of km ^{2}, is a demonstration of buffalo adaptability to management and environmental conditions. They are very different along the completely immense territory: from Río Grande do Sul (in the South) untill Pará, Amapá and Amazonian in the North; and from Sao Paulo and Río do Janeiro in the east untill Acre Rondonia in the West; covering all the climates: mild, sub tropical and tropical.

The most important breeds in Brazil are Meditrranean, Murrah, Jafarabadi and Carabao, in this order of importance. The three first are called “Preto Buffalo” breeds. The last one is also called “Rosilho Buffalo”.

In the Mediterranean breed, the most numerous, differences between the herds of San Pablo and Minas Gerais can be appreciated. They are crossed with Jafarabadi and Murrah breeds. The herds of the Amazon region are very much alike to the Italian Mediterranean (though very little crossbreeded with the Carabao or Rosilho). There are herds of the Italian type in Río Grande do Sul, too.

Murrah breed, since 30 years ago has had great diffusion in the whole of Brazil. Jafarabadi is greatly spread in the centre, southeast, southwest and south of the country.

It is in our continent where the growing of the most spectacular bubaline population for beef, milk and labor is going to happen in the new century.

The Americans from all latitudes should be conscious of the enormous area available with great potential for buffalo production. It goes from the south, and north sub tropics (Argentina, Brazil, Paraguay, Bolivia, Mexico, United States, etc.), up to the tropics and the equatorial zone (Venezuela, Brazil, Peru, Colombia, Central America, Caribbean, etc.).

In the last 30 years, very much has been done in America. However, there is still very much to do from now onwards with this valuable tool for food and the prosperity of our people. Moreover, if we consider the crisis, especially in production, developing countries are suffering.

Principal Breeds

The breeds of the species *Bubalus bubalis* are 19 in the world, including as a breed a different type called the Swamp Buffalo (with 48 chromosomes) destined principally to labor and also beef. The 18 breeds left are used for milk and beef. They are river buffalos (with 50 chromosomes), from which 16 are defined in this way in the sub continent Indo-paquistani, and they constitute the 20% of the bubaline population in this region. The sixteen Indian breeds are the following:

1- Murrah
2- Nili-Ravi
3- Kundi
4- Surti
5- Mehsana
6- Jafarabadi
7- Nagpuri
8- Pandharpuri
9- Manda
10- Jerangi
11- Kalahandi
12- Sambalpur
13- Bhadawari
14- Tharai
15- Toda
16-South Kanara

The 80% left is represented by the so-called “desi” or crossbred buffalo, indefinite. Lastly, the Mediterranean breed, of Indian origin, which was defined in that way in the Mediterranean Valley, principally in the south of Europe.

It is possible to reach to 20 breeds, considering the Buffalypso or *Trinitaria* (called in that way in Trinidad and Tobago) as a breed for beef and labor. This breed was selected by Dr Steve Bennett in the Caroni State during 40 years with crossings of four Indian breeds for beef production.

From all the breeds, it is worth mentioning the ones of major economic importance in the world: Murrah, Mediterranean, Nili- Ravi, the principal in Pakistan (Picture 4), Jafarabadi, Carabao, *Trinitaria*, *Surti* (important in the west center of India, with up to the 11-14% of B.F. butyric fat).

Picture 4: Breed, Pili-Ravi: The principal of Pakistan. In the Picture a female buffalo with a milking of 12 liters daily, with 8% of. B.F. Ambala Farm, cnear New Delhi.

Three breeds that exist in Argentina are going to be described and a fourth that lives in the Amazonian area of Brazil and in Cuba (the Carabao). The following breeds exist in Argentina: Mediterranean, Murrah and Jafarabadi, in order of importance.

Picture 5: Female buffalo of Surti breed: Dhamrod-Gujarat Farm -N. W. of India. It is the genetic predecessor of the Mediterranean.

Mediterranean breed: They are Indian buffalos descendents principally of the Surti breed, defined as a breed in Europe and other coasts of the Mediterranean, the common colors are black, dark grey, dark brown and grayish black.

White spots are not accepted. There are animals with partial depigmentation of the eye iris (*sarcos* eyes)

Horns are medium sized, turned backwards and sideward, tips are closed turned upwards and inwards forming a crescent.

Its face is long and narrow with long and few hairs in the lower jaw. Its body is comparatively wider than longer, limbs are shorter and stout. Prominent withers, higher than the sacrum, deep chest and large abdomen. The tail is short but it reaches the hock because it is set low down. In general, it is a solid, muscular and deep animal. The top rump has a good structure (Picture 6).

The udder is medium sized, well formed and with quarters well fitted.

The average weight for adult males is 700-800 kg and 600 kg for females.

This breed forms the bubaline populations of Italy, Rumania, Azerbaijan, Turkey, Egypt, etc; and it is the biggest in Bulgaria, Brazil and Argentina.

Picture 6: Mediterranean breed: Milk buffalo, Antonio Palmieri- Capaccio Scalo- Salerno- Italy.

Murrah breed: It is native from the region near Delhi. Its name is a Hindu word that means “spiral” and derives from the form of its horns. They are black and spiral from their base. First, they turned sidewards and then they complete the spiral backwards. The color of the skin and hair is jet black. White spots are not accepted, except in the tip of the tail.

They are strong with a deep and wide bone structure, short limbs and weighty bones, short and light head and short ears.

They have well developed udders, dearly visible veins and firm rear ends. Nipples are easily handled and pulled. As they are excellent milk buffalos they spread all over India, all of which contributes to turning it out in a superior dairy cow. Due to this characteristic, it is well known in Brazil.

The live weight is of 600-800 kg in males and 500-600 kg in females (Picture 7).

Figura 7: Murrah buffalo: 3200 liters per lactation, 23 liters daily, 8 % B.F., Rayudu Farm of Mr. Mullapudi Narendra in Tanuku – Andhra Pradesh – S.E. of India.

Jafarabadi breed: Its name derives from de town of Jafarabad, to the west of India. It is black. There are white spots that are accepted. Its forehead is prominent. Horns are heavy and wide, tilted downwards behind the eyes, and they curl up and backwards at the tip. It is the biggest sized breed (Picture 8). It is an animal of large, deep and long chest, with an enormous heart girth, what makes it excellent to produce milk.

Udders are well developed. This breed has gained national milk tournaments in Brazil, surpassing the Murrah breed.

Picture 8: Jafarabadi: Buffalo in the experimental station Rajkot, Gujarat (N.W. of India).

In India, since in the year 1949 (with the independence) big landed properties disappeared, this breed is not widely seen due to scarce availability of forage. In Brazil, this breed and its crossings are widely spread because they are excellent beef producers when there is abundant grass. When feeding diminishes, its recuperation is longer. Weight in males is from 700 to 1,500 kg, and in females from 650 to 900 kg. There are two varieties: one medium sized, Gir- Buf, which is widely known, and the other big one, the Palitana, used for crossings.

Carabao breed: The Swamp Buffalo, Krbau, Carabao (Spanish name in Philippines) or Rosilho, is the principal breed in the Far East (China, Indonesia, Philippines, Vietnam, Cambodia, Thailand, etc.) destined to labor in the rice fields and for pulling. It is also a beef producer. In Pará State and in Marajó Island, in Brazil, it is used for beef production.

Horns are long and open. They have a cross triangular section and make a 90° angle when separating from the head.

They are brown gray and have many white spots in their limbs, in the forehead and neck in the form of “necklace”).

It has a short body and wide abdomen. It is solid and strong, developed for labor and it is apt for beef (Picture 9).

The forehead is plain, the eyes are prominent, the face is short and the muzzle is wide. The neck is relatively long and the withers and rump are prominent.

The limbs and tail are short. The udder is small and turned backwards. There are no marked differences between males and females.

Average weight for males is 600-700 kg and for females 450-500 kg. Cockrill (1967) tested that Carabao buffalos from Thailand and from Sumba Island (Indonesia) and from Laos, weigh more than in the majority of the other countries.

It is called the living tractor of the East, drawn in china pots since ancient time.

Milk production is very low, but when crossing this breed with the Indian buffalo, as in China, Philippines, Thailand and other countries of Asia as well as in Australia, milk production can reach levels near 1,000 liters.

In Vietnam, Indonesia and Thailand many albine Carabao buffalos appear due to excessive consanguinity.

It has excellent capacity for labor, but the intensity of its use varies very much in the different countries.

Farmers select males for working, when they are 3 – 3.5 years of age, according to the size and height to the withers. In most of the cases, buffalos are castrated before they start being used for labor. This use begins when they are 4 years of age and goes on until 12 or in some cases up to 20. The average time for labor is 5 hours and the annual average of days is from 20 up to 146 days.

Picture 9: Carabao breed: Alacid Númes da Silva's Buffalo calf of 24 months, Marajo Island, Brazil.

THE BUFFALO IN ARGENTINA

Introduction

The commercial buffalo production in our country is twenty- seven (27) years old in 2004. In 1976, there were only 1,300 buffalos in Argentina. Nowadays, there are 60,000 -the third population in America-, from which 24,000 are breeding cows.

Corrientes has 36,000, Formosa 15,500; Santa Fé 2,200 and the rest are distributed in Chaco, Misiones, Entre Ríos and Buenos Aires.

Thus, in only 27 years beef production is completely solid, in its management, productivity, rentability and, recently, its commercialization is being consolidated.

Milk production started developing en the last 11 years.

Everything has its origin during the first decade of the XX century when Mediterranean buffalos were introduced in Brazil, as they could not cross with bovines; they were abandoned in the different farms and used for consumption there. They became wild and consanguineous due to lack of management.

This situation remained until the 70s when breeders started again looking for low fields to exploit that were little productive with bovines. They were situated in the Paraná River Valley.

Then they expanded to the high fields of the Argentine Northeast (A.N.E.), transforming the obligatory breeding fields into breeding and fattening fields.

During the 80s, excellent levels of beef production were obtained and a new way of marketing started.

In this decade with great sacrifices, it was necessary to overcome burocratic obstacles in the sanitary frontiers. Importations of animals of excellent genetic quality started from Italy, Brazil and in less quantity from Paraguay. This caused a qualitative improvement that allowed our country to be placed in a first genetic level of the three existing breeds: Mediterranean, Murrah and Jafarabadi.

In the 90s, importations of breeding herds (more than 5,000 cows) and of selected reproducers from Brazil were done.

This quali and quantative improvement consolidated buffalo breeding in the country.

In the last years, genetics goes on improving thanks to insemination programs with heat synchronization in which imported semen principally from Brazil is used. Jafarabadi breed was reduced to two herds, one in Villa Mercedes (San Luis) and other in San Cristóbal (Santa Fé).

The Argentine Buffalo Breeders Association (A.B.B.A.), under the presidence of José Enrique Bencich, was established in 1983 with the aim of improving buffalo production, giving technical information to producers and students about management, breeding, crossings, reproductions, promoting investigations, auctions, congresses, etc. In 1985, a Genealogical Register was open, having 4,000 reproducers recorded today.

Since middle 90s, in the Veterinary Sciences School from the National Northeast University (N.N.E.U.), a qroup of technitians from the Phisiopathology of Reproduction and Obstetrics Course, with the help of local breeders, are working hard in scientific research related to reproduction, artificial insemination and beef production.

The major inpediment for the rapid spreading of buffalo in Argentina is, as in any other country, the limited number of females and the lack of good quality males.

Few breeders with pure herds of high genetic quality are found, even at world level, and they are also working in insemination with high quality material. Nevertheless, it would be highly advisable to import buffalos of good quality, young and healthy for breeding, coming from any country. However, Europe and Asia should not be included due to sanitary barriers and the buying value and cargo cost. The most appropriate sources should be Brazil, Venezuela and Trinidad and Tobago. Nowadays, sanitary conditions make importation possible from these countries.

It is necessary, urgent, to adapt technologies to difficult areas, because the buffalo allows a more efficient production in them. It is essential to train people devoted to this work, to educate managers, to prepare technitians and family micro enterprises and its inclusion in regional economies.

Beef production

In beef production, during 27 years, through several production controls done in Corrientes and Formosa principally, it was revealed that in the humid sub tropic of Argentina, the gain of buffalo weight is almost 100% superior to bovines. They easily reach 200 kg when they are 8 months of age and 550 kg when they are 27/30 months of age and in addition, buffalos reach maturity and weight for slaughtering earlier, improving the carcass quality. During 20 years of improvement, the benefits of slaughtering have changed between 49 and 57%, being the most numerous between 52 and 54%.

With the opening of exportations, the weighty young bull is required, without excessive fat, which are the characterisatics of the buffalo calf.

The suckling buffalo of 250-300 kg has always had good local market in Corrientes, Formosa, Santa Fe, etc. (Alemán, 2000).

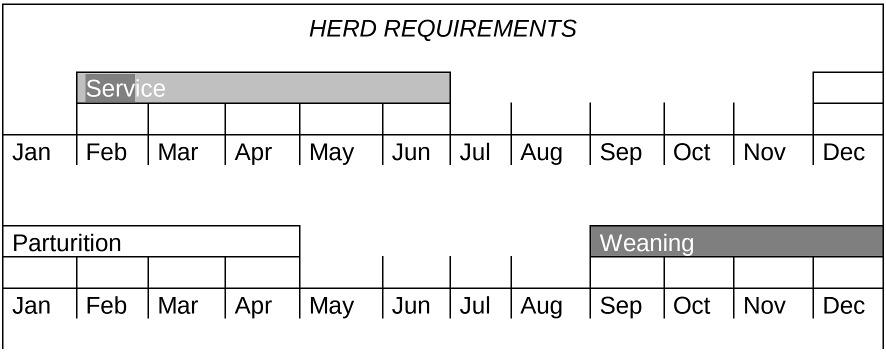
The biggest concentration of buffalo breeders for beef production is found in the provinces of Corrientes (with 17 breeders), and Formosa (with 12 breeders).

The *Compañía General de Hacienda S.A*, with more than 9,000 buffalos is one of the biggest breeders in Formosa. In this province, there are also others breeders: *TALCON S.A*. with 2,500 heads; the *Salvación* Ranch with 1,200 heads; Diego Reynal with 1,000 heads, Mr. Guillermo Martinez and Ricardo Maglietti with 600.

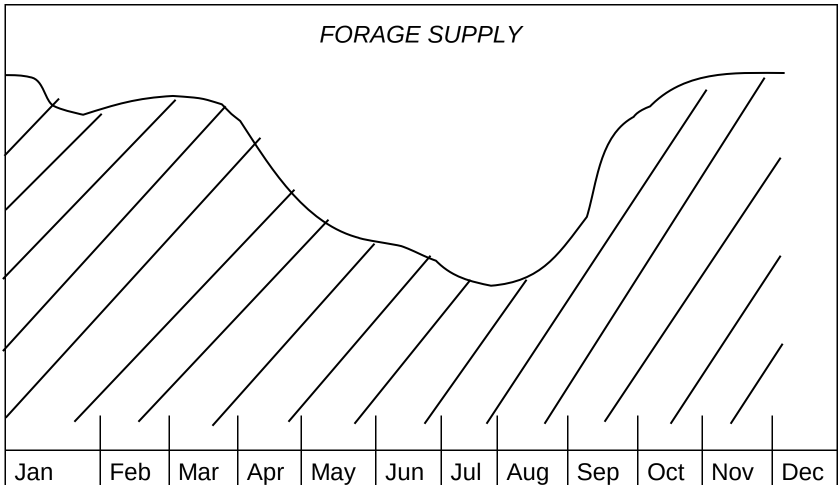
The other important breeder is in Corrientes: it is *Salentein Argentina B.V*., with more than 9,000 heads. In this province in order of importance, we have Jorge Félix Gómez with 2,000, Alberto Winkler with 1,000, Susana Prévide de Erro Ubiría (Beba Erro) with 500 and *Forestal Correntina* with 500. In addition, in our country, 17 breeders go from 250 to 450 heads each one. Armando Cadoppi has 400 on Ibicuy Island, Entre Ríos.

The other breeders, who belong to the other half, are about 28, have in their explotations between 50 and 200 buffalos each one.

For example, it is worth mentioning a case of beef production during 16 years from 1981 untill 1996. It took place in *Santa Rosa* Ranch (in those times property of *Emebé S.A*. and administered by the author), in Esquina, province of Corrientes, one proof of gain in weight with weight control during weaning and slaughtering age. The major efficency of buffalo conversion in natural fields situated in our humid sub tropic, and the total coincidence with the curve of requirements of the herd with the curve of forage supply have made the extraordinary results possible in this evaluation. That coincidence mentioned before can be seen in the following pictures (10 and 11):



Picture 10: Herd Requirements



Picture 11: Forage supply

The results obtained in weight controls in *Santa Rosa* Ranch can be summarized in the following Chart 1:

Chart 1: Production Control- *Santa Rosa* Ranch, Esquina, Corrientes. (Average figures with animals of Mediterranean breed)

Evaluated parturition	6 parturitions (1981 to 1983)	10 parturitions (1987 to 1996)
N° of animals per parturition	90	220
Sex	Castrated males	Castrated males
Estimated weight at birth	42 kg	42 kg
Daily gain in weight pre-weaning	0.660 kg/ day	0.692 kg/ day
Average weight at weaning	240 kg	208 kg
Weaning age	10 months	8 months
Daily gain in weight post-weaning	0.529 kg/ day	0.519 kg/ day
Average weight for slaughtering (at 27 months)	510 kg*	504 kg*

* Weights vary from 480 to 570 k g

It is necessary to make clear that there were years with better post weaning daily gains, but an average is done with years of drought and /or floods.

The bovine, in the same conditions, has in *Santa Rosa* a weaning weight (with 8 months of age) of 160 kg, a live weight at 27 months of age of 300 kg and it reaches a slaughtering weight, of 400-450 kg, with 39-42 months of age.

Gain in weight in buffalos results almost 100% superior than in bovines. Moreover, buffalos reach maturity and slaughtering weight earlier improving the quality of the carcass. This information is employed year to year, by students of the Zootehnics Course in charge of Dr Carlos Taboada Candioti from the Veterinary Sciences School from N.N.E.U.

Milk Production

In 1992, bubaline milk production started in Argentina. Nowadays there are some dairy farms: most of them are devoted only to milking. Only one industrializes (including Mozzarella manufacturing) and sells with trademark. Cabezas' enterprise in Santa Fé and Guanziroli's in Corrientes were very important (Picture 12). Rozemblum in Formosa, González Fraga in Buenos Aires, Leston and Morales in Misiones can be mentioned.

As a case of bubaline production in Argentina, it is worth mentioning to Javier González Fraga, whose Farm is in Torres, near Luján, Buenos Aires. He started with non-selected buffalo cows in 1991 with an average daily milk production of 4.5 liters a day. Today, it has an average of 8 liters with two daily milkings with individuals of more than 13 liters (many of them reach 2,500 liters per lactancy), and the 8 % of butyrometric fat. He is the milk supplier of *Salamandra S.A*. and covers all the links of the chain: from pasture ground to the supermarkets shelves with trademarked products. They produce 22.22 kg of Mozzarella cheese with 100 liters of milk.

Thinking about perspectives in buffalo milk production in Argentina there are two ways of producing with a promising future:

- One is the micro familiar enterprise in regional economies, wrongly called marginals, principally in the humid sub- tropic, where the buffalo can produce milk in a total estate of confort, converting pastures of low quality into manufacture products of local consumption.
- The other is the presence of integrated agroindustries near big cities.

Picture 12: Milk buffalos from “Santa María del Rosario” belonging to Guanziroli family, San Cosme, Corrientes, 1992.

The leather

It has been demonstrated in our country that the leather is very thick and allows exellent heavy manufacture, with major resistance to pulling, tearing and explosion. It is used for polo stirrups. This was verified in several tests done by the N.I.I.T. (National Institute of Industrial Technology) in Buenos Aires.

It is possible to obtain one flower (leather) and two flesh scrapings. With the flower, of unique and inimitable quality, light manufacture is produced: morocco leatherwork of the highest quality and luxurious car tapestries, etc.

- The areas per leather go from 3.50-5.20 square meters.
- In Argentina, the value per square metre of flower is $50 against $25 of bovine. If problems about manufacturing and commercialization are solved in Argentina, the buffalo can double its commercial value with its leather.

A BIT OF HISTORY

When I worked as an administrator of *Santa Rosa* Ranch *of Emebé S.A.,* in Esquina Corrientes, in the year 1976, my boss was Ricardo Mastropaolo. He was the general administrator. Ricardo told me that he had seen buffalos of excellent productivity in Paraguay (where we also administrated a ranch) and that José Bencich and Luis Angel Cabezas (the firm's stockholders) were interested in developing a bovine proyect with buffalos in *Santa Rosa* (out of its 45,000 ha, 30,000 are island fields, in the banks of *Paraná*).

The first thing we did was to go through an enormous area of Brazil: South, Southwest and Central regions. I knew very little of the Brazilian coasts (in my trips to Europe with my family by ship). It was an amazing discovery: the immensity of a moving country (we had bands of *guerrillas* at home) and the existence of a species, the water buffalo, producing beef and milk everywhere. A reality that was completely ignored in Argentina.

Soon afterwards, the ranch's administration was divided and we were alone with *Santa Rosa*'s management, José Enrique Bencich, as the owner and I, the writer, as the administrator (with the help of many people, among whom Hernán Frette and Raúl Macko can be especially mentioned)

In that year Gerardo (Chito) Erro Ubiría, owner of *La Invernada* Ranch, near *Curuzú Cuatiá*, bought female buffalo calves (heifers). We bought them very young to be able to tame them in Santa Rosa, we were helped by the ranch's administrator, Mr. Juan Carlos Arreseigor and an excellent country's personnel. Thus, during 10 years, it was the first herd base, the first commercial herd in the country.

They were pure Mediterranean buffalos, descendents of the ones that crossed Uruguay River near the year 1910. These animals remained in big ranches up to the 70s, without management, increasing their consanguinity and destined to internal compsumtion.

Gerardo Erro Ubiría, who was the honorary president of the Association since it was founded in 1983, was the first great buffalo diffuser in the country. He could sell it or simply give it to important breeders from different parts of the country: Anzola (Mercedes-Corrientes); Emilio F. de Álzaga (Monte Caseros- Corrientes); Margarita Perkins de Anchorena (Junín- Buenos Aires Province); Pilagá S.A. (Guaycolec- Formosa); Carlos Romero (Concordia- Entre Ríos); Eloy Agosti (Mercedes- Corrientes); Raúl Magnasco (Saladas-Corrientes); etc. All these businessmen made up with enthusiasm the Argentine Buffalo Breeders Association in 1983. Others started incorporating to this sector, buying reproducers: Bernardo de Hertelendy, "*La Florencia*" of Cabezas brothers, represented by Bernardo Alemán, Armando Rozemblum, Félix Noguera, Guillermo Martinez, Marco Zava, Elinor Reed, Raúl Lagger, Jean Marie Berger Vachon, Herman Miedvietzky, Jorge Félix Gómez, Eduardo Tomasella, Gustavo Piczman, Carlos Guanziroli, Carlos Taboada Candioti, Juan Carlos Relats, Francisco Carvajal, Fabio Clebañer, Carlos Snaider, Lagherheld, Javier Gonzalez Fraga, Omar Leston, etc.

Neverthelless, the trip to Brazil was not enough. Thanks to Enrique Bencich enthusiastic support, I could travel along three of the five continents (America, Europe and Asia) during more than 15 years. I did research on buffalo more efficiently than the one carried out in countries such as Italy, Venezuela, Brazil, the United States, Peru, Colombia, Trinidad, Uruguay, Paraguay, Bolivia, Bulgaria, Turkey, India, Pakistan, Philipines, Egypt, Thailand, England, Australia, etc.

In this list, there are countries I did not visit, but I received information during international congresses where we shared everything thanks to our common passion – the buffalo. The longest trips were two. The first, during three months, in 1981, started in San Pablo in January, passing along Italy and the United States, to finish in the Southwest of Brazil at the end of March. The trip was so long that Hernán Frette, my right hand in Santa Rosa Ranch, had to report weekly the things that were done and the missing ones, answering my phone calls, calculating the differences in the time zone. After this trip the first edition of the book about buffalo appeared. But all the photos had been veiled! One friend, Savigny Serejo Sauáia, who had taken the same photographs, helped me. They were good photographs because he had studied photography in the United States. I remember he gave me a shoebox full of photograph rolls to make what I wanted with them.

In 1987, I made another trip, which lasted 5 days, I traveled though Brazil from South to North, from Uruguayana, Río Grande do Sul up to

Boa Vista, Roaraima, to the North of the Amazon. I traveled by land the Venezuelan frontier, which I crossed from side to side. This time I made it with Savigny Sauáia, who was the principal buffalo breeder in Maranhao State, in the North of Brazil. We were extraordinarily served by the Reggeti Gomez and Moser Guerra's families.

During more than 15 years (until 1990 approximately) Enrique Bencich, as a businessperson, was very enthusiastic about the project. He decided to buy and organize general herds and pure herds. He worked with the three breeds: the Mediterranean principally, the Murrah and the Jafarabadi. In addition, he made all the trips possible that resulted in a great quantity of information. Everything was written in a book about buffalo production. The purpose was to have a book to orientate the buffalo breeders that were appearing in the country, Bencich was the only bisnessperson truly engaged with the buffalo (we had a herd of near 1,500 buffalo cows, the first in Argentina). I was the only technitian working for the cause. We produced the same impression in our circles: "there comes the crazy man with his buffalo circus…"

A friend and colleague told me ironically in 1982: "Marco now you will be rich because we can supply the troops with beef in Mavinas Islands: trying to reach the place with the buffalos… swimming!"

Later, this loneminess turned into interest that started growing gradually, not only in business circles but among technitians as well, thanks to the efficency in production that the species was demonstrating.

In 1980, more than 100 Jafarabadi buffalos were imported from Paraguay. In 1981, another importation from Paraguay failed, due to sanitary burocracy.

In 1984, the same occurred with another one made from Brazil, with Jafarabadi. With this tragedy, we lost the opportunity of bringing the best Jafarabadi genetics from Brazil. But miraculously, the same as in the 80s, Murrah and Jafarabadi of excellent quality, arrived in the country.

It was a hard way, at the expense of economic damages to livestock businesspeople of first class and to the professional prestige of the writer of this article.

I have to mention Argentine Buffalo Breeder Association (ABBA) president in the 80s, Mr. Elio Micheloni, a stock farmer of San Pablo, who was like my father in Brazil, who apart from helping me in editing my book there, traveled with me in his car along 7,500 km. We visited 44 Jafarabadi herds for the importation that finally failed in 1984.The Architect Jonas Camargo de Assumpcao, from Campinas, San Pablo, and the best Jafarabadi breeder in Brazil who also helped me, was my host (he translated my book into Portuguese) and finally years later, we could introduce his excellent Jafarabadi to Argentina.

I will never forget the endless but pleasant trip of 2,500 km done in 1984, together with the Veterinary Dr Alfredo Zeferino Rodrigues Correia. He was in charge of the sanitary section of the exportation. We traveled in his Ford Escort car, following the jail tracks full of buffalos, from Rio and San Pablo to Lazareto de Santana do Livramento (in the Brazilian and Uruguayan frontier). It was a severe winter, we covered them with black plastic protections but we had to take them out because the buffalos ate them. From Santana we followed by train up to Paso de los Libres.

Nevertheless, from all these we got enough experience and convinced Bencich to make a Sanitary Protocole clear, practical and feasible between Brazil and Argentina (negotiated by us personally in Buenos Aires and Brazilia),and it served Argentina to export reproducer bovines to Brazil. In 1989 and 1990, we made the first importations from Brazil without any problem. We bought herds in Río Grande do Sul for *Santa Rosa* Ranch, principally Mediterranean of Delfino Beck Barbosa, and Murrah of José Luiz Pons.

It is very important to mention that in 1981Bencich imported a little Mediterranen bull from Valsecchi of Eboli Herd, Salerno, Italy, which I had selected, being still a calf in 1980. It was brought to Ezeiza by plane in the middle of a “charter” of Chianina that came to *San Luis* Ranch from *Agipgas S.A*., situated in Cerrito, Entre Ríos. It was possible thanks to the help of Dr Alberto Viganó, my friend, General Director of ANABIC (Associazone Nazionale di Bovini Italiani da Carne), from Rome, great Chianina diffuser at world level.

This buffalo, which resulted exceptional, was also called “the Italian” in *Santa Rosa* and produced 300 to 400 exceptional daughters, during 13 or 15 years, with Mediterranean “Correntinian” mothers (descendents of the ones brought from Brazil in 1910), of great purity, I would say, consanguineous. With this crash of blood within the breed, a revolution was done in the Mediterranean in Argentina.

Picture 13: Santa Rosa Ranch (1.985): Mediterrnean Buffalo cows crossing of “The Italian” with “correntinian mothers”, resting in a pond.

Within the same working line, other blood lines were imported from Italy: in 1989 one male (*Cantante*) and three Mediterranean females. The trip stopovers were Salerno- Milán- Frankfurt, Buenos Aires; the last two steps we spent in Lufthansa cellars, covering the horns in order not to disturb the passangers floor! They were Evelina Salati de Salerno’s buffalos, with the milk and butcher highest genetics of Italy. One of the best Mediterranean bloods from Brazil was introduced too, bringing two bulls (*Príncipe* and *Zorro*), from Delfino Beck Barbosa’s Panorama fazenda, in Camacuá, Río Grande do Sul, in 1989.

As we have seen, miracuosly, there was Murrah in the country and everything of VR origin (Vicente Rodríguez da Cunha) from *Zebulandia* Ranch, of Aracatuba, San Pablo, descendents of the one brought by José (Dico) da Silva, my friend, in 1962, for his boss Vicente (Torres Homem) Rodríguez da Cunha. In this occasion *Karvadi*, a bull, founder of Nelore in Brazi was also imported. Nevertheless, the number in the country was not significant for Murrah breed. The Murrah “revolution” (today represents the 30% of the national herd) occurred in the years 91-96. First, it was an importation of 1,000 Murrah and Mediterranean breeding herds, which I coordinated for Félix Noguera.

We bought a very important nucleous of female and male Murrah of pedigree (Madhú and Orloff bulls) from *Barra Mansa* Ranch (one of the best in Brazil) belonging to Luiz Claudio Surugi Guimaraes, situated in Siqueira Campos, to the North of Paraná state. We brought them to Ituzaingó (Corrientes) and Montelindo (Formosa), through Foz do Iguazú, with a previous concentration in a field, Bela Vista Ranch, near Ponta Grossa, Paraná state, which I administrated for Noguera in Brazil.

These buffalo cows, in small proportion, included female Murrah breeds for Armando Rozemblum, for Javier González Fraga and for me (then I sold them to González Fraga). In 1986, I started personally Mediterranean buffalo purebreeding, thanks to the accessible buying allowed by Don Carlos Romero in *La Invernada,* Concordia, Entre Ríos. In this opportunity, Bernardo and Laura de Hertelendy and José Eloy and Liliana Agosti, among others, bought them, too.

Afterwards, in 1993 and 1994, an important breeder from Uruguayana (Río Grande do Sul, Brazil), Dr. Manoel Osorio Luzardo de Almeida, during that time president of ABCB, rented fields in Argentina (in Mercedes, Corrientes, in Misiones and in Formosa) and made several importations to Argentina, about 4,000 females, and the males.

The principal buyer was Félix Noguera. Juan Carlos Relats, Fabio Clebañer, Jorge Félix Gómez, Herman Miedvietzky, Omar Leston, Eduardo Tomasella, Jean Marie Berger Vachon, John Nelson, Carlos Guanziroli, Architect Terranova, Carlos Snaider, Jacobo Levitzky bought them, too.

In March 1991, we started producing milk and manufacturing cheese with Murrah buffalos imported from Brazil, in a society of friends, *Prolebú*, in *La Celia*, Carlos Casares, Buenos Aires, whose owners were the Scala family. Marco Zava, Jesús Reggeti, Javier González Fraga, Armando Rozemblum, Eugenio Scala and the person who was in charge of the dairy, the Brazilian zootechnician Luiz Fernando Aguirre were working partners.

With the time, we separated and every one went on by their own with the buffalo business.

Along these years, many Murrah and Murrah crossbreed breeders imported semen of Murrah pure bulls such as *Montenegro, Coloso, Topacio, Guatambú*, all of them from the *Fazenda Paineiras da Ingaí*, in Sarapuí, San Pablo, belonging to Wanderley Bernardes, the first and best milk producer in Brazil. His son Otavio Bernardes continues this work with excellence.

In 1994 due to sanitary problems, the frontier was closed and it was only reopened for 6 months in 1996. During this time, Luzardo brought 1,000 buffalo cows more for Noguera and I bought 17 excentional males (VR blood and Bulgarian blood) to Marcos Rodríguez da Cunha (Andradina San Pablo). He was one of the best Murrah breeders in those times (together with Luiz Claudio Guimaraes and Wanderley Bernardes). The buffalos were destined to Noguera's *Cabaña Coé Porá* herd, being the best Murray herd in Argentina.

I also took advantage of those 6 months to bring 300 Murray buffalo cows of excellent quality. I bought them to Luiz Pons de Uruguayana for Martín Devoto and Francisco Tejerina from Formosa.

In 1981, Bencich made with U.B.A. (University of Buenos Aires), through the Veterinary Dean Dr Elizalde, the first technological agreement. Thanks to this doctor, investigations were done about Artificial Insemination and Embryo Transfer, which later did not continue.

In 1986, the ABBA and the INTA made, under the leadership of Dr Garriz, Meat Technology Department of the INTA Castelar, the first evaluation and typification of the bubaline carcass, with a complete cutting up of the butcher cuts and evaluation of them, with tasting tests included. From yield to tasting, the results were excellent.

In the ABBA, a lot of work was done with genealogical registers to be able to reach Palermo with the close help of the BBBA (Brazilian Buffalo Breeders Association), ANAS B (Associazione Nazionale Allevatori Specie Bufalina) Italy and the ARA (Argentine Rural Association).

The investigations started controlling pure and crossbred herds by absortion. I integrated the team during decades, being the chief of the Genealogical Registers of the ABC. The Engr Alejandro Naón and the Veterinary Dr Federico Kyburg were inspectors and Mr Hernán Frette was the counsellor and collaborator in the cattle shows.

In 1986, the first buffalo presentation in Palermo Cattle Show took place. The level of the Mediterranean, Murrah and Jafarabadi reproducers was excellent. It was a total success: it was the comment of that year in Palermo. The animals were very well sold and the president of *Asobúfalo* from Venezuela Jesús Reggeti, visited us as well as many of the principal breeders from Brazil. There were more than 26 persons, coming from all the states of the federation, whom we attended with great pleasure, with a celebration in Bencich's palace and trips in his yacht, everything facilitated by the family with generosity.

The Brazilian delegation was integrated by Mr Elio Micheloni (BBBA President) and family, Mr Jonas Camargo from Assumpcao and his wife, Mr Antonio Cebrera Meno (filho), Mr Savigny Serejo Sauáia and his wife, Delfino Beck Barbosa, José Luiz Pons, Manoel Osorio Luzardo de Almeida, Luiz Claudio Surugi Guimaraes and Evaldo Canali, among others.

All of them came to the country delighted by the buffalo entrance in Palermo, one of the most prestigious cattle show of the world.

I remenber clearly some images, one is that of Enrique Bencich near the stairs wearing a neat blue blazer and a captain cap receiving the guests. Another one is that of Renata Mioto, descendent of a Veneto family (Venetian) settled in Uberaba, in a very rich region to the North of San Pablo State, married to Savigny Serejo Azuaya, from Maranhao State, my close friend and partner in the trip to India. She interpreted in a grand piano in one of Bencich's big rooms, several classical musics leaving everybody standing up enchanted by her grace and virtuosity. Everything mixed with the great brotherhood that there was, there is and there will be among the ones who love the buffalo and work with it.

The buffalo presence in Palermo was always mantained and is maintained with a stand to attend breeders and to have institutional force.

From 1988 to 1991 the buffalo, thanks to the work of Elvio Colombo (owner of Colombo and Magliano S.A.), was incorporated to what was the most important bull cattle show in the North of Argentina, in Reconquista where 700 bulls were sold. We made it with a beautiful stand of the ABBA, with roast buffalo beef for tasting and technical talks. In the cattle shows the buffalos started to be well sold and in increasing quantities, allowing new breeders (especially small and medium) to be incorporated.

In 1995, the National Rotating of Buffalos (as it began to be called) was moved to the cattle show of the Rural Society of Formosa, where

Noguera built an espectacular stand for the ABBA, the best of the place, with gridiron and dinning room included.

Nowadays, it is a tradition, and the Rotating goes for its XIIIth edition, always gathering many people with good sellings and tasting tests thanks to the effort of *formoseños* breeders.

In 1991, in Esquina, Corrientes, the First Meeting of the Southern region took place, with local and foreign specialists. Engineer Jesús Reggeti, from Hato Terecay, San Fernando de Apure, Venezuela, was invited for the first time (Picture 14). The meeting had the Provincial Government (Ricardo Leconte Governor) and National Senate (thanks to Senator Ramón Aguirre Lanari) support.

Picture 14: First Meeting Of. The Southern Región, Esquina (1991) : Veterinary Dr Federico Kyburg, Engr Marco Zava, Engr Jesús Reggeti Gómez, Engr Luciano Staiak Barbosa and Mr Delfino Beck Barbosa.

There were more than 300 people, from which 60 had come from Brazil. The following year the II Meeting took place in Uruguayana (Brazil).

On the other hand, year after year, the ABBA has organized 14 breeder meetings in the open field. They were always successful due to the interest that arouses in *Santa Rosa, Rincón del Guayaibí, Clarín, Rincón del Madregón, La Florencia, Don Enrique, Guazú Cuá, Loma Alta, La Salamandra*, among others (Picture 15).

Picture 15: The great buffalo family: in the XIIIth Meeting in the open field of the ABBA, *Rincón del Guayalbí* Ranch, Mercedes, Corrientes; Agosti Pietrantueno. (November 2002).

In 1992, Dr Gustavo Crudeli, started a tiredless and endless investigation about the buffalo, especially in reproduction, artificial insemination and milk and beef production. He did it and does it holding the chair of Physiopathology of Reproduction and Obstetrics in Veterinary Sciences School from N.N.E.U. (Corrientes); and with and excellent team formed by Drs Pablo Maldonado, Sebastián Flores, José Cedrés and Exequiel Patiño, among others.

Crudeli has also worked in genetic improvement through AI (Artificial Insemination) at fixed time in several herds of the country. He is the principal engine of an extraordinary event that occurred in the years 2000, 2002 and 2003: the First Mercosur Symposium with the participation of Brazilians and Venezuelans. The Expo Buffalo Fall of Corrientes is also beating records, with 400 buffalos sold at auction, at convenient prices and that it is the only auction exclusively for buffalos in the country (Picture 16). This could not have been possible without the close collaboration between the N.N.E.U., the Corrientes Rural Society (owner of the land where it takes place), the ABBA and the consignee Feganor S.A.

Picture 16: First Mercosur Symposium, Corrientes (April 2000). Armando Rozemblum, Humberto Tonhati, Jonas Carmargo de Assumpcao, Pietro Sampaio Baruselli, Javier González Fraga and Jesús Reggeti Gómez.

The results are clearly seen, and in 2004 courage increased and in Corrientes the II Buffalo Symposium of the Americas! is added to the previous activities.

In Tucuman, interest for the buffalo has started and today it is a door for the ANW (Argentine Northwest). Ten years ago Alberto Parra started to breed buffalos. Nowadays, he has 100 buffalo cows near Tucuman. At the end of the 90s the National University of Tucuman, through the Head of the Subject Dairy of the Zootecnia Course, Engr. German Bottger, and the RECELA (Reference Centre of Lactobacillus) through its head Dr Pesce de Ruiz Holgado, made a contract and started doing research on milk and Mozzarella properties. In addition, this year, they started to do research on beef.

In 2003, the First ANW Buffalo Expo took place, with Agosti buffalos (Mercedes, Corrientes), which allowed the introduction of new breeders from Tucuman.

In 27 years, conferences, talks, panels and round tables were endless in the country, looking for knowledge diffusion about the species.

Mr José Enrique Bencich, buffalo pioneer, was ABBA president during 19 years: from 1983 tol 2002; and nowadays is our Honorary President.

The current president, Engr Federico Romero, is a buffalo enthusiastic and is linked to one of the principal breeders (Salentein Argentina BV). In two years he has improved the economy of the ABBA (after the terrible 2002), and he is present in all the forums, defending the breeders' interests.

The Argentine bubaline culture, since the first times of *Santa Rosa* Ranch, and since the geanological registers in the ABBA, started to be known internationally. A proof of this is the appointments as judge to Marco Zava in the cattle show of Esteio in 1989 (Río Grande do Sul, Brazil), San Pablo 1991 (Sao Paulo, Brazil), and *La Dorada* 1995 (Magdalena Valley, Colombia) (Picture 17).

Picture 17: Marco Zava, judge in 1995, "La Dorada" National Exposition; Magdalena Valley; Colombia.

In 1985, IBF (International Buffalo Federation) was founded being Mohammed Shalash (Egypt) its first president. Argentina was a founder member through its representative Marco Zava in the Standing Commeettee. Mr Armando Rozemblum was also incorporated in 2001. The general secretary is in Rome and in charge of Dr Antonio Borghese.

The presidence is rotatory and is accomplished by the representative of the country that organizes the following World

Congress. The previous president was Mr Pablo Moser Guerra from Venezuela and the current one is Dr Prof Libertado Cruz, from Philipines. This Institution has already organized 6 World Congresses: in Egypt (1985), India (1988), Bulgaria (1991), Brazil (1994), Italy (1997) and Venezuela (2001). The 7° World Congress will be held in Philipines in the year 2004.

The IBF allows the interchange of information, to keep personal links valuable for the sector, international technical assistance that helps a lot to the development of our sector in the country.

In 2001 Otavio Bernardes, great Murrah breeder of San Pablo, Brazil skilful in coputers and heir of his father's passion for buffalos (the extraordinary Wanderley, the Brazilian bubaline milk father) created a buffalo forum in internet called "buffalogroups". It was spread from Brazil to the rest of the Americas and Europe too. This Forum is a golden tool for our updating and keeping personal contacts.

As the project *"Prolebu"* was stopped (in agreement with some friends), I restarted breeding Mediterraneans (pure pedigree) from December 19th, 1992 in my farm *Imará* in Mantilla, Corrientes with the help of Mr Tomás Rossi. We have worked and are working with great enthusiasm in management as well as in genetics. The results are spectacular (Picture 18).

Overall, the wheel is moving and we cannot stop it. It is a great pleasure to be a humble protagonist of this new cattle raising alternative in our country which in addition has one of the most important and prestigious livestocks (in spite of our polititians and ourselves).

Picture 18: Mediterranean Herd of Marco Zava's Imará farm; Mantilla, San Roque, Corrientes (March,l 2001). ANEr the banks of the *Batel* Marshes*,* calves of 20-45 days.

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CHAPTER 2

PARASITIC DISEASES

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1. INTRODUCTION AND ANTECEDENTS

The aim of this chapter is to put into the consideration of zoo-technicians; cattle raising technicians; students of agriculture and livestock production and producers the parasitic problems that affect the bubaline production in our country.

The knowledge of the problematic as regards parasitism will allow them to accomplish suitable managements of treatment and prevention, improving the efficiency of the productive systems.

In the subtropical area of Argentina in 1985, the buffalo herd was formed by 1,128 heads belonging to the Indian breeds: Mediterranean, Murrah and Jafarabadi.

Distributed in the provinces of:

- Formosa: 100+40+11=155
  (three farms).
- Corrientes: 350+200+20+20+3=593
  (five farms).
- Entre Ríos: 20+160+150+50=380
  (four farms). (A.B.B.A 1).

In the year 2002 the national herd went up to 55,000 heads (Crudeli, *et al,* 2002) and it is estimated that in the year 2004 it will go up to 70,000 heads (Crudeli, G.[2]).

Today the buffalo was incorporated to new provinces; there are farms where there are over 500 heads.

The plain analysis of these figures show us the fast expansion of the species (trend that is maintained) and the importance that this area of cattle production is acquiring.

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2. PARASITOLOGIC ASPECTS: THEIR IMPORTANCE

The internal parasites in general interfere negatively in digestive processes; preventing a suitable nourishment absorption (proteins; carbon hydrates; fats and minerals), which affect the reproductive development and capacity of the infected animals.

The external parasites in general cause irritation, which keeps the infected animals in a state of permanent uneasiness. The consequence is limited ingestion of food and digestive disturbances, producing the deficiencies mentioned in the previous paragraph.

Both kinds of parasites represented by numerous genera affect all the categories in high percentages.

The heaping conditions to which the different animal species are exposed to in the diverse managements implemented by men worsen the parasitism.

The final result is a decrease in the level of organic defenses, predisposing the hosts to catch infectious illnesses.

The parasitic diseases constitute in a way the most relevant health problem in animal production due to the direct or indirect damages that they produce.

The present productive systems, in some way, have placed the buffalo in environments different from the natural ones, where it evolved across centuries since its domestication.

The result was a rusticity loss and a common infestation with the parasite fauna of the bovine species, more and more related, as they share the same natural and artificial pasture systems.

Because of its great body growth, the bubaline in all the stages of its reproductive life ingest a greater volume of forage and therefore they parasitize more.

The parasites adapt quickly to new environmental conditions and develop their biological cycles producing enough eggs a day to guarantee the perpetuation of the species when contaminating waters and forages.

This phenomenon of adaptation together with the buffalo gregarious behavior favors the increase of the parasite population in the environment and the number of infected animals.

The parasitic diseases in buffalos are considered to be a restrictive factor in the performance of the herds, moreover where the weather conditions are favorable for parasite dissemination.

The most critical period for the development of these diseases is at the calf birth and it continues until it is two years of age (Starke, *et al*., 1992).

The most sensitive categories belong to the systems of breeding and fattening. The adults develop some grade of immunity and act as reservoir infecting constantly the environment where the herd is.

In general, these diseases continue in a sub-clinic way, mortality is rare so they are generally considered of little importance.

Great mistake! They are very important as they produce less beef and milk quantity, affecting directly their offspring. They will suffer a delay in their growth with unfavorable impact on their productive future.

Some of the economic losses these illnesses cause in the different animal species (including buffalos) in productive systems have been known for some decades.

They have been studied in different countries, for example: in Brazil, losses of 40 kg in relation to treated animals are mentioned (Láu, 2002).

Other losses have not been quantitatively evaluated due to their complexity, as they are produced along all the life causing decreased levels of productivity.

Less beef, less milk, less leather, less growth, less fertility, less amount of calves during their reproductive life, more infectious diseases and a greater mortality constitute a long chain of negative results, decreasing the profitability.

The impact in the field of Public Health that involves the human being is not known; in particular for those who carry out productive tasks and in general for those who consume the resulting products of their exploitation.

In Argentina very few publications deal with buffalo parasitoses; the ones that refer to epidemiologic aspects are absent and the losses have not been evaluated yet, it does not mean they do not exist.

This situation opens a wide scope for the research of the parasitic diseases that affect the *Bubalus bubalis.*

The information we give is the result of the parasitologic analysis and research carried out in the diagnostic service of the course.

We consider the parasitic diseases according to the location in the body, endoparasitoses (internal) and ectoparasitoses (external).

The endoparasites diagnosed in Argentina are:

- Protozoary: *Coccidios spp*.
- Nematoda: *Cooperia sp., Haemonchus sp., Oesophagostomum sp., Strongyloides sp., Toxocara sp. y Trichostongylus sp.*
- Cestoda: *Moniezia sp*
- Trematoda: *Fasciola hepatica* and others not identified.

The ectoparasites diagnosed correspond to: *Haematopinus tuberculatus; Boophilus microplus* y *Haematobia irritans.*

3. ENDOPARASITOSES

Toxocarosis

Parasitic disease produced by the *Toxocara vitulorum* (*Neoascaris vitulorum*), this vermi or round worm has a complex biological cycle.

The calves are born with the parasite, they are infected during the fetal growth (prenatal life); then they continue being infected by the ingestion of larvae present in the calostru and milk (lactogenic or transmammary way)

In the digestive tract of the buffalo calves, the parasites become adults which copulate and lay a huge amount of eggs, 8×10^{6} per female per day, which go out to the environment with feces.

Six weeks after calving, a high percentage is infected by the parasites. Láu (2002) states that a 100%.

Between the 4 and 6 month of life they start to eliminate adults of a big size (25 to 30 cm long and 0.5 cm of diameter) until they disappear in the digestive tract.

The pathogenesis is characterized by fetid diarrhea and colic that may end in a state of emaciation or death.

Due to its big size and being free in the intestine, the parasites can group together making balls (ileo – verminous), blocking and causing the breakage of the wall. The intestinal content, when passing to the peritoneum, causes a peritonitis that kills the host.

In India they contribute to the mortality of buffalo offspring (Soulsby, 1987).

The adults do not present pathological signs.

The buffalo calves ingest with the food and water eggs with infecting larvae that are freed inside the digestive tract. Then through blood and lymphatic way they are distributed forming cysts in the different tissues of the organism.

In the pregnant buffalo cows the parasites move during the last month of pregnancy, infecting the fetus and locating in the mammal glands, going to the calf during the lactation period.

The diagnosis is confirmed by the coprology analysis where the typical eggs are found or by the spontaneous disposal of adult specimens (25 to 30 cm) or by observing necropsies.

Treatment and prophylaxis: (see control).

Strongyloidosis

A parasitic illness produced by the *Strongyloides papillosus* parasite that has a more complex biological cycle than the *Toxocara vitulorum*.

Newly born animals are seriously affected, adults are not.

These vermi or round worms can reproduce during the free stage of their lives, without need of animal herds, which they infest and where they reproduce.

The buffalo offspring are infested at birth; they are infested by larvae during fetal growth (prenatal life). Then they continue being infested by the ingestion of larvae present in the calostru and milk (lactogenic or transmammary way).

These larvae get to the small intestine where they evolve sexually in 7 days, copulate and lay eggs that go out with the feces, there they leave the eggs and contaminate the environment.

The adult specimens are small 3.5 mm to 6 mm long and 0.5 mm of diameter. They cannot be seen with the naked eye.

The humid environments are highly favorable to the biological cycles.

They also go into the skin (percutaneous way), then through the blood reach the lungs and via bronchioles, bronchi and trachea, get to the pharynx where they are swallowed. They locate in the small intestine and in a week they evolve to copulate and lay eggs and start the cycle again.

At two weeks of birth the buffalo calves show positive diagnosis.

The pathogenesis is characterized by lesions of the intestinal mucus and liquid contents, causing digestive impairments (catarrhal enteritis) with diarrhea, anorexia, light anemia and weight loss. Deaths are not frequent.

Adults do not present pathological signs because a light infection at birth produces a marked immunity (Soulsby, 1987).

The diagnosis is confirmed by coprology analysis when the characteristic larval eggs are found.

Treatment and prophylaxis (see control).

Eimeriosis (Coccidiosis)

Parasitic illness produced by a microscopic element that parasitizes the inner part of the intestinal epithelium cells (endocellular parasites) which the parasite rapidly destroys together with the intestinal hairiness.

These coccidia of the *Eimeria* genus have many species, they are spherical, sub-spherical, ellipsoidal and ovoid according to the species, sizes vary from 45 to 11 microns.

They develop a biological cycle in a few days (one to three weeks).

It implies an asexual phase (schizogony) with two to three stages where they destroy different levels of the digestive wall.

A sexual phase continues (gametogony) forming an oocyst (zygote) that goes out with the feces, then a sporule (sporogony – form of resistance) and when it is ingested by an animal it frees the sporocysts that are introduced in the cells, starting the schizogony again.

This reproductive mechanism develops immunity on the part of the host that limits new infestations.

It affects the newly born animals. Several species that parasite the bovine are common to the buffalo.

The pathogenesis comprises lesions in the intestinal wall, it manifests with anemia, profuse diarrheas which cause dehydration and can be stained with blood causing emaciation and even death.

Those who work in intensive exploitations are afraid of this illness due to the high percentage of affected animals, up to a 100% in Italy (Medical Record 1996). Damages in growth and production can be economically important.

The diagnosis is confirmed by coprology analysis when the characteristic oocyst eggs are found.

Treatment and prophylaxis: (see control).

According to what has been mentioned before, during the first month of life, three genera of parasites present in the digestive tract cause disturbances in the digestion and absorption of nutrients, interfering with body growth and productivity (*Toxocara, Strongyloides y Eimeria*).

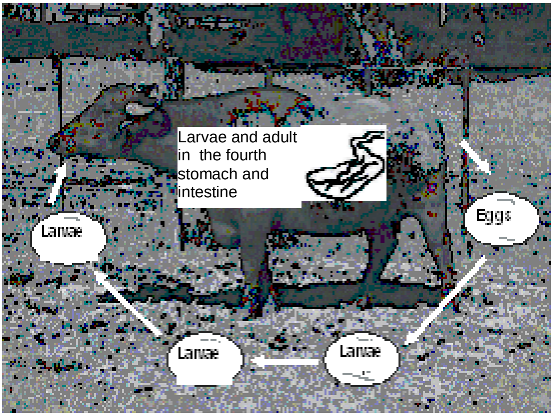
These are important data to bear in mind to implement suitable prophylactic managements.

When the calf is a month of age, the ingestion of forage starts due to the physiologic necessity of developing the proventricle glandular system. Together with the forage nematoda larvae of different families and genera with different species are incorporated, causing the verminous gastroenteritis (VGE) and others, like the *Oesofagostomus; Bunostomun, Moniezia* and Trematoda.

Verminous Gastroenteritis (V.G.E.)

It is a parasitic illness caused by different families of nematoda which affect the normal functioning of the digestive system.

The biological cycle is direct; four weeks are enough to develop it (Picture 19).



Picture 19 : Biological Cycle of nematoda.

The newly born calves do not have the right defenses. At a month of age they start eating tender grass incorporating at the same time the parasites in the form of larvae, they transform into adults, then copulate and the females lay eggs, which go out to the environment with the feces. In one or two weeks they free larvae that contaminate the forage and are ingested by other animals to start the cycle again. Positive diagnoses are obtained when the calf is two month of age.

They locate in the fourth stomach (*Haemonchus, Ostertagia y trichostrongylus*) and intestine (*Cooperia, Trichostrongylus, Oesofagostomun, Bunostomun*).

When the animals are being milked they suffer the consequences, less kg and growth, with a very critical period during weaning.

This also happens during the first year of fattening which delays impregnation as reproducers.

This situation compromises the productive future of the bulls and cows.

An adult which suffers growth impairments will have less capacity to add kg. in the fattening season.

The losses do not only occur in the clinical evolution but in the sub-clinical as well, which makes the problem worse as they are evident when evaluating the performance of the category during selling or selection management (late).

This pathology is worldly distributed and it is the main economic problem from the point of view of the hazards it causes in animal production. A suitable management should be carried out to avoid it.

Annual evolution (approximated): in spring a favorable period starts for the increase of the parasite population in the animals, it reaches the highest level in autumn then it remains latent during winter (unfavorable period) until it appears in spring and so on.

At this excellent time the pastures and waters are contaminated.

As the grasses are staking, the ruminants are highly parasitized, as they prefer the green sprouts which are infected with larvae.

When there is good and plenty of forage, the parasites are masked due to the height of the pasture and good nutrition but they produce losses of kg and growth (sub-clinical course).

When feeds decrease, clinical symptoms appear which indicate the greatest hazards in production.

To a greater or lesser extent, the pastures remain contaminated during all the year. There are not any farms free from parasites (exceptionally artificial pastures before bearing animals). It is necessary to bear in mind the exposure at which a specific category is, according to the time of the year that it is analyzed.

The rain distributes larvae and eggs everywhere.

The diagnosis in the animals is done by coprology, which makes it possible the control of the illnesses through the effective and varied therapeutics.

It is at the producer's hand. The relationship cost-benefit is widely favorable and the return of the investment is very quick.

An effective dose of a Benzimidazole of good quality for 250 kg is u$s 0.15 (0.15 cts).

In 90 to 120 days the profit obtained (in gains of kg of beef up to weaning) allows the necessary investment to develop the sanitary plans against parasitoses and infectious illnesses up to two years of age.

In parasitoses there are no fixed sanitary calendars as there are in infectious illnesses that are prevented at a determined age with vaccination.

The parasites evolve if the weather conditions are favorable; on the contrary they remain latent until the conditions are the right ones.

It is necessary to evaluate the evolution of the herds in a correct way, to apply the necessary preventive treatments.

Treatments: (see control)

Monieziosis (Cestoda)

The *Moniezia sp*. is a parasite of the ruminants, whose characteristic is to have a flat and segmented body in the form of ribbons.

They are attached by suckers in the small intestine; they can be several meters (600 cm) long and 1.5 cm wide (Soulsby, 1987).

Their biological cycle is indirect and they need an interim host (IH)

They are hermaphrodites and eliminate the mature segments with the feces. These segments have embryonated eggs inside, when they are ingested by acarus oribatids of different genera, they remain like cysticercoids until they are swallowed by the ruminants together with the grass and freed in the intestine by the digestive juices.

The biological cycle lasts about two months.

The embryos have hooks that are used to attach themselves to the mucous and from there they evolve until they have dimensions that are a cause of surprise and amazement in the necropsies.

The pathogen actions are determined by irritations of the intestinal wall (enteritis); blockage due to the size and amount of specimens and permanent withdrawal of nutrients through osmotic mechanisms along the length of the body.

The symptoms that can be observed are diarrhea, anemia and loss of body soundness, which cause a reduction in production.

The diagnosis is done by coprology techniques; the observation of proglottid in feces and /or necropsies.

It has been observed in animals of a year of age (fattening).

Treatment: (see control)

Distomatosis (Trematoda)

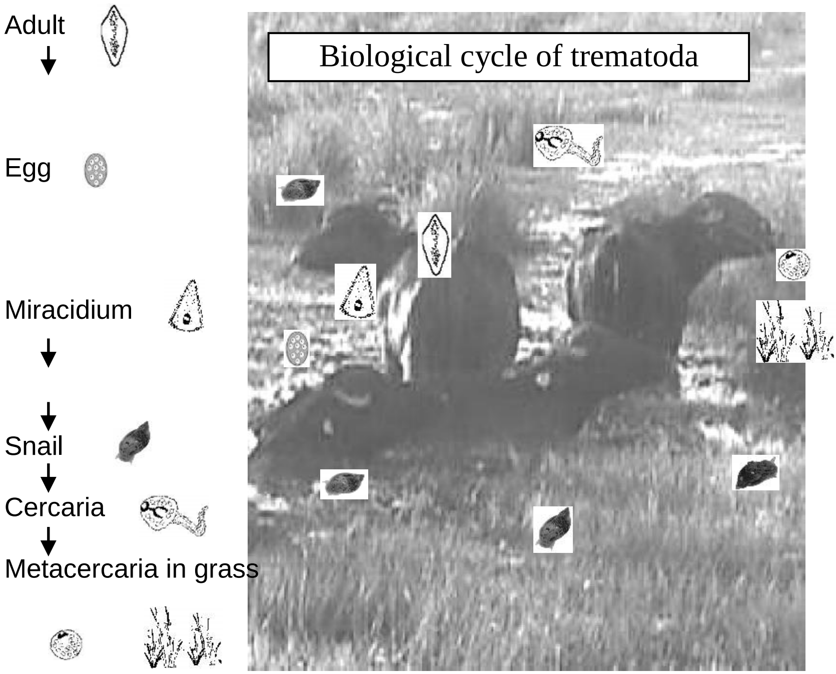
This parasitosis is produced by the *Fasciola hepatica,* a parasite of the ruminants, whose characteristic is a flat body, not segmented, 3 cm long and 1.5 cm wide, they have the shape of privet leaves and are located in the biliary canaliculus.

The biological cycle is indirect (Picture 20), it needs an interim host (IH).

They are hermaphrodites and they eliminate characteristic eggs that go to bowel lumen carried by the bilis and out with the feces.

They develop a miracidium (1 to 2 months) inside the eggs that remains there until the environment becomes aqueous (rains), then they leave the eggs to find a snail of the *Lymnaea sp* genus (IH) where they stay from two to three months transforming themselves.

In an aqueous environment they leave the snail and encyst in the pastures which are ingested by the animals. In this way they get to the intestine where they loose their wrappings and actively go through the intestinal wall to pierce the liver capsule and penetrate the hepatic parenchyma, until they reach the canaliculus where they evolve into adults.



Picture 20: Biological cycle of trematoda

The pathogen actions are a consequence of the irritations of the intestinal mucous, (enteritis) of the biliary canals (cholangitis) and hepatic impairments (hepatitis).

Gallstones and adult specimens block the normal drainage of the bilis, causing symptoms of jaundice (obstructive type) and alterations in the digestive processes with profuse diarrhea (aqueous caquexia);

anemia and loss of nutrients (due to difficult absorption and elimination) which affect productivity.

The diagnosis is done through special coprology techniques and / or necropsies.

In the year 2000 in a farm in the *Iberá* marshes (Corrientes), we took individual samples of 100 buffalo mothers as part of a research project to prove the efficiency of a diagnostic technique by coproantigen (not published). All the samples were positive (100%). We used Denis Stone Swanson's technique (special sedimentation).

Nevertheless their offspring which had been weaned a week before were negative.

There were eggs of other trematoda (two different) not identified.

Treatment (see control)

4. MANAGEMENT OF THE PARASITISM PROBLEM

We have mentioned at the beginning the need to carry out epidemiologic research to widen and deepen the limited knowledge we have today about the parasites of buffalos in Argentina.

Even though while they are the same genus that parasite the bovines, ovines and caprines, some management can be considered, taking into account the different stages of the productive process.

It is important to bear in mind that in the field of animal production prevention treatments are <u>necessary and imperative</u> to avoid consequences.

When the illness is evident through the symptoms, the losses have already taken place.

Though curative treatments are effective, the production time lost cannot be recovered.

The following steps and their management should be taken into account as they coincide with critical moments.

1. Pre-weaning at the “parturitionhead” (4 to 5 months of age).
2. Weaning (the most critical).
3. Before winter.
4. At the end of spring.
5. Fall.
6. Before winter.
7. Stress conditions.

Every time weaning tasks are carried out, either in common (eg. development) or special (eg. early weaning, to free the mother from the offspring) managements, the corresponding treatment should be applied.

If the weaning is early, it may be necessary to apply one more treatment before winter.

The day in which the calves are separated from their mothers they should be deparasitized, in this way it is possible to prevent the unmendable damages that the parasites would cause in an organism in a condition of stress.

In the processes of fattening, the objective is to avoid the three biological cycles or more, because of this it is necessary to deparasitize every 60 to 90 days.

In the “Reproducers” which have not finished the process of teeth change (stress) it is convenient to deparasitize when they start and finish impregnation.

In “Adults” there are not enough technical works that determine what happens in this category.

There are empirical references of colleagues that in difficult climatic years, the “Adults” show and important improvement in their body condition after being treated.

There is a concept that should always be present:

“Every stressing mechanism produces a fall in the organic defenses, which may lead to a serious parasitism”.

5. ENDOPARASITES CONTROL

Active principles to control:

Nematoda

Benzimidazoles, Imidotiazoles, Ivermectinas, Abamectinas, Doramectinas, Moxidectin and Phosphorates. Fosforados.

Cestoda

Benzimidazoles y Niclosamida

Trematoda

Triclabendazole, Netobimin, Closantel, Rafoxanide, Oxiclosamida, Nitroxinil.

Coccidium (Eimerias)

Sulfonamidas, Nitrofurazona, Amprolium.

These drugs are administered in a preventive way with the food and / or water.

When applied to curative treatments, they are used only in water, as the ill animals do not eat but they drink because of the intense thirst (polydipsia) caused by the dehydration that diarrhea produces.

The medication used should be prescribed by veterinarians according to the diagnosis and the evolution of the different herds.

The doses to be administered should be the ones indicated by the Pharmacology (therapeutic doses).

The trademarks should be effective. It is possible to verify the effectiveness through the coprology analysis pre and post treatment.

The objective is to obtain effectiveness with the least investment.

In the light of the experience obtained with bovine parasites it is convenient to use different drugs to avoid resistance to some parasitic genera.

"The producer who does not carry out the suitable control will suffer the losses and the veterinarian the loss of prestige".

6. WORKS CARRIED OUT

The results detailed below constitute the consequences of the analysis done in the 80s and in 2003 (Chart 2).

They simply constitute a basis to bear in mind in the research works that should be accomplished to have an exact idea of the epizootiologic development of the parasitoses and to obtain the best management for each one.

Lombardero (1987-1989) visited the ranch "Santa Rosa" near Esquina city - Corrientes to evaluate the parasitic aspects.

The work methodology consisted in the examination and taking samples to analyze from the different categories. The results were the following:

Verminous gastroenteritis (V.G.E.), the study was performed on the basis of quali-quantitative coprology and the culture of larvae (Chart 3).

It is worth to establish the prevalence of *Oesophagostomum sp.* in calves and adults of Mediterranean breed as well as the presence of *Haemonchus sp.* and *Cooperia sp*. in greater degree in young animals.

In Murrah breed *Haemonchus sp* and *Trichostrongylus sp.* prevail, the percentage of *Strongyloides* has not been determined, approximately a 20/30 percent could be established.

Chart 2: Quantitative Coprology Results, (eggs per grame).

Season	Category	Mediterranean	Murrah	Jafarabadi
Winter	Calves	0	25	-
	Buffalo cows	0	50 (c)	-
	Buffalo bulls	0	50 (c)	-
Spring	Calves	25	0	-
	Buffalo cows	25	25 (a)	-
	Buffalo bulls	25	25)	-
Fall	Calves	-	850 (b)	1100 (c)
	Buffalo cows	-	0	0
	Buffalo bulls	0	0	0

*Chart of References (-) feces was not obtained. 0 (-) Result.
(a) Oocysts of *Eimeria sp* only in regular quantity.
(b) only *Strongyloides* from three calves and 15,300 e.p.g. of *Toxocara vitulorum*.
(c) only *Strongyloides* in one calf.

Chart 3: Results corresponding to larvae cultures.

Agents of V.G.E.	Mediterranean		Murrah		Jafarabadi	
			adult – calves			
Oesophagostomum sp.	50 %	80 %	-	20 %	-	-
Cooperia sp.	20 %	10 %	-	0 %	-	-
Haemonchus sp	30 %	5 %	-	40 %	-	-
Trichostonbylus sp	0 %	5 %	-	40 %	-	-
Strongyloides sp	0 %	0 %	-	YES	-	-

Reference: These results correspond to the larvae culture from the material obtained in 1987, which resulted positive to the quantitative coprology that corresponds to each breed.

It is worth mentionining that the sampling in 1988 was performed 4 months after having been deparasited with Febantel [(3)] therefore the figures were negative.

Only the presence of two species not considered in V.G.E. was recorded, like *Strongyloides sp*. and *Toxocara-vitulorum* in large quantities.

<u>Hepatic Fasciola:</u> The search of hepatic *Fasciola* eggs was performed using the Dennis, Stone & Swamson's method in both opportunities with negative result.

<u>Coccidiosis:</u> A regular quantity of *Eimeria sp*. Oocysts was observed in adult fecal samples from Murrah breed.

According to reports from farm staff the coccidiosis seems to be an important problem, because of this calves are habitually treated with "Sulphas" orally, when diarrheic symptoms are present in the calves of the herd.

Culture of larvae: The three samples of the Murrah breed confirmed only the presence of L3.*Strongyloides sp.*

Coprology using the Dennis, Stone & Swamson's method to determine trematoda eggs was performed and the results were (-) negative in both years.

In 2003 quantitative coprology analysis and larvae cultures were performed to determine the genus present in Empedrado and Itatí (Corrientes) and in Formosa (Chart 4).

The material analyzed corresponds to weanings from 7 to 10 months of age, which have received antiparasitic treatment two months before obtaining the sample (Empedrado and Formosa).

In Itatí they were not deparasitized.

Chart 4: Results of quantitative coprology analysis and larvae cultures.

Place	Breeds	Results	Larvae
Empedrado	Varied	75 epg	*Copperia sp*
Iratí	Varied	130 epg	*Cooperia sp* *Haemonchus ha.* Oesophagostomum sp.
Formosa	Varied	30 epg	*Cooperia sp Haemonchus sp*

7. ECTOPARASITOSES

The bubaline evolution in an environment preferentially aquatic has made this species quite refractory to external parasitoses, which are prevented with mud. (Picture 21)

The fact of being exploited by men in productive processes has changed the buffalos' life habitat and it has exposed them to be parasitized by genera and species which rarely occur in natural environment. Even though in unfavorable climatic periods, when leaving the water or when the environment is dry. They are common parasites.

Picture 21: Natural control of ectoparasites.

The **Hematopinosis** is caused by the *Haematopinus tuberculatus*, the buffalo anopluro louse. It is the most important ectoparasite because of the permanent irritation and blood sucking; the parasitized animal scratches continuously damaging its body in few days.

The first research work published in our country (Moriena *et al,* 1982) about buffalo parasites was motivated by a herd imported from Paraguay that stayed in "*Cambá Punta*" quarantine station - Corrientes.

The inspection performed to groups of different ages made it possible to determine the presence of eggs and adults. They were seen with the naked eye due to their big size 3 to 4.5 mm long by 1.4 to 2.2 mm wide.

The distribution is general; there is no preference for anatomic areas.

The most affected one was the Mediterranean breed as it has the longest hair.

Calves – in the three breeds – are also affected as they have high hair density.

Parasites are spread through contact; their biological cycle is direct and from egg to adult it takes from 18 to 25 days, this is the reason for the rapid increase of the population when there is a favorable period.

This sucking louse reproduces more actively in cold weather, coinciding with the heat period, in spite of being a polyestrus species, which according to Pérez and Pérez (4) is a characteristic high natural selection species.

Its proliferation is favored, as the buffalos do not visit aquatic environments (because of cold or dry weather) which avoids the skin protection with mud (natural control).

Control: Baths with a piretroid (5) (flumetrine) at the end of Fall (June) once a year according to the parasitism incidence were performed not only to the general herd but to the herd of the three breeds. The treatment was very effective.

It is convenient when performing rectal tact to explore genitals and to detect pregnancy to search for nits among the hairs of the tail end (place where they hide).

If it is positive, apply the preventive treatment.

In Brazil the effectiveness of the different avermectinas was shown (Bastianetto, *et al.*, 2002).

The phosphorated organs like the Triclorfon and Cumafos can be alternatives of treatments due to the great insecticide power they contain.

They should not be given to gestating buffalo cows (danger of abortion) and those in the lactation period as they contaminate the milk.

Apart from the treatments of immersion baths or injections, “pour on; Spot on and / or aspersion baths can be used.

The **Boophilosis** is caused by the *Boophilus microplus*, the common bovine chigger.

In the thorough inspections performed in 1987-1988 in about 100 buffalos no specimen could be detected.

Perrier, J.J (1987) [(6)] informs the finding of chiggers in the lower eyelid of a young buffalo.

It was mentioned above that buffalos are exposed to baths, once a year (June) when it is cold to fight pediculosis.

As the chiggers are sensitive to the same active principles used for lice they are simultaneously controlled.

When the weather is hot and it is a favorable time for the chiggers, the rain season starts, the animals return to the aquatic environment and the chiggers are naturally controlled.

Comparing with the bovine, the buffalo is refractory to chiggers.

The farm staffs inform that in calves chiggers can be found as their skin is thinner.

In adults, it seems that the resistance to infestation would be due to: 1) thickness of the leather, 2) aquatic habits and 3) aptitude for wallowing in the mud.

Muñoz Cobeñas (1987) published the finding of *Boophilus microplus* in buffaloes from Corrientes.

That is the only genus of chigger present; others like -*Amblyoma* y *Ripicephalus*- were not reported.

The **Haematobiosis** is caused by the *Haematobia irritans* which also parasitize the bovine.

It is commonly known as the “fly of the horns or little fly”. It does not produce great problems.

The exiguous *Haematobia* (Soulsby, 1987), is a natural species of the buffalo from India and it causes problems in the buffalo productive capacity; up to now it has not been reported in our country.

If a treatment is necessary, the fly is sensitive to the drugs mentioned for lice and chiggers.

Other parasitoses like the **skin Myiasis** (common *bichera*) produced by *Cochliomyia hominivorax* and the **Dermatobiosis** (warble fly or worm) caused by *Dermatobia hominis*, has not been reported yet.

8. FINAL CONSIDERATIONS

The parasite problems, even when they have different causes and they are very complex to manage within the productive processes, can be easily controlled.

It is a question of care and follow-up.

Even when it is impossible to eradicate them for ever, it is possible to reach levels compatible with production (income) and to avoid the losses that the subclinical presentations produce.

To manage the parasitoses adequately, the technicians, professionals and producers, should bear in mind the permanent existence of parasites in the herds in the environment where the animals grass and they should not forget that the subclinical effect can be suppressed with treatments.

The effective treatments control the parasites, but the animals are infested again, when they feed and drink and develop the biological cycles in the times previously estimated according to the genus.

Because of this it is necessary to pay attention to the evolution of the herds, to apply the necessary preventive treatments.

In the different categories, mainly breeding and fattening, the color of the animals should be considered.

The hair must be pleasant to look at (shine and color) and to feel (strong and flexible).

This condition shows us that the hair follicles are well irrigated and nourished. This happens when the organisms work physiologically well.

On the contrary if the hair is dry, it does not shine, it is weak and easily broken, it shows us follicular malnutrition, characteristic of the states of anemia.

Kilogram losses and delay in the growth of the category show common problems in a population, which in general are due to parasite diseases.

The ideal thing would be previous diagnosis, though the parameters mentioned and the critical moments anticipate the actions to follow for preventive control.

NOTES

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CHAPTER 3

BEEF YIELD OF THE BUFFALO

José F. Cedrés

In this chapter some results of works carried out by the author and collaborators are transcribed. The research is about buffalos raised on natural pastures in low fields of the Argentine northeast (ANE), a large part of the surface of these fields are flooded most of the year. The animals were from 24 to 32 months of age with a mean of 28 for the group.

Together with the description of the work, comparisons are made with the results reported by other researchers in buffalos as well as in bovines, which are in different models of production and with different variables such as: breed, age, nutrition, confinement, climate and others. Frequently the variables cause the results to be dissimilar but at the same time are useful to make comparisons and to choose one or other production alternative.

BUFFALO BEEF PRODUCTION IN THE WORLD

Buffalo beef production is indisputably an activity of great importance in many countries of the world.

At world level it occupies the fifth position in importance per volume produced after porcine, bovine, ovine and caprine meat (Chart 5).

In 2002 according to FAO the meat world production of all the species went up to 245.0 million tons (T) from which 1.2 %, i.e. 3.0 million T were buffalo beef.

Between 1970 and 2000 the increase in bubaline beef production was 130.8%, on the other hand the increase in bovine beef production was 48.6% in the same period.

Argentina has the third bubaline population in the American Continent after Brazil and Venezuela. The present population is estimated in 57,000 heads concentrated mostly in the humid subtropics of the northeast of Argentina, in the provinces of Corrientes, Chaco, Misiones, Formosa and the north of Santa Fé, Crudelli *et al.* (2002)**.** Corrientes is the province with the greatest amount of buffalos in the country, over 32,000 heads.

Chart 5: Beef world production per species (millions of tons).

Animal	Year				Increase in the period (%)
	1970	**1980**	**1990**	**2000**	
Porcine	35.8	52.6	69.8	89.5	150.0
Bovine	38.3	45.5	53.4	56.9	48.6
Ovine	5.5	5.6	6.9	7.5	36.7
Caprine	1.3	1.7	2.7	3.8	192.3
Bubaline	**1.3**	**1.6**	**2.3**	**3.0**	**130.8**
Other	18.2	29.4	43.4	72.9	300.5
Total	100.4	136.4	179.8	233.6	132.7

Sourse: FAO (2003)

SLAUGHTER WEIGHT, YIELD AND TYPIFICATION

In any rational exploitation of beef production, producers want the animals to be able to convert, in the shortest time, the feed consumed for their growth and termination. The animals should have a good daily weight gain so that at the slaughter time carcasses with a good relationship among muscle, bone and fat are obtained.

The main characteristics to obtain a carcass of high yield for the industrialist are an optimal conformation and a just termination of the carcass. The conformation refers to the relationship muscle / bone especially in the areas of greater commercial value. This value is subject to the correct distribution of the muscular mass and its adjacent fat. It is also important the fat color to be creamy white or nacreous white, aspects which are sought by the consumers as they indicate youth and good nutrition.

The animal termination looked for differs according to the market it is being produced. If slaughter plants for exportation are being supplied the corporal status will have to be of an excellent butcher conformation. The fat thickness should not be more than 10 mm thick, measured between the tenth and eleventh thoracic vertebrae of the carcass. The skeleton size should correspond to a 480 kg live animal or more. The fat excess in the carcass constitutes an important loss in the cutting up of the animal. Most of the chilled and frozen cuts without bone exported by Argentina are red. In general they present a maximum of 2 to 3% of removable visible fat. On the other hand the slaughter plants that supply supermarkets and butcher shops prefer lighter animals with little dorsal fat. If it is possible the fat should not exceed 5 mm of thickness. This characteristic is a mark of tenderness and a good taste and at the same time it allows a maximum yield in the cutting up of the animal as there is less waste in the preparation of the cuts.

It is different when the person who commercializes the animal is the slaughterer; in general he prefers fatter animals as the yield at the hook is greater. When transferring the price of the half carcass the slaughterer obtains more income as the cattle was paid for live kg, this is against the interests of the butcher as he obtains less beef yield.

When the animal obtains a high yield in the hook due to fat excess, in the cutting up the yield is not so good because of the excessive slashing, that is why it should be avoided.

Now consumers in our country as well as in Europe in general prefer lean meat, with some intramuscular fat (streaked), as it determines tenderness and it also gives beef the taste and sensation of juiciness.

The best commercial integration of the half carcass is obtained with a greater proportion in the hindquarter where the most valuable cuts are located. From this hindquarter the most important cuts for the Hilton quote are obtained. It is important to bear in mind the percentage of the Hind *Pistola* Cut on the half carcass which represents in the steers approximate variations of about 42 to 48% according to the phenotype evaluated.

The muscular yield of the Hind *Pistola* quarter varies mainly due to the fat content. The greater the amount of fat the less muscular proportion in the Hind *Pistola* quarter, the same happens to all the carcasses. The bone keeps almost a constant with little variability.

The age is one of the reasons that influences more in the animal yield, as once they have reached their height they increase the thoracic perimeter causing the depreciation of the carcass integration provided that the cuts of forequarter are the ones that have less commercial value.

As it has already been mentioned the slaughter weight of the animal obtained in a short time is one of the main indicators of the quality of the carcass and it is directly related to the meat tenderness. Unfortunately the typification system in Argentina does not consider this factor that most current systems in other countries do. A steer of three years or more with four to six permanent teeth costs the same as another one of about 2 years with milk teeth and which has been well fed and raised.

In the typification system two parameters well differentiated are considered: the relationship muscle / bone, (conformation or type) which is identified with letters, differentiating in the steer category the following types: JJ (superior), J (very good), U (good), U_2 (medium), N (fair), T (inferior) and A (bad). To establish the conformation types it is necessary to observe the half carcass in its internal surface as well as its external one and its profile i.e. on the side of the sirloin. In this way it is possible to see the shapes, surfaces and profiles that reveal the muscular mass development, relating the shapes observed with the bone structure, discriminating the fat participation in the determination of those shapes. The second parameter is the relationship muscle / fat (degree of fat or termination) which values the subcutaneous tissue fattening, both in its distribution and in its thickness. In addition the greater or lesser disposition of fat found among the muscles (inter-muscular fat), the presence of fat among the vertebrae and areas such as the basis of the tail and the chest and the fat remains of the castration, adipose tissue surrounding kidneys and pelvic, establish five degrees of fat that are represented with numbers from 0 to 5. The following adjectives correspond to the numbers: rare, not abundant, moderately abundant, abundant but even, exceeded and or badly distributed. The fat excess in the animal termination makes the beef content imprecise as the intermuscular and subcutaneous fats are responsible for widening the animals visually, confusing the butcher quality as regards muscle percentage. After the evaluations of both parameters the types are discriminated with different degrees of fat to determine the carcass quality, there are two qualities: Special Consumption and Consumption.

Cedrés, *et al.* (2003) in a work carried out from December 2001 to October 2002 found a net slaughter yield of 51.40%. The sample included two hundred and twelve buffalo steers of the Murrah, Mediterranean and their crossbreeds raised in an extensive way in farms of the provinces of Formosa, Corrientes and Chaco, with a dental age of 24 to 30 months, being destined to slaughtering in slaughter plants Type "A" located in the provinces of Corrientes and Misiones. The figure is considered acceptable despite being inferior to the historical mean for bovine steers; this is compensated by the live animal weight obtained in less time. The typification obtained was quite homogeneous among the samples, a greater quantity of U_2-1 was present and it coincides with the observations of buffalos slaughtered in the area and comparable to the values of the bovine piebald steers.

Mansutti *et al*., (1997) in a study where 33 water buffalos not castrated, mainly Murrah and 18 bovines with zebu features not castrated were used, conclude that the buffalos yield less in carcass compared with the bovines. They explain that these differences are due to the fact that the leather is heavier and to the great proportion of their full live weight such as digestive tract with a greater gastrointestinal content.

Garriz *et al*. (1982) in a work carried out on seven steers of Criollo Breed raised from the eight months of average age (weaning) to twenty months were fed in the open fields using the following pastures, oat, white clover, alfalfa, forage sorghum, Rhodes grass and some natural pastures like fork stake grass and *setarias* (perennial sub tropical grass). During the last three months previous to the slaughtering they received a supplement consisting in hay, alfalfa and ground corn grain. At the slaughter time the animals had the following general characteristics: live weight in the open field 522.00 kg; slaughter live weight 463.00 kg process of eliminating dung 59 kg; age at slaughter time 32 months, net carcass yield 60.50%.

Capellari *et al.* (2002) working with a group of ten crossbred steers Zebu x Hereford, fed on natural pastures and receiving a seasonal adjusted supplementation in winter, which at the slaughter time were between 32 and 34 months of age, found: live weight 430.50 kg. carcass weight 217.70 kg, net yield 50.57 %. They also reported the head, legs and leather yield which were 2.59 %, 1.55% and 8.58% respectively.

Jorge (1999) reports his own work and several from other authors in which buffalos from different ages and raising systems were used. The buffalos were compared with bovines. An average net yield of 52.10% was found in six groups of the Mediterranean breed. The bovines of different genetic groups had an average net yield of 56.37%.

Cedres (2002) Personal communication. A study performed in *Tomás Arias S. A.* and *Yaguané* slaughter plants about the slaughtering of seventy nine (79) buffalos gave an average live weight of 533.75 kilograms and a net yield of 51.62 % average. The buffalo history was unknown. They came from Corrientes and Santa Fé and were classified seventy five (75) as steers and four (4) as bulls. In the same work the typifications of one hundred and thirty (130) steers were recorded, as a result one hundred and three (103) carcasses with typification U_2 – 1, twenty one (21) U_2 – 2 and six (6) typified as U – 1.-

The results found in the current work can be seen in Chart 6. They show the characteristics of the steers used, the yield and typification as well as their age and weight.

Chart 6: Live weight in the open field, yield and typification of carcasses of buffalo steers in the ANE.

Weight	Age	Typification	Net Yield	Breeds
530.70 kg.	28 months	U_2-1	52.64%	Murrah, Mediterranean and crossbreedings

Source: Cedrés, J. F. (2003)

Comparing our results with the ones obtained by Garriz *et al.* (1982) in bovines of older average slaughter age, it was found that the bovines reached a weight in the open fields of 522 kg, less than the buffalos, but the yield was significantly greater in the bovines (60.50%). It is worth noting that the yield in buffalos was calculated without the process of eliminating dung i.e. on the live weight in the field, on the contrary the bovines were evaluated after undergoing such process. The typification coincided in both cases. Analyzing the results of these experiences and bearing in mind that the feed received by the bovine cattle during all the production period was on cultivated pastures of excellent nutritive quality and finished with a supplement of hay and ground corn grain, it is possible to observe that the buffalos gain weight even with low quality pastures more efficiently than bovines.

If the results obtained in bovines by Capellari *et al.* (2002) are compared, the slaughter weight of the buffalos was 100 kg. more, even when they received less quality feed. The carcass net yield in the bovines was also inferior, an unusual datum as in most of the statistics the bovines have greater yields.

The net yield 52.63 % reached by the specimens of the study is similar to the ones found in buffalos from this area by Cedrés *et al.* (2003) and inferior to the average of the bovine steers finished in the region, being compensated by the greater weight obtained in the half carcass in less time.

It can be agreed with Mansutti *et al.* (1997) that the buffalo yield is less than the bovine one, due to the heavier weight of the leather, head and legs and the greater proportion of the digestive content in the slaughtered animal.

As it can be seen later in the results of our work, the weight of the offals have a negative influence in the yield but less than the other subproducts.

The results obtained as regards slaughter weight in this experience let us conclude that the buffalo presents an excellent adaptation to the ANE region because of its rusticity and the ability to convert natural pastures of low digestibility.

The typification recorded was quite homogeneous among the samples, coinciding with the observation of the buffalos slaughtered in the area and comparable to the figures of the bovine black steers.

EVALUATION OF THE HALF CARCASSES.

The figures found in the half carcasses are shown in Chart 7. The decrease caused by the chilling process is within the normal parameters of the bovine species which would be the most analogous.

Chart 7: Absolute and relative values of the warm and chilled buffalos half carcasses and weight and yield of the chilled half carcass components.

Variables	Live weight	Warm½ carcass	Chilled ½ carcass	Decrease	Muscle	Bone	Fat
Average (kg)	530.70	139.67	136.56	3.11	97.84	28.80	8.90
S. D.		11.83	11.75	0.23	8.86	3.96	1.61
Yield (%)	52.64	26.32	25.73	2.26	71.65	21.09	6.51

Source: Cedrés, J. F. (2003)

The percentages of the muscle component recorded are similar to the ones described by Charles *et al.* (1970) and Ognjanovik *et al.* (1970), numerically inferior to the 73.43 percent reported by Torres Mignaguy (inedited). In the last one, it is necessary to bear in mind that the inquiry was performed on one specimen of fourteen months of age in which a reduced quantity of fat was observed.

Comparing our data with the other authors' in buffalos, it was observed that the percentage of muscle was scarcely superior to the ones indicated by Nacimiento *et al.* (1989) and Nascimento and Moura Carvalho (1993), 68.88% and 69.73% respectively and significantly superior to the ones reported by Romita *et al*. (1979), Moletta *et al*. (1987), Muller (1994) and Jorge *et al.* (1997) who give values of 66.46%; 57.90%; 59.50 and 55.90% respectively. The difference with the last ones should be attributable to the confinement and diet received by the animals. It results in an increase in the quantity of fat in detriment of muscle.

The bones total weight per half carcass is similar to the weight reported by Charles *et al.,* (1970) and Torres Mignaguy (inedited), inferior to the cites of Romita *et al.* (1979) and Moletta *et al.* (1987) who obtained 22.96 % and 25.70 % respectively and superior to the values obtained by Ognjanovick *et al.* (1970); Polihronov (1974); Muller (1994); Jorge *et al*. (1997); Nascimento (1989) and Nascimento and Moura Carvalho (1993) who reported figures between 16.05% and 19.54%.

The fat value found in this work was 6.51 % which is coherent with the fat degree described in the typification. Comparing with the bibliography used this result was scarcely superior to the ones cited by Charles *et al.* (1970), who reports a value of 4.9 % and Torres Mignaguy (inedited) (3.64 %). This last figure is the one that shows the greatest difference. It is coherent as the experience was carried out in one buffalo of fourteen months, age in which the animal is in the middle of its growth being bone and muscle production more important than fat.

On the contrary they were inferior to the ones reported by Romita *et al*. (1979) and Nascimento *et. al.* (1989) and Nascimento and Moura Carvalho (1993) who report values of 10.58% and 9.17% respectively. They are significantly inferior to the values cited by Muller (1994) and Jorge *et al.* (1997) who obtained values of 21.14% and 27.6% respectively. These figures are justified as cultivated pastures were used in the first and confined animals in the second.

Comparing with the results in bovines of Garriz *et al.* (1982) in Argentine *criollo* steers, who report values of 68.12% in muscle, 16.22% in bone and 13.00% in fat, the percentage in muscle and bone was superior and inferior in fat for buffalos.

The research work carried out by Rebak *et al.* (2002) about the cutting up yield and commercial cuts from two biotypes of steers crossbred 2/3 Zebu (2/3Z) and 2/3 Hereford (2/3H) of 32 to 34 months of age, raised in the north of Corrientes on natural pastures with a seasonal supplementation in winter, gave the following results in the composition of the half carcass whose weights were112 ± 7.78 kg. and 100.5 ± 8.49 kg respectively: Muscle 71.11%, bone 19.30% and fat 4.33%. It can be observed a very significant difference in favor of the buffalos in the weight of the half carcass. The relative values of the muscle component are similar. On the contrary the percentages of bone and fat were inferior in the bovine. It is interesting to observe that these animals gave less fat quantity than the buffalos.

Considering the results of these parameters and others, related to the adipose tissue, the lean beef of the buffalo carcass raised in the open fields with regard to the bovines is highlighted. It is a desirable quality in the present market trends.

Even when it could be observed that the bone yield of the buffalo carcass is bigger than in the bovines most of the times, this difference does not influence the beef quality of the carcass as it has a good muscle / bone relationship (parameter indicating quality) and it is also compensated by the little percentage of fat present in the carcass.

The muscle, bone and fat components of the buffalo half carcass found in this work have a good relationship, showing a high yield in muscle, a moderate percentage of bone, and a low relative value of fat. These values are similar to the ones found by other authors in buffalos raised in the same conditions. But the muscle percentage decreases while the fat increases when they are compared to animals raised on implanted pastures or with special feed. The muscle and bone percentages are greater in buffalos than in bovines but the fat is the other way round.

Hindquarter

The yield of the hindquarter with bone (in Argentina is divided behind the last rib) in relation to the half carcass found in this research was 46.75%. It can be considered very good and it agrees with the historical values cited for bovines (Chart 8).

Chart 8: Absolute and relative values of the hindquarter, forequarter and *pistola* .

Description	Hindquarter			Forequarter			*Pistola* Cut		
	W. (1) Kg	**S.D.**	**Y. (2) %**	**W.(1) kg**	**S.D.**	**Y. (2) %**	**W.(1) Kg**	**S.D.**	**Y. (2) %**
Total	63.84	6.12	46.76	73.19	5.50	53.60	57.00	5.43	42.11
	M. (3)	**B. (4)**	**F. (5)**	**M. (3)**	**B. (4)**	**F. (5)**	**M. (3)**	**B. (4)**	**F. (5)**
Average (kg)	46.07	12.66	4.60	51.73	17.11	4.68	39.48	12.74	3.52
S. D.	5.15	1.68	1.00	3.95	1.17	0.59	3.78	1.82	1.23
Y(2) (%)	72.15	19.82	7.21	70.68	23.38	6.39	68.65	22.16	6.13

Source: Cedrés J. F. (2003). W (1) Weight, Y (2) Yield., M. (3) Muscle; B. (4) Bone, F. (5) Fat. S.D. Standard Deviation.

These results compared with the work of Jorge *et al.* (1999), considering the weights that correspond to the Argentine forequarters and hindquarters are similar, even if the primary cuts of Brazil described by the author do not coincide anatomically. Such authors found similar yields in the three bubaline genetic groups. Nevertheless, in only one group of bovine (Nelore) of four years of age the yield was similar to the buffalos', it reached 47.1% for the hindquarter, the yield for this quarter was in the groups of 1.5 and 2.0 years of age.

The percentages of the muscle, bone, and fat components of the hindquarter with regard to the half carcass have similar values. It can be observed a slight increase in muscle and fat and a little decrease in bone weight.

Forequarter

Relating to the half carcass, contrary to the values found in the Hindquarter, in this cut it is possible to find a greater bone weight and a muscle decrease (Chart 8).

Pistola Cut

The values found about weight and yield of the *Pistola* Cut (Chart 8) can be considered satisfactory as regards the relationship muscle, bone and fat. It is possible to observe a greater percentage of bone with detriment of muscle and fat. The yield was similar to the 41.56%.cited by Torres Mignaguy (inedited).

The weight and yield of the *Pistola* Cut reported by Garriz *et al.* (1982) was 62.1 kg and 45% respectively in Argentine *criollo* steers, superior to the ones of the current work (57.00 kg – 42.11%). In a comparative chart done by the same authors on different breeds and crossbreeds it can be observed that the absolute and relative values are scarcely inferior in buffalos as regards the crossbreeds: Holstein Argentine x British (59.7 kg - 44.9%), moderately inferior to the crossbreeds: Charolés x British (62.9 kg - 46.9%), Aberdeen Angus x Limousin (46.5%), Hereford x Nelore (60.9 kg – 49.2%) and Brown Swiss x Nelore (62.4 – 50.45%).

The muscle, bone and fat percentages of the hindquarter as regards the half carcass have similar values. A slight positive difference in muscle and fat and a scarce weight decrease can be observed.

The *Pistola* Cut yield was inferior to the values reported for bovines, even though it can be considered satisfactory as the weight was obtained in less time.

Rib meat weight and yield (ribs and flank)

The weight and yield result of the rib meat is described in Chart 9.

Comparing the relative values found by Torres Mignaguy, (inedited) in buffalos and Garriz *et al.* (1982) in bovines, the results of this experience were quite superior in these cuts.

Chart 9: Absolute and relative values of the rib meat.

Variables	Average(kg)	S.D.	Yield (%)
Rib meat	24.69	2.20	18.16
Ribs	17.21	1.35	12.60
Flank	7.48	1.09	5.48

Source: Cedrés, J. F. (2003) S.D. Standard Deviation

The rib meat weight and yield were superior to the results compared in the bibliography consulted in buffalos as well as in bovines. It is important to highlight that in our country whenever cuts are exported, either destined to the Hilton quote or to Jewish or Muslim communities, the rib meat is destined to the internal consumption with a good commercial value.

Individual cuts of the Hindquarter with and without fat

The result of obtaining individual cuts with and without fat is described in Chart 10. These results are quite superior in weight and yield to the ones reported by Mignaguy (inedited), except the strip loin which has less yield.

Comparing the values found by Garriz *et al.* (1982) from Argentine criollo steers no differences were found in most of the cuts, both in weight and yield of the cut up cut with fat, except in silverside and strip loin where the bovine cuts were superior, but in the buffalos the round roll and flank were superior in weight and yield. Comparing our results with the ones published for the different breeds and crossbreeds in the comparative chart of the author’s work cited above, it could be observed that the yield percentages of the rump, topside, strip loin and flank are greater in the British, Holstein Argentine, Argentine x British and Charolais x British but the tenderloin, thick flank and tail of rump are smaller.

The absolute and relative values of the individual cuts without bone and fat of the hindquarter have variations among them, in buffalos as well as in bovines. After the process of fat removal these values have the same variations, but as the buffalo has less fat it can be observed in the yield that the percentage lost is smaller after the cutting up.

The absolute and relative values of the individual cuts with and without bone and fat of the forequarter have the same considerations as the hindquarter.

After the cutting up and fat removal process according to the procedure accustomed for exportation cuts, they maintain a good weight and yield due to the little fat the animals present (Chart 10).

Chart 10: Weight and yield of the hindquarter individual cuts with and without fat.

Variables	Average (kg)	S.D.	Yield (%)	Average (kg)	S.D.	Yield (%)
	With fat			Without fat		
Tender loin	2.73	0.27	2.00	2.31	0.35	1.69
Round Roll	2.78	0.31	2.03	2.60	0.23	1.90
Silverside	5.73	0.59	4.20	5.24	0.68	3.84
Round	5.87	0.57	4.30	5.49	0.63	4.02
Topside	7.86	0.52	5.75	7.32	0.61	5.36
Rump	6.59	0.84	4.83	5.93	0.75	4.35
Strip loin	4.81	0.94	3.52	4.46	0.85	3.26
Tail of rump	1.81	0.31	1.33	1.47	0.29	1.07
Flank	7.48	1.09	5.48	5.90	1.07	4.32
Shank	2.30	0.24	1.68	1.99	0.18	1.46
Leg of beef	2.56	0.22	1.87	2.22	0.18	1.63

Source: Cedrés, J. F. (2003) S D.. Standard Deviation.

Comparing the values found by Garriz *et al.* (1982) in the removed fat cuts of Argentine *criollo* steers, the weight and yield are balanced in favor of the buffalo. This is due to the greater percentage of fat present in the bovines at the slaughter time, a logic percentage considering the feed received, cultivated pastures plus ration.

Main individual cuts of the Hilton cut

From all the cuts that compose the carcass, we are interested in the *Pistola* Cut. It contains most of the cuts with the highest commercial value and the best industrial and culinary aptitude (Chart 11). Analyzing the relative values of the muscle component, it can be observed a yield similar to the ones found in the Argentine criollo steers by Garriz *et al.* (1982). They report a 32.01 % including the heel muscle, shank and leg of beef.

Chart 11: Weight and yield of the main cuts without bone with and without fat that are part of the *Pistola Cut* and Hilton Cut.

Variables	Average (kg)	S.D.	Yield (%)	Average (kg)	S.D.	Yield (%)
	With Fat			Without Fat		
Tenderloin	2.73	0.27	2.00	2.31	0.35	1.69
Round Roll	2.78	0.31	2.03	2.60	0.23	1.90
Silverside	5.73	0.59	4.20	5.24	0.68	3.84
Round	5.87	0.57	4.30	5.49	0.63	4.02
Topside	7.86	0.52	5.75	7.32	0.61	5.36
Rump	6.59	0.84	4.83	5.93	0.75	4.35
Strip loin	4.81	0.94	3.52	4.46	0.85	3.26
Rib eye	4.57	0.55	3.34	4.12	0.45	3.02
Total	40.94	0.56	29.97	37.42	0.57	27.44

Source: Cedrés , J. F. (2003) S.D. Standard Deviation.

Relating these results, it can be observed that the exportation cuts including the meat from the heart of clod have a greater muscle and weight percentage than the other two groups, if consumption, manufacture and exportation cuts are discriminated as the ones described above by the author.

Comparing some percentages of the hindquarter individual cuts of the Mediterranean buffalos and Nelore bovines published by Jorge *et al.* (1999) and Mattos *et al.* (1997), it can be observed that in the current work the percentage obtained in the strip loin is significantly inferior to the percentages obtained in both species. The percentage of the topside is scarcely minor but the values found for the tenderloin and round are greater being similar in the round roll and silverside. In some cases the rump had greater percentages while in others it had minor ones.

When considering all the cuts, it can be observed that the values maintain a similar yield despite the individual differences among some bovine cuts.

Analyzing Chart 11 after the cutting up process in which the presentation required by the market is given, the values maintain a good yield due to the little fat production in the beef of this species. The buffalo can be considered an animal economically suitable in obtaining high quality chilled cuts.

The cuts that can be destined as Chilled Cuts of High Quality (Hilton) weighed 37.47 kg (without the beef from the heart of clod). They have a yield of 27.44% as regards the half carcass, can be considered very good, and it is comparable to the values cited for the bovine steers.

Individual Cuts of the forequarter with and without fat

The individual cuts weight and yield with and without fat that correspond to the forequarter are depicted in Chart 12.

The yield found in this experience for the individual cuts without bone and with fat that make up the Forequarter differs significantly from the yield reported by Torres Mignaguy (inedited) in most of the cuts, for example in the Rib Eye, Middle Rib, Shoulder clod, boneless Hindquarter and Rose Meat. The yields found in this experience are quite bigger, being the same in Heart of Clod and Shank and inferior in the Brisket, Chuck Tender and Neck. These variations may be due to the age difference among the animals compared and fat percentages that those specimens had.

The same as in the Hindquarter occurs in this case. When considering the group of cuts it can be observed that the absolute and relative values, despite the individual differences among some cuts, have a yield similar to the ones found by the author. He states a value of 40.28% in the cuts with fat, being the same with the removed fat cuts.

Even if considering the weight and the percentages of the individual cuts or as a whole it does not give relevant information. It shows a trend and the differences should be attributed to factors such as age, termination, exercise and cut up among others, apart from the genotype.

From the results of this work as regards the cuts, many figures found coincide or are similar to the ones published for the Argentine *criollo* cattle and the crossings of milk cattle with British and / or European ones.

Chart 12: Weight and yield of the individual cuts of the Forequarter without bone and with and without fat.

Variables	Average (kg)	S.D.	Yield (%)	Average (kg)	S.D.	Yield (%)
	With Fat			Without Fat		
Rib Eye	4.57	0.55	3.34	4.12	0.45	3.02
Middle rib	4.61	0.85	3.38	4.50	0.35	3.30
Brisket	2.28	0.34	1.67	1.88	0.24	1.38
Heart of clod	5.86	0.59	4.29	5.29	0.53	3.87
Shoulder clod	2.74	0.35	2.01	2.44	0.31	1.79
Chuck tender	1.92	0.14	1.41	1.72	0.16	1.26
Shank	3.64	0.83	2.67	3.20	0.75	2.34
Neck	10.92	1.97	8.00	9.66	1.95	7.07
Boneless Rib meat	12.41	1.14	9.09	11.67	1.20	8.54
Rose Meat	2.07	0.23	1.51	2.00	0.19	1.46
Navel	3.98	0.79	2.91	3.47	0.63	2.54
Total	55.00		40.28	49.95		36.57

Source: Cedrés, J. F. (2003) S. D. Standard Deviation

EVALUATION OF THE HARD AND SOFT RESIDUES

With the sacrifice of animals the man prefers the use of meat as it is very nutritive because it contains high quality proteins. But during the animal slaughtering process not only meat is obtained but residues classified as sub products. They are often a 50 % of the total weight of the animal. These residues have diverse physic-chemical characteristics whose rational utilization brings about characteristics to bear in mind:

Economic: they are important. Many times the price obtained by the carcass does not cover the value of the live animal; therefore the transformation costs and the generation of benefits for the slaughter plants are covered with the industrialization of the sub products. Otherwise it would not be possible to compete with other protein sources from vegetal origin.

Many of these sub products are eatable for the man, having as well as the meat a considerable nutritive value and being cheaper than meat. Some of the sub products can be used as animal feed of excellent quality which in turn generates more meat production.

The non-eatable residues also have a vital economic importance for industry development. The industries obtain an added value generating additional benefit development and population welfare, when using more specialized hand work.

Environmental: the complete use of these sub products has a favorable effect. It avoids environmental pollution and additional costs in the elimination of the products to prevent pollution, something that industries are obliged to do.

Sanitary: this factor has double importance, on one hand with the adequate handling of the residues and with the rational elimination of the ill animals the chain of illnesses that could be transmitted to animals and men with the pathologic material are cut. On the other hand these procedures prevent species considered plagues from surviving which are responsible of transmissions of illnesses for both men and animals.

In the beef industrial system in our country about 12,000,000 bovine heads are slaughtered annually in slaughter plants for exportation and internal consumption. Only the slaughter plants for exportation and some of the ones for internal consumption make use of the sub products in a more or less adequate way. Other plants make use of them insufficiently and others do not use them at all. This leads to a waste of value either due to the insufficient productive scale or for the kind of slaughter plant. Because of this a great part of the sub products value is lost in animal slaughtering, mainly in bovines.

Due to the bubaline species increase in the Argentine northeast, it was necessary to determine the proportion the sub products have in buffalo slaughtering and then to compare with the bovine (the most similar species) slaughtering. The results will help to establish the economic value of the residues when they are used rationally.

The existing data regarding the relative value of the sub products of animals raised extensively in the Argentine northeast are scarce or incomplete. There are also no research reports about this on buffalo steers. There is only the work of Torres Mignaguy (inedited) in an animal of fourteen months of age.

Non-eatable sub products

From the values found in Chart 13, it can be observed that the weight and yield of the leather, head, legs and horns represent an important average in the components into which the slaughtered animal is cut, influencing the carcass yield.

The yield of the heads and leathers (adding the weight of the mandible and the skull) are similar to the ones found in buffalos by Jorge (1997) who reports an average value of 12.65% and 3.35% respectively.

We compared the values found by Capellari *et al.* (2002), who carried out yield studies of head, leather and legs in two bovine biotypes. The bovines were 32 to 34 months of age raised on natural pastures receiving only one seasonal supplementation. The bovines had weight and yield values of 32.15 kg 7.37 %; 11.57 kg - 2.64% and 6.55 kg - 1.50%, respectively. It can be observed a significant difference in more than these three sub products in buffalos.

Comparing the values found in these residues with the ones reported for the bovines in the specialized bibliography for bovines (Delfino, 1989 and Ockerman and Hansen, 1994), it can be observed that the weight and yield of leather, head, legs, hands and horns are significantly greater in the buffalo, but the other variables even when they are also greater except the fat residues (greater in bovine) do not have an important difference.

Chart 13: Non-eatable subproducts as regards the live animal. .

Description	Average (kg)	S.D.	Yield (%)
Leather	59.02	11.32	11.30
Fat residues	6.93	1.43	1.33
Legs	5.00	0.73	0.96
Hands	4.56	0.64	0.87
Jaw	3.11	0.54	0.60
Horns	2.50	0.46	0.48
Gall Bladder	0.21	0.06	0.04
Tail end	0.30	0.09	0.06
Bile	0.35	0.14	0.07
Ears	0.80	0.18	0.15
Head bone	13.06	1.45	2.50

Source: Cedrés, J. F. (2003) S.D. Standard Deviation

Green Offals

The weight and yield of the green offals are described in Chart 14. Comparing these results with the ones described for buffalos by Torres Mignaguy (inedited) the yield gave similar results.

Confronting these values with the ones described by Delfino (1989) and Ockerman and Hansen (1994) in bovines it can be seen that only the gall bladder and the fourth stomach are similar in weight and yield but the other components of this group are greater in buffalos.

Chart 14: Weight and yield of the green offals as regards the live animal.

Description	Average (kg)	S.D.	Yield (%)
Small intestine	5.72	0.68	1.10
Large intestine	3.12	0.41	0.60
Cecum	3.85	0.66	0.74
Rectum	3.01	0.56	0.58
Bladder	0.28	0.10	0.05
Tripe	12.66	3.51	2.42
Omasum	4.28	2.15	0.82
Fourth stomach	2.37	0.62	0.45

Source: Cedrés, J. F. (2003) S.D. Standard Deviation

Red Offals

The values found in this work about red offals corresponding to buffalos are detailed in Chart 15. From the offals values compared with the ones given for bovines by Delfino (1989) and Ockerman and Hansen (1994), a significant difference can be appreciated among the variables considered. The yields in tongue and jaw are greater in bovines, while they are smaller for heart, lungs, kidneys, tail and spleen and they are similar for the other components.

Chart 15: Weight and yield of the red offals as regards the live animal.

Description	Average (kg)	S.D.	Yield (%)
Liver	5.43	0.98	1.04
Spleen	1.47	0.52	0.28
Lung	5.35	1.43	1.02
Heart	2.20	0.27	0.42
Tail	1.25	0.25	0.24
Tongue	1.37	0.18	0.26
Kidneys	1.65	0.37	0.32
Jaw	1.26	0.27	0.24
Meat from the head	1.42	0.40	0.27
Brains	0.61	0.14	0.12
Meat from the tongue	1.61	0.12	0.31
Muzzle	0.70	0.19	0.14
Offals	0.98	0.20	0.19
Esophagus	0.58	0.14	0.11
Sweetbread	0.22	0.04	0.04

Source: Cedrés, J. F. (2003) S.D. Standard Deviation.

Total values of the products and sub products

From the total slaughtering resulting products and sub products (Chart 16) it is perceived that the buffalo carcass yield, though without reaching the registered values for the ordinary bovine steer, can be considered good yield. It is compensated with the slaughter weight obtained by the buffalos, in the breeding conditions of this work in a shorter period than the ones required for the bovine, comparing with the ones described by Delfino (1989), Ockerman and Hansen (1994).

The yield reached in buffalos sub products is greater than in bovines mainly due to the heavier leather, legs, hands, heads and horns weight. From the yield of both green and red offals it can be seen that these are an important percentage, greater in buffalos than in bovines.

These elements that come from the cutting up of the animal represent a greater yield in buffalos than in bovines.

Chart 16: Weight and yield of the grouped components resulting from the slaughtering of the live animal.

Description	Average (kg)	S.D.	Yield (%)
Live weight	522.37	80.88	100.00
Chilled carcass	268.62	37.48	51.42
Sub products	94.93	14.50	18.17
Green offals	35.93	5.85	6.88
Red offals	26.05	3.61	4.99
Waste	96.85	29.43	18.54

Source: Cedrés, J. F. (2003) S.D. Standard Deviation

The sub products taken from the carcass during the slaughter process are an important percentage in the buffalo. They influence significantly in the Net Yield of the carcass. Considering all of them the Net Yield is greater in buffalos than in bovines.

From the yield of the group of red and green offals it can be inferred that even when they constitute a greater percentage than in the bovines they do not influence significantly in the yield of the carcass if they are compared to the bovines.

The waste that results from the buffalo slaughtering such as ingestion, dung, blood, fat remains plus the decrease of the process influences in a considerable way. The high percentages of the first two could be attributed to the slow digestive process delaying the process of eliminating dung.

The manufacture of the sub products resulting from the slaughtering represents additional earnings in those cold storage industries that use the waste rationally compensating the smaller carcass yield obtained in this species.

BEEF CHEMICAL COMPOSITION

The results of the chemical composition are in Charts 17 and 18.

Chart 17: Centesimal chemical composition and energetic value of buffalo fresh beef.

Water (%)	Protein (%)	Fat (%)	Mineralsd (%)	Glucides (%)	Gross Energy (kcal)
74.26 ± 0.69	23.43 ± 0.80	0.52 ± 0.35	1.06 ± 0.09	0.73 ± 0.12	101.10 ± 2.94

Source: Cedrés, J. F. (2003)

Chart 18: Mineral content of buffalo beef (mg / 100g).

Phosphorus	Potassium	Sodium	Calcium	Magnesium	Iron	Copper	Zinc	Manganese
213.46 ± 38.53	159.35 ± 43.67	33.92 ± 11.29	11.45 ± 2.87	2,41 ± 0.24	2,46 ± 0.66	0.29 ± 0.34	4.39 ± 1.43	0.08 ± 0.003

Source: Cedrés, J.F. (2003)

The water percentage was scarcely greater than the values reported by Kurbanov (1961) in Mediterranean buffalos in lean beef and significantly greater in the studies about medium fat and fat beef. He describes values of 73.35%; 68.87% and 64.42% respectively. It was also greater than the values described by Ferrara *et al.,* quoted in Cockrill (1974) in two different experiences with animals of the same breed where buffalo and bovine milk were included in the feed and a 71.68% and 73.15% were reported.

It was similar to the ones reported by Polhironov (1974) and inferior to the ones reached by Cosentino *et al*. (1976) in Mediterranean buffalos and Holstein bovines and Barone *et al.* (1982) in the same breeds, they were all cited by Nascimento and Moura

Carvalho (1993), inferior also to the ones reported by Nascimento *et al.* (1982) and Huerta - Leidenz *et al*. (1997a) in buffalos of trinitario origen and Murrah breed respectively.

A proteic value of 23.43% was recorded, being superior to the values reported by all the authors mentioned for both buffalos and bovines whose results were in a range of 19.08% and 22.40%.

The fat percentage obtained in this work was similar to the ones obtained by Cosentino *et al.* (1976) and Girolami *et al.* (1975) who reported values of 0.50% and 0.65% respectively, both in Mediterranean buffalos and similar to the percentage found by the first author in bovines.

But it was smaller than all the results published in the other works consulted, whose relative values fluctuated in most of the cases between 0.9 and 3.3%. There were cases in which the figures are very different such as the ones published by Ferrara *et al.* cited by Cockrrill (1974) in two works carried out in buffalos whose ration included buffalo and bovine milk individually. The results obtained in both inquiries were of 5.83% and 5.35%. More significant differences were reported by Kurbanov (1961) in fat and medium fat beef whose values were 15.4% and 9.6%.

This difference in the results could be due to the non-standardization of the intramuscular fat.

The values recorded in carbohydrates were a little superior to the ones reported for bovines in specialized texts Lawrie (1977), which give between 0.3 and 0.5%.

The result of total minerals (Chart 14) was similar to all the ones reported in the bibliography consulted. These showed values superior in phosphorus and calcium and inferior in sodium, potassium and magnesium, if compared to the values reported for bovine beef by Pellegrini *et al.* (1986).

The buffalo beef would have some advantages as regards the bovine, from the point of view of the consumer preferences to eat lean products of low calories.

Fatty acids in the intramuscular fat

In the analysis of the intramuscular fat (Chart 19) it could be observed that the value found in the saturated acids was scarcely greater than the 31.3% in buffalos and smaller than 40.2% in bovines reported by Sharma (1995) cited by Huerta - Leidenz *et al.* (1997c). In a report from USDA, mentioned by Vale (1994), values of 0.60 g in buffalos and 8.13 g in bovines are reported, it could be presumed that in this study bovines of different termination and genetics were examined.

The values found for Omega 6 and Omega 3 have a relationship of 2.39 – 1.00, which can be considered appropriate if the research that advises a relationship of 3 – 1 in an ordinary diet and of 1 – 1 in illness processes are taken into account.

Chart 19: Percentage of intramuscular fat and fatty acids present in it.

F/100g Beef	SFA (%)	MIFA (%)	PIFA (%)	Omega 6 (%)	Omega 3 (%)	CLA (%)
0.956	34.7	27.56	22.80	12.50	5.23	0.45

Source: Cedrés, J.F. (2003) SFA= Saturated Fat Acid: 14:0+16:0+18.0 - AGMI= Monoinsaturated fat acids: 16:1+18:1t+18:1c -PIFA= Poliinsaturated fat acids = All the acids with more than one double bond. -CLA= Conjugated linoleic acid.

The centesimal chemical composition of beef can be considered similar to bovine beef, being present in the buffalo with greater protein, carbon hydrates and water tenor, similar in minerals and smaller in fat. From the result on the fat acids of the intramuscular fat in the buffalo it can be concluded that this species has a significantly inferior percentage in saturated acids if compared with the bovine species. The percentage of the insaturated fatty acids is also inferior, coinciding with the values reported in the bibliography. Considering the nutritional quality in general of the intramuscular fat, it can be affirmed that by the presence and proportion of the fatty acids bubaline beef has comparative advantages over the bovine.

Considering in general the butcher aptitude of the bubaline species, from the point of view of the cuts as well as the organoleptic and nutritive beef quality it can be concluded that this species has enough conditions to be a valid alternative for cattle production, especially in those areas that do not have favorable soil and climate conditions for traditional bovine production.

PHYSICAL CHARACTERISTICS OF BEEF

Area of rib eye

Values of the rib eye study are reported in Chart 20, the size of the area was smaller than the values chosen for bovine steers in the comparative chart shown in the work of Garriz *et al.* (1982). The size of the rib eye (cm^2) in buffalos is smaller than in bovines. It would be similar to the British breeds; which are also smaller than the Holstein and its crossbreeds with British and significantly smaller than the continental European beef breeds.

Chart 20: Values of the rib eye measurement.

Variable	Age (months)	Weight (Kg)	Area (cm^2)	Length (cm)	Width (cm)	Fat Width (mm)	Streak
Average	30.8	569	53.54	11.18	6.2	8	1.1

Source: Cedrés, J. F. (2003)

The length and width dimensions of the *Longissimus dorsi* muscle is characterized for having small measures. If we compare these results with the bovine ones, they are inferior to all the breeds compared, being even smaller in length and similar in width in values found by Garriz *et al.* (1982) in the Argentine *Criolla* breed.

The fat width was in some cases superior and in others inferior to the reported for bovines, but it was greater to the 4.03 mm cited by Huerta – Leindenz *et al.* (1997b) in steers and heifers with Zebu features raised in natural pastures.

The values of streak obtained are “scarce” for the Mediterranean Breed, “light and scarce” for the Murrah and “light and traceable” for the crossbreeds. Similar streak results were described in buffalos by Huerta- Leindenz *et al*. (1997a).

The streak average compared with the bovine is present in an analogous way in several cases and inferior in others. This species has very different values among breeds and crossbreeds, emphasized in many cases by the different terminations. On the contrary in the buffalo it is present in a more analogous way, even in animals with different genetics and always with low values, being similar to the ones presented by the *Criollos* and Nelore and the crossbreeds steers.

The results of this work on streaks allows to highlight the benefits of the buffalo beef on the basis of the general recommendation of consuming low fat percentages in the diet.

Objective tenderness and decrease by cooking

The results of these characteristics are recorded in Chart 21. The values obtained at the effort to cut cooked beef (objective tenderness) in pounds, correspond to “tender” beef for the Mediterranean breed, “neither tender nor though” to “tender” for Murrah and for the crossbreed. This result can be considered acceptable and it is comparable to the result found by Garriz *et al.* (1982) in *Criollos* steers of the same age. He reported a value of 8.2 pounds per square inch.

The results corresponding to the decrease by cooking were very variable among the samples. Even though they are greater than the results reported by Huerta-Leidenz *et al.* (1997ª) for buffalos and similar to the ones for the Zebu bovines.

Chart 21: Tenderness and decrease values by cooking in buffalo beef.

Variables	W.B. (lb/ pulg)	Decrease(%)
Average	8.69	33.52

Source: Cedrés, J. F. (2003)

Color and pH

The color and pH values measured are within the expected range (Chart 22). The beef has a not very bright red color coinciding with Matassino *et al.* (1978), Romita *et al.* (1979), Grasso *et al.* (1982) although other authors like Borghese *et al.* (1976, 1978, 1980) state that those differences can be not very significant.

The pH results were variable, being similar to the results reported by Montes *et al.* (2002) who cites a value of 5.9.

Chart 22: PH Average values and color in the *longissimus dorsi* muscle.

Variables	PH	L*	a*	b*
Average	6.06 ± 0.02	31.78 ± 0.09	16.58 ± 0.08	14.51 ± 0.09

Source: Cedrés, J. F. (2003) L* luminosity; a* green-red coordinate; b* blue-yellow coordinate.

The physical characteristics of the bubaline beef are in general similar to the bovine. The scarce streak can be especially highlighted and also the tenderness in this species at the average age of 30 months is very acceptable.

Trying to be objective in the use of the bibliographic information and despite the long way to walk in bubaline production, it could be affirmed that this species would be the productive alternative for a great amount of land located in marginal areas, available for rational exploitation.

The rusticity, fertility and longevity characteristics of the buffalo, allow a vegetative development of the herds significantly superior to the bovine cattle raised in non ideal conditions for cattle exploitation.

Considering the greater buffalo beef production exploited in the conditions object of this study, it can be offered to the industry a product in the same conditions as any other traditional bovine breed. Thus, it is possible to enlarge the commercial chain of the farming products, benefiting regional economies and developing a great amount of land of low commercial value in our country.

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CHAPTER 4

CATTLE RAISING MODELS AND BEEF BUFFALO PRODUCTION

Pablo Maldonado Vargas

INTRODUCTION

Cattle raising activity has constituted for the Province of Corrientes a productive activity of exceptional importance throughout its history. It has socio-economic influence in terms of use of land, labor, fiscal resources, and basically goods production.

The agrarian structure of Corrientes has been kept without important changes in the last decades. Cattle raising is the most important economic activity in the current use of land. The provincial farming surface is estimated in 6,760,000 hectares being the productive base of bovines, ovines and bubaline production (PROSAP, 1995).

The number of bovine cattle producers in the Province is more than 26,000 with a herd of about 1,400,000 heads that represent the 7% of the total amount of bovines in the country.

The buffalo showed an excellent adaptation to our region due to its origin, the tropical and subtropical areas of western Asia. They have been naturally selected because of its rusticity and adaptation to an environment of extreme marginality.

The bubaline population is about 182 millions of heads in the entire world, being India the main producer with more than 80 millions of heads, which represents almost the 50% of the world population.

Since some years ago there is an increase in the buffalo population in our region ANE, where out of 60,000 heads that are found in the country the 50% (36,000) belongs to Corrientes, according to the data given by the Argentine Buffalo Breeders Association.

Buffalo production is an increasing alternative of production for great areas of our province and the country for fields with a forage offer of poor quality, low digestibility grasses, high parasitism and low lands with inefficient drainage which most of the year are flooded.

A significant proportion of the producers of the province, according to the surface of the production units, capitalization, labor employed and technological levels, make up medium businesses that have as main productive system bovine production, **being buffalo production still an incipient productive alternative.**

In this context it is important to highlight that the increase in beef demand will be associated to a diversity of products strongly related to the consumer's health. The buffalo has an important place in the context of transformations that are taking place in world markets.

We understand that all these will happen in a setting of imperfect competence, reduced number of economic agents, differentiated products, incomplete information, and restrictions to the mobility of factors and entrance barriers. These concepts should be bore in mind from the approach carried out, from the point of view of the new institutional economy (Ordóñez, 2002).

The introduction to the provincial reality of new productive alternatives should necessarily be carried out from institutional, organizational and technological designs, focusing on the market access and the customers' preferences.

The potential design and implementation to provide from buffalo production elements to determine the viability or inviability as economic system of the medium farming businesses of Corrientes imply the challenge of creating new tools capable of management.

In that sense it will be necessary to determine and show the competitive and comparative advantages of our beef buffalo production systems obtaining data to be evaluated and analyzed.

The north of Corrientes offers us a great variety of farms in aspects such as surface, animal load and productivity indicators of herds. Bearing in mind this productive reality it was necessary to model in order to evaluate economically and financially the viability of the determined productive models, through a static analysis of the farm (Maldonado Vargas *et al.* 2000).

In the farming businesses the measurement of the physic and economic results prior to make an investment decision allows to determine the viability of the proposals.

DESCRIPTION OF THE SCENERY

Due to the lack of regional data, since 1991 from the subject of Animal Reproduction of the School of Veterinay Sciences of the National Northeast University, records of productive and reproductive data of the bubaline herds located in the Province of Corrientes and especially in the northwest region are carried out.

This area designated by INTA as the Capital Triangle is characterized by the presence of farming systems similar in variables such as productive structure, technical coefficients and herd management.

Medium farms of the northwest of Corrientes were identified as unit of analysis. There were variables of structural type of the business and managers. They were closely affected by economic and social contexts that influence in the productive reality and sustainability as a useful system for the economic and social development of the producer.

In general it could be affirmed that the technological breach among the farms which have incorporated technologies and those which have not will be greater and greater. It depends mainly on the attitude and aptitude towards change on the part of the producer. The adoption of technologies in farming is not an easy task for the strongly structured and refractory idiosyncrasies in the social environment of the farming section of the province.

The analysis was restricted to a medium model of cattle raising producer of the north of the province, owner of the cattle in a range of 350 to 1,000 heads, represented in the province by 2,500 producers.

The method for the study combined the descriptive research based on the analysis of data already existing or obtained through theoretical models designed to produce conceptual and operational definitions of the productive systems.

Analyzing the levels of the current technological development, a close correlation is observed with the scale of the livestock exploitations. Over a minimum surface considered suitable for cattle raising exploitation, the productivity levels are related to more complex factors intra or extra property.

The most modern conceptions support the necessity to change the farming production system based mainly on intake technologies that are applied or consumed by another system based on process technologies which are based on information, knowledge and efficiency.

The first ones always have a certain cost even when their application is simple due to their own characteristics, without great intellectual demand and of joint impact. The process technologies on the contrary are not easily acquired, they have a personalized application, intellectual cost and they are time consuming (Viglizzo, 1992).

The enterprises capable of changing and reconverting will have more possibilities if the producer assumes the attitude of an enterprising businessperson or gives the management to a third party and complements species (buffalo), processes or managements that are no viable. Thus the producer will have more possibilities to survive without turning into an ex producer (Drucker, 1998).

Organized efforts are necessary to change the preconceived structures. The producers should try to incorporate the understanding of the external, the society, the economy and the consumers so that they become the basis of the strategy and policy to develop. (CREA, 1999).

The setting described supports the idea that for analogy to what the famous Charles Darwin said when he spoke about natural selection: "… to survive any animal species should develop the aptitude to live in the world surrounding it, otherwise it would only be recognized as a fossil and not as a creature with which we share the earth". **The business environment is changing quickly. Which trend will cattle raising take in the Province in front of the productive alternatives presented? 1. the fossils which give proof**

that could not adapt to the environment or 2. the producers who change and adapt having the possibility of being successful.

CHARACTERIZATION OF PRODUCTION MODELS

It is convenient to give a brief summary of the historical process of land appropriation and the modalities manifested in cattle raising evolution in Corrientes which determine the existence of heterogeneous agrarian and social agents and productive systems. They are developed on a fundiario structure in which small, medium and large production units coexist, which despite the size of the exploitations can be grouped in different productive models.

Llovet, (1990) mentions that the social types of production can be defined from two essential attributes: productive resource availability, land, labor, technical capital and the use of such resources, which the Rural Sociology Group of the SAGYP also denominated of structural character. The other attribute is the combination of activities and technological pattern. In most of the cases there is a correspondence between social types and productive models.

In relation to what has been said, the cattle raising productive models susceptible of being differentiated from the information available allow us to accomplish an approach. Agro economic variables such as: surface, existing livestock, production technology and social variables such as: relationship between family work and hired work were taken into account. According to the author's criteria the existence of the following classification is verified: 1. Familiar of infra subsistence, 2. Familiar of subsistence, 3. Capitalized familiar and 4. Business familiar (Codutti, 2000).

The description of the first two models will help to clarify the profile of the cattle raising producer, with potential to diversify the productive activities with the incorporation of the buffalo.

The Correntinian farming production has been characterized by an important presence of small and medium exploitations. Nevertheless during the 90s there was a tendency to the increase of the medium size exploitations. This situation generated anxiety due to the possible displacement of familiar exploitations by mega business of greater scale and organization.

The Familiar model of Infra subsistence represents the production units that under the different forms of tenancy produce in conditions of shortage of natural resources, quantity, quality, and ways of land and capital tenancy with a bovine herd of 28 heads average.

The same work states that the main characteristic is the prevailing of the family work, the production for the family consumption and the sale of work in rural and urban markets as a source of an extra property income.

It is worth to highlight that producers of this model value sources considered marginal by business farming. Sources such as low quality land, non-transferable labor, production means of low cost and very low productivity which are used in socially productive tasks. Thus the following argument is developed: “it is clear that the availability of production means prevents producers from overcoming the threshold of accumulation of capital as a consequence of the inexistent economic benefits”.

In this kind of production units a fundamental characteristic is the multi occupation, this is the combination of different activities that includes not only cattle breeding but also the sale of work and the land cultivation for family consumption.

The authors propose a denomination that very clearly shows the reality and that is “cattle holders”. They are social subjects who may be salaried workers who do not have enough land to keep their herds. They use community street borders, narrow lanes or open fields as grazing areas. This is very common of towns like Mburucuyá, San Miguel and San Luis del Palmar. In this model, the rural tenants keep their herds in fields which do not belong to them in return for their work, usually related to the care of herds.

It is mentioned that the mean farming surface is 54 hectares with receptivity of 0.5 UA/Ha. The global cattle raising produced by this model can be considered marginal as regards its quantitative importance as it only comprises 14% of the provincial herd (600,000 heads). It has a social impact as the amount of producers in this model is of 21,307 which implies 80.31% of all the cattle raising producers of the Province (FUCOSA statistical report 1999) (Codutti, 2000).

As regards the objective of the farms they dedicate to breeding and female and heifer fattening which are terminated at the age of 3 years and more.

The fields have perimeter wiring not very well kept which do not usually have internal paddocks. The only facility available is the confinement corral.

The process of making decisions is in charge of the producers or a some member of the family, fact that shows the familiar characteristic of the model. The place of residency of the producers is the same field or towns located near the Capital of the Province.

The following model, which could be assimilated to the **Familiar Subsistence** one, represents the production units with an average herd of 235 heads. The number of producers included is 3,546, which represents 13.37% of the total producers of the Province.

In general in this stratum of producers it jumps out the bad use of the resources. This circumstance impedes the accumulation of capital. Such process is subject to specific historical conditions being able at certain times to increase the production means or to decrease them varying the capacity to produce income.

The producers of this model have some characteristics of the previous one such as the relationship between land and familiar work but it is observed a greater capacity of salary payment, purchase of goods and greater capital.

The producers included in this model produce with low technological levels. They incorporate only the maintenance of the existing investments in their plots such as wiring, house and corral repair as management activities of the farm.

Maldonado Vargas (2003) points out that there are individual characteristics in this group of producers. They can explain differences in the management, in the economic results and in the adoption of new technologies. The adoption of technologies in cattle raising is more difficult due to the farmer idiosyncrasy and the length of the intervening biological cycles.

The mean animal load is 0.52 heads per hectare, commercializing the 25% of the calf production. The rest is retained commercializing as steers of 2 years of age (40%) and 3 years of age and more (60%).

The infrastructure consists of perimeter wiring in a good or not very good maintenance state with one or two internal paddocks. The farms have corral and the 75% have chute, too.

The pasturing system is continuous and there are few producers who do the animal load adjustment in accordance with the seasonal availability of forage recommended by Institutions like INTA or the University.

The service is continuous and the sanitary management is reduced to the control of the most common diseases and the use of external anti parasites.

The analysis of these factors allows inferring that there is a low productivity and a high growing potential with the adoption of productive techniques especially of processes.

The decision making is in the 83% of the cases in the hands of the family members while the opinion of the professional is irrelevant in the process of making decisions.

The residency of these producers is the farm itself (50%) and the town where the farm is located or the Capital (38%). The level of education of the ones who make decisions is primary school in the 73% of the cases.

It is important to highlight that the two previous models have a high percentage for the introduction of bubaline production as a component of the productive mix of the agriculture and cattle raising systems for small producers. They will be able to obtain significant benefits as additional income and nutrition betterment direct or indirectly from the buffalos as beef, milk and labor source.

And as Lema *et al.* (2002) says when he states that the farming activity is not typically represented by production function with increasing returns according to scales. As a consequence the small farms should not be less efficient than the big ones.

In the two models developed below, examples of buffalo production adoption in different variants are found.

So, the third model known as the Capitalized Familiar comprises the production units located in different areas of the Province which have a mean farming surface of 1,400 hectares with 1,092 producers representing 4.12% of the total producers included in this model. The technological level reached by this group can be considered as a combination of elements associated to the structural characteristics of the farm and to factors such as the idiosyncrasy, economic rationality, training opportunities and knowledge management of the social subjects described by the author (Codutti, 2000).

Analyzing the above model two productive systems and social types can be differentiated according to the different production organization and the level of adoption of the physical, biological and organizational technology. The authors coincide with Viglizzo, who develops concepts that are mentioned in previous paragraphs.

As regards the production system two types are mainly identified: a) the familiar subsistence or traditional cattle raising model and b) the business one.

The first is characterized by the predominance of an economic irrationalism perhaps associated to the profile of a part-time producer with an extra income, where the maximization of the business profit rate is not prioritized. This behavior associated to the traditional management and administration modalities is reflected in the low rate of incorporation of technologies and management practices. The technical coefficient and the productivity indicators of the herd are under the provincial means.

The second is characterized by an economic rationalism where the producer’s objective is to attain the maximization of the business profit rate. To succeed in this objective the producer adopts practical management technologies and production systematization based on business management modalities. In both cases the influence of extra farming income is evidenced (Solá and Llovet, 1990).

Both models represent production units with a mean of 700 heads, the first characterized by low productivity levels while the second is characterized by a greater level of technological adoption reflected in the productivity indicators. The 60% is included within the traditional cattle raising system (low technological level) and the 40% in the business cattle raising system (high technological level).

The extensive pastoral breeding is the main productive system in the traditional farming units, where the branding reaches 45%, the percentage of cow and bull replacement is 16%, the service system is continous and the beef production is from 25 to 35 kg ha/year.

In the business production systems with technological adoption a greater adoption of stationary services and herd categorization is observed. The branding percentage reaches 75% and the sanitary management includes apart from the recommended vaccination, a group of complementary sanitary controls whose major component is bull revision and rectal tact.

In general and compared with the strata developed before the mechanization level of this one is superior. The 55% of the units have tractors, most have perimeter wiring in a good or not so good condition with internal paddocks. The farms have corrals and 86% have a chute, 68% have scales and 82% have platforms for cattle.

In most of the farms a continuous pasturing is used 73%, preponderance level that allows inferring a marked technological delay in the pasture management practices, as well as a great potential to generate changes with impact in a short term.

The making of decisions in most of the cases is in the hands of the producers (60%) or of the members of the family, wife or children. In the 22% of the cases it is in the hands administrators and in the 18% it is in charge of technical assessors. This situation contributes to affirm the existence of systems with some business management in this model.

The percentage of producers who live out of the province is the greatest of all the models analyzed, as regards the level of education a 50% has tertiary education.

The Business Model or the one of greater scale corresponds to a range that goes from 2,000 to 4,000 heads average; it includes more than 600 producers in the entire Province.

In the considerations taking into account to characterize this model as regards the technological level reached by the farms, the economic rationalism and the social types, two models are presented. They are associated to the cattle raising production systems: the traditional and the business of the previous model. The differences of greater importance are related to the physical size of the units and to the availability of the production means.

The farms of this model are in different agro-ecologic environments of the province, with a mean farming surface of 4,500 has. The number of producers in this model is more than 600 representing

4.8% of the Provincial total, concentrating 2,352,565 heads which represents the 58% of the bovine existence in the Province.

In the last two models described the buffalo producers of the province are, highlighting that the original introduction was for mega cattle raising business. For a long time buffalo production was considered a completely marginal activity of the farm.

Only in the last four years buffalo herds have been incorporated to medium farms. They may have been acquired in the annual auction of the Expo Buffalo and Buffalo Production Symposiums of the *Mercosur* organized by the Veterinary Sciences School of the National Northeast University.

PRODUCERS CHARACTERIZATION

A phrase commonly heard when talking about management deficit in cattle raising systems is to become a businessperson from a producer. It means to go out from individualism to the making of decisions in a group emphasizing ideas and capacities to attain a change of the commercialization productive reality or of the economic management of the system (Royo Pallares, 1999).

In this way, we coincide with Gallacher, M. cited by Lema, *et al.* (2000), when he estimated the interaction between education and scale returns. He suggested the existence of decreasing returns in the traditional producers, while the returns are increasing when they are incremented together with the education levels. It is evident that optimal sizes of the farming business could increase with the human capital of the producer.

It has been argued that technology availability is not a limiting factor to increase productivity, in the province nowadays, but its application is a limiting factor, giving as a result the reason for not adopting it. So, there are certain questions to be answered: is it not well spread?, Is the producer not interested in changing or incorporating new productive alternatives? Doesn’t the producer realize that he has to produce efficiently to survive? Isn’t he trained enough to manage the farm? Doesn’t he live in the farm? or doesn’t he have the necessary resources to do that?

In that context to operate an extensive breeding system is not an easy task. And even less if we add buffalo production with its management particularities. We talk about a secondary production system where it is necessary to produce grass and transform it in beef. This gives characteristics of extreme complexity in terms of intellectual demand to implement process technologies.

All this indicates that cattle raising needs strategic investments in human resources in all its actors, technical producers and rural workers (Maldonado Vargas, *et al*., 1990).

Maldonado Vargas (2003) points out that the aim is to optimize the main role of the decision makers. The making of decisions will be among the most complex alternatives in a world increasingly more dynamic. What the producer cannot do is not to make decisions.

A first question to know which would be the subjects the livestock producer considers more relevant when thinking in the possibility or conveniences of incorporating buffalo production as a new activity. And the second question is which vision the producer would have about the non-governmental organizations (or those that do not depend on the government as the case of INTA, Universities, National Programs) to know if they can provide solutions to the problematic stated.

Analyzing a work done by Cellario, W. (2000) when the Province is divided into five regions, the producer is asked about the problems he faces. The lack of credit to improve the actual cattle raising is the most common problem (Chart 23). The answers are distributed in the following way: first the absence of credit suitable for the sector (27%), the second great problem is the market (25%), the third problem is the sectorial policy (17%), size or rank of the farm (13%), technologies (11%), others (6%) and lack of qualified labor in the area (2%).

It is also considered that the family environment constitutes a factor to bear in mind when profiles of great concentration of management in the chief of the family are found. They are associated with the following negative factors: 1. Lack of original investment in the inherited capital. 2. Conception of a mixture of means: life-sustenance and future family-business-activity of the heirs. 3. Almost inexistent administration perceiving the result in a subjective way as if it was a good or bad year, taking into account some indicators. 4. Conception at a family level that it is an easy industry to learn by any of the heirs without any demand of greater level of specialization (Rebay, 1996).

Chart 23. Main cattle raising problems.

REGIONS	I	II	III	IV	V	TOTAL
Technological	13%	11%	7%	16%	12%	11%
Markets	20%	26%	26%	16%	25%	25%
Scale or size of the farm	16%	10%	14%	8%	14%	13%
Sectorial policy	16%	23%	14%	8%	15%	17%
Lack of qualified labor in the area	0%	4%	5%	0%	1%	2%
Abscence of suitable credit	29%	23%	24%	48%	27%	27%
Other	7%	4%	9%	4%	5%	6%
TOTAL	100%	100%	100%	100%	100%	100%

Source: Cellario,W. (2000)

To generate a change in this reality that beats us, the Rural Change Program is perhaps the only instrument of active development policy implemented by the State in the last decade. We reiterate, it was not thought as a structural development instrument but as a social palliative and a holding instrument destined to the most affected sectors by the new rules of the current economic game (Rural Change Program, 1995).

When the main aspects or the changes carried out in the farms are analyzed it can be appreciated that despite the fact that the objectives of the program encouraged association, the real practice was null. It is observed that the cattle raising farms of the region that are part of the Program are in processes of intensifying the activity (50%), incorporating new practices 50% of them and using the existing technology in a better way the other half (Voss and Acosta, 1998).

It can also be seen in the work of Cellario (2000) that the smaller exploitations in cattle raising surface have a negative concept about the tasks carried out by the Rural Societies.

Despite the consensus level the CREA groups have in the province, the ignorance added to the assertion of inexistence continues being important.

All this process has shown that the farming PYMES have real possibilities, even in uncertain situations as the present ones, showing the strong deficit in business management as the main limiting problem for growth and consolidation.

DESCRIPTION OF THE PRODUCTIVE MODELS

We worked with the aim of identifying some key variables that would allow an improvement in the decision making when the incorporation of buffalo production to the cattle raising systems is considered. We used the information gathered in fourteen years of following up the farms dedicated to buffalo breeding in the north of the province. And we compared it with the data about the productive system models of bovine cattle raising given by the Rural Change Program of INTA, FUCOSA, Production, Work and Tourism Ministry of the Province and the School of Veterinary Sciences of the UNNE.

Our objective is to evaluate the economic and financial aspects of the beef buffalo production models in the northwest area of Corrientes and to compare the results of the costs and income structure and the indicators of profitability with two bovine models in the same agro ecologic and production conditions. The aim is to improve the sustainability and competitiveness of the breeding business.

The description of the models is associated to specific social types. In every case it should be interpreted as a conceptualization based on the reality, stating that abstractions of empiric cases built with the purpose of making comparisons and examining the relationship about productive alternatives are considered in all the cases.

The traditional cattle raising systems of the Northwest area are extensive. They are characterized by an inefficient use of the forage resources, together with a deficient productive management and distribution in paddocks.

What have been said influences negatively on the herd productive efficiency. The mean of calves obtained varies between 40 to 50% with an average weight of 150 kg at weaning and a production of 140 to 150 calves every 1,000 has.

The mean of production of the region is between 20-25 kg of beef/ha/year in the low fields while in the high fields it is near 30-35 kg of beef/ha/year. Even though in these environments the producers that have adopted suitable technologies reach superior production levels, being clear that this productive breach indicated deficiencies in the technical-economic validation process, transference and technology adoption in the region (INTA. Farming Project, 1998).

This area comprises the Northwest Triangle of the Province where the departments of Berón de Astrada, Capital, Empedrado, General Paz, Itatí, Mburucuyá, San Cosme, San Luis del Palmar and San Miguel are located. Alternatively some areas of Ituzaingó department could be included, even when it belongs to another agro economic zone but which has a reduced percentage of cattle raising producers.

Ituzaingó is located in the Northwest Sector of Corrientes. In the North it limits with the river Paraná, in the East with the same river; in the South with Saladas and Concepción departments, the beginning of the *Batelito* Marshes and *Rincón del Carambola* of the System of the *Iberá* Marshes; in the East with the *Iberá* Marshes.

This area is located between the parallel 13° to the North and 15° to the South and the meridian 31° to the East and 35° to the West according to the epidemiologic map of SENASA.

The total surface of the area is 1,383,070.92 hectares with 5,101 farms, 7,237 producers and 502,066 bovine heads distributed as it can be seen in Chart 24.

Chart 24: Distribution per surface, heads, farms and producers of the northwest region.

DEPARTMENTS	Surface	Nº Heads	Nº Farms	N° Producers
Berón de Astrada	72,179.12	19,655	120	230
Capital	53,619.01	22,439	473	499
Empedrado	206,567.40	96,740	816	1.137
General Paz	257,244.90	87,238	786	1.342
Itatí	80,214.78	35,994	183	465
Mburucuyá	99,536.86	46,738	409	612
San Cosme	60,286.95	28,451	576	608
San Luis del Palmar	261,337.50	103,035	1,075	1,544
San Miguel	292,084.40	31,766	663	800
TOTAL	**1,383.070**	**502,066**	**5,101**	**7.237**

Source : FUCOSA (1999)

It is a plain area with a little slope to the south with predominance of depressed areas with deficient drainage (swamps, marshes and streams), alternating with sandy and low fertility hills characteristics of the *chaqueño* park with great potential for buffalo breeding.

In the strata of medium surface cattle raising activity predominates, with a reduced and deficient productive infrastructure. It has insufficient paddocks, situation that conditions the productivity of the forage and cattle resources.

The beef buffalo production was the alternative considered in front of the present situation of models with a system of traditional management.

The variables used for the design of the models are: production system by productive scale and production type **(750 ha – 2.000 ha. / BOVINE – BUBALINE)**, in all the cases the cost of the land was determined in a value near 100 dollars/hectare $ 270 (two hundred seventy *pesos*) market value of marginal fields for cattle raising activity.

The models identified are named in the following way: buffalo production model 1, named (BF1) of 750 ha; buffalo production model 2, named (BF2) of 2,000 ha. The model BV1 corresponds to production units that have an average herd of 350 bovine heads which was extensively mentioned in previous paragraphs within the Familiar and Capitalized models.

The system is characterized by a low adoption of technology, mainly in the processes of herd management. The service in most of the cases is continuous, observing a high grade of consanguinity and low quality of the product, associated to a low-medium health resulting in low productivity.

There is a person in charge and a permanent salaried farm worker, without any kind of machinery but with the necessary facilities to work with cattle.

The decision making of the farm does not often have any professional support, it is in the hands of the producer or family.

The BV2 model (2,000 hectares) represents production units that have a herd of about 1,000 bovine heads; they are in a rank higher than the model previously mentioned.

In this producer's stratum variations as regards technology adoption are manifested, considering those exploitation units with productive indexes and a producer profile similar to the model previously mentioned.

It has a person in charge and two permanent salaried farm workers; it has machinery and the necessary improvements to work with cattle.

The buffalo production models determined are the same as the bovine ones as regards the exploitation surface, the productive structure, and the producer's profile. The main differences as regards the productive indicators are: branding percentage of 75%, useful life of the breeding cows (20 years), replacement percentage (10%) and age for breeding season (24 months), among the most important.

In chart 25 the productive indicators of the buffalo models are compared with the bovine models.

Chart 25. Productive Indexes according to models**.**

INDEX	MODEL BV1	MODEL BF1	MODEL BV2	MODELOBF2
Branding %	50%	75%	50%	75%
Replacement %	20%	10%	20%	10%
Service	Continuous / Stationary	Estacionado	Continuous / Stationary	Stationary
Heiffer breeding season	50% at 2y3 years	100% at 2 years	50% at 2y3 years	100% at 2 years
First breeding season weight	300/320 kg	400 kg	300/320 kg	400 kg
Usefull life of the breeding cows	10 years	20 years	10 years	20 years
Weanning	Fall / Spring	Spring	Fall / Spring	Spring
Mortality %	7%	2%	7%	2%

Source: Maldonado Vargas, *et al.*, (2000)

The information generated by the models was processed using the Program of Economic, Financial and Patrimonial Analysis of Farms – CALSIS 2.3 – done by Balcarce INTA. With the information obtained summary charts were done in which the physical results and the main economic and financial indicators of the reference model are depicted (Genovés, 1994).

From this information comparisons that allowed having elements for discussion and analysis of the results were established. In the opinion of Gándara and Arias (1999), the production costs vary according to the business scale, the production level and the structure and operation expenses between 0.35 to 0.75 $/kg of live weight.

This situation in front of the relative price depreciation which was seen in the past decade, added to a low productivity average of the current cattle systems in the province made their capacity to generate economic surplus limited, decreasing the investment and growth possibility.

The same authors think that the production scale is a determining factor of the profitability and net income of the farm, estimating that nowadays a great proportion of the farms have possibilities to revert their negative net income situation.

The low level of technology adoption can be seen in the breach that exist between physical results of the business which have adopted the available technology and the averages the province has, added to the management inability to carry out successful economic results for the business.

It is also highlighted the scarce number of producers who make strategic and operative plans, with well defined objectives; which measure the physical production, estimate the expenses and plan the sales, the investments and the withdrawals.

According to Alippe (1999) business management, with all its implication in making decisions, is without doubt the main tool to associate the productive efficiency to the business profitability.

The most important advantage is to obtain the best economic result for the business to allow sustainability as economic system, pointing out that there is a great demand of time and qualified time as the cattle raising systems do not need more capital they need more intelligence and devotion.

To analyze the behavior the two situations mentioned by Calvi (2001) were compared for the Capitalized Familiar models in the traditional version and with technology adoption as it is observed in

Chart 26, taking the models with low or null adoption for the work carried out.

Chart Nº 26: Adoption of technologies in the traditional and business models.

Technologies	Traditional Capitalized Familiar Model	Business Capitalized Familiar Model
Management of the natural field	Poor. Does not adjust charges	Efficient. Forage Reserve. Adjust charges
Pastures	No	5% summer-like
Paddock Distribution	Scarce to Null	Paddocks 200-400 has
Staff	1 farm worker, 1 foreman	1 farm worker,1 foreman, 1 Councellor
Sanity	Minimum Sanitary Calendar	Complete Sanitary Calendar + breeding cows and bulls
Mineral Suplement	Null	Complete the entire year
Proteic Suplement	No	Heifers 1st winter
1st service age	36 months	24 months
Service	Continuous	Stationary 4 months
Lactation Management	No	Body Condition 50% canned 10% precocious

Adapted from Calvi, M. (2001)

PHYSICAL ECONOMIC AND FINANCIAL EVALUATION

Physical results

The information obtained from the different models as regards the effective surface used, kg of beef production per hectare and animal charge, can be appreciated in Chart 27.

Chart 27. Surface, production and animal load of the models.

INDEX	BV1 MODEL	BF1 MODEL	BV2 MODEL	BF2 MODEL
Surface (has)	750	750	2,000	2,000
Animal Charge	0.50 UA/ha	0.50 UA/ha	0.50 UA/ha	0.50 UA/ha
Production (kg/ha)	34.1 kg/ha	55.1 kg/ha	35.2 kg/ha	54.9 kg/ha

Source: Maldonado Vargas, *et al.,* (2000)

The chart shows that the beef production is increased in the buffalo models, this increase of productivity is based on the increase of calves obtained which increments the amount of kg and heads during selling.

If the same animal charge is maintained, bearing in mind an increment of 30% for each category in relation to the cow equivalent (CE=1), for buffalos it would be of (CE=1.30). It will have to be necessarily compensated by a smaller number of breeding cows in service and fewer categories in the farm.

The kilogrames of beef/ha produced are more significant in the buffalo models, being similar among models and superior in 1.57 times the bovine models.

It is demonstrated that the BF1 model of 750 hectares surpasses, as regards beef production, both bovine models, according to what has been observed in the chart mentioned.

Economic Results

It is convenient to remember habitual terms in this kind of analysis so that the producer is accustomed to them. Conceptualizing that profitability is an efficiency economic measure that indicates the yield of the capital affecting production. Profitability determination allows the business analysis in a global way, the comparison with other productive models and the planning to optimize the use of land, work and capital resources (D’Angelo, 1993).

To obtain profitability it is necessary to know previously the concepts of the other indicators that are considered to calculate it:

gross margin, structure expenses, redemption, net income and the business capital.

The Gross Margin is a tool that allows estimating the economic benefit of a productive activity. The gross margin is the result of the subtraction of the direct costs to the gross income.

In cattle raising production the components of the gross margin are the Gross Income and Direct Costs.

The cattle sales by the gross price paid, the consumption of cattle in the farm and the stock difference between the end and the beginning of the exercise are considered Gross Income.

The expenses in staff, sanitation, feed, cattle purchase and commercialization discounts are regarded as Direct Costs.

Structure Expenses are the indirect expenditures corresponding to the existence and functioning of the business, it is formed by: mobility, countable and technical evaluation, structure staff (foreman), maintenance of the assets, taxes and others (energy, gas, staff insurance, etc).

The Net Income indicates the amount that becomes business utility after the discounts affecting the business are performed. The net income appears when subtracting the structure and redemption discounts to the gross margin.

The capital that the enterprises have is composed mainly by the land, the facilities, the cattle and the machinery.

The profitability is expressed in percentage and it is obtained relating the net income with the total capital.

The models developed were evaluated and analyzed on the basis of real data production such as income, effective outlay and direct expense. When the work was carried out the Convertibility Law in force was 1Peso = 1Dollar so the current prices had to be updated with the relationship 1Dollar = 2.80*Pesos*.

As regards the indirect outlay, administration and structure, zonal averages coming from the farms located in the analysis area were taken.

Chart 28 shows the Total Capital of each model. The ones corresponding to Fundiario Capital (land and assets) and the Live

Fixed Capital (cattle) and Inanimated Fixed Capital (machinery) are detailed. The data are expressed in percentages on the total.

Chart 28. Capital Composition per productive model. In percentages.

CAPITAL	BV1 MODEL	BF1 MODEL	BV2 MODEL	BF2 MODEL
Land	51.75	46.4	49.3	43.7
Assets	5.6	5.0	3.4	3.0
Machinery	0.0	0.0	0.6	0.5
Cattle	42.6	48.5	46.6	52.6
Total (%)	100.0	100.0	100.0	100.0
Total ($)	391,211	436,141	1,095,243	1,233,818

Source: Maldonado Vargas, *et al.* (2000)

The participation of the Cattle Capital in the buffalo production models is highlighted. It is observed that it exceeds the Fundiario Capital and in both cases constitutes almost the 50% or more of the Total Capital, while in the bovine models the participation of the Fundiario Capital is superior to the Cattle Capital. This would indicate an advantage in the buffalo production systems as it has a greater proportion of working capital.

Chart 29 shows the sales discriminated by categories and relating the variables sold Kg and obtained prices.

Chart 29. Cattle sale, according to models and by categories. In *pesos*.

BOVINE MODELS			BUFALO MODELS		
Categories	Kg	Price ($/head)	Categories	Kg	Price ($/head)
Steer 2-3	380	646	Steer 1-2	400	680
Discarded heifer	-------	------	Discarded heifer	350	500
Discarded cow	350/400	452	Discarded cow	550	550
Discarded bull	550	600	Discarded bull	700	700

Source: Maldonado Vargas, *et al.* (2000)

Many times the commercialization of bubaline productions is considered a bottleneck. This is due to the selling problems of the fat cattle and in some cases to the commercialization destiny (manufacture) of the discarded cows.

When these situations that are not structural of the production are solved, the most significant difference is observed in the discarded heifer. The price breach that reached a 70% higher in the buffalo than in the bovine in the last years has considerably decreased.

It is also important to point out the lack of presence of this category in the sale mix in the bovine models as there is no surplus available. On the contrary there is a strong presence of this category in the sale components of bubaline production.

This is due mainly to the bubaline cow longevity and its high reproductive efficiency. It is possible to have surplus as the replacement percentage is lower, it is a stable herd. Once the replacement is done there will be a great number of heifers for sale.

Chart 30 shows that the buffalo models have a marked impact presenting a better economic situation compared with the bovine models.

Chart 30. Economic situation of the productive models. In *pesos*.

INDICATORS	**BV1 MODE L**	**BF1 MODEL**	**BV2 MODEL**	**BF2 MODEL**
GROSS INCOME	37,840	61,050	104,375	170,775
DIRECT COSTS	13,891	13,477	34,111	32,521
GROSS MARGIN	23,949	47,573	70,264	138,254
STRUCTURE EXPENSES	11,740	11,740	18,000	18,000
EFFECTIVE RESULT	12,209	35,833	52,264	120,254
REDEMPTION	1,166	1,166	3,620	3,620
NET INCOME	11,043	34,667	48,644	116,634
PROFITABILITY	**2.82%**	**7.95%**	**4.44%**	**9.45%**

Source: Maldonado Vargas, *et al.* (2000)

In general the increase of the economic result is related to the alternatives of buffalo production. It should be pointed out that the intensifying of the production by the adoption of bubaline production in both scales does not increase in a significant way the direct costs of production, but it is important to analyze the impact on the kg produced.

The efficiency of bubaline production is observed when producing a beef kg at a cost of 55 cents in comparison of the 85 cents of bovine production.

The gross income of the BF2 model is 1.64 times superior to BV2. While BF1 model is incremented in 1.61 times the income as regards BV1 model.

As regards the Net Income it is observed that the BF2 model is 2.4 times superior to BV2. Likewise, BF1 model is slightly inferior to BV2. With an area of 750 hectares it is possible to obtain a net income inferior only 0.3 times to a bovine model of 2,000 hectares.

As regards Profitability the BF2 model is 2.1 times superior to BV2 model. The same as the case above mentioned BF1 model is 1.79 times more profitable than BV2 model and 2.8 times more than BV1.

In Chart 31 the indicators previously mentioned are detailed. They are expressed in *pesos*/hectare. The Net income and the Financial Result of the BF1 model of 750 hectares are pointed out. It is superior to both bovine production models BV1 and BV2 of 750 and 2,000 hectares respectively.

Chart 31. Economic situation of the productive models. In *pesos* per hectares.

INDICATORS	BV1 MODE L	BF1 MODEL	BV2 MODEL	BF2 MODEL
GROSS INCOME	50.4	81.4	52.1	85.3
DIRECT COSTS	18.5	17.9	17.0	16.2
GROSS MARGIN	31.9	63.4	35.1	69.1
STRUCTURE EXPENSES	15.6	15.6	9.0	9.0
EFFECTIVE RESULT	16.2	47.7	26.1	60.1
REDEMPTION	1.5	1.5	1.8	1.8
NET INCOME	**14.7**	**46.2**	**24.3**	**58.3**
FINANCIAL RESULT	**9.6**	**41.1**	**18.6**	**52.6**

Source: Maldonado Vargas, *et al.* (2000)

Financial Results

To obtain the business Financial Result the difference between the Production Effective Income and the Effective Outlay is performed. This indicator determines the business liquidity state and the available cash at the end of the productive cycle.

The Effective Income is constituted by the Gross Income, the loans obtained, the amount of money available and other incomes. The Effective Outlay is composed of the direct and structure expenses, the money drawings of the producer and his/her family, redemption and loan interests, investments, paid debts and other outlays (D'Angelo, 1994).

Chart 32 shows the financial situation of the models developed. The Effective Income, the Effective Outlay and the Financial Result are depicted in it.

Chart 32. Financial situación of the productive models. In *pesos*.

INDICATORS	BV1 MODEL	BF1 MODEL	BV2 MODEL	BF2 MODEL
TOTAL EFECTIVE INCOME	37,840	61,050	104,375	170,775
Efective Outlays (Direct and Structural)	25,631	25,217	52,111	50,521
Money drawings	5,000	5,000	15,000	15,000
TOTAL EFECTIVE OUTLAY	30,631	30,217	67,111	65,521
FINANCIAL RESULT	7,209	30,833	37,264	105,254

Source: Maldonado Vargas, *et al.* (2000)

As it was previously mentioned, the models are stable and it is evident that in the BF2 model a better financial situation is observed.

In the four models developed to study the family-exploitation results a money drawing was considered, which was done by the producer and destined to eventual expenses (Tosi*, et al.* 2001).

At the end of the productive cycle BF2 obtains a result of about $105,254 being 3.4 times superior to BF1 model of 750 hectares. The impact of the scale is clearly shown in the financial result.

Considering what has been said, it is worth asking if the incorporation of productive alternatives by itself is enough, as for the producer and his/her family the crisis starts when the money is not enough. Situation which is not observed in the models analyzed, even in the present conditions.

As Loti, 1999 states as regards the crisis concept, when the producer feels that the money is not enough, it is because the balance among the income, drawings and debt interests (in case there is debt) has been broken.

FINAL CONSIDERATIONS

After the analysis of the results obtained the following considerations can be done. It is worth mentioning that the producer and his/her circumstances are determining factors for the viability of the models analyzed, as the financial flow is the determining element of any re-conversion which implies the access to new investment alternatives.

In front of similar scales and productive structure, the branding percentage is significantly higher in buffalos. The beef production is greater in this species with not very intensive management layouts and adoption of intake and process technologies.

When carrying out a static study of the models the current price level, a little superior in buffalos, impacts in the results obtained.

The strong presence of the discarded heifer category in the sales composition, contributes significantly to the farm income.

The analysis of the determined models showed that buffalo production models exceed the bovine models not only in physical but in economic and financial results as well.

In this preliminary analysis it is observed that the scales of 750 and 2,000 hectares for buffalo production constitute alternatives to bear in mind in a productive layout of bovine cattle.

Even though, there is a great economic impact as the premise of investing to increase the production and the income level is achieved.

On the other hand an economic benefit equivalent to a fair retribution to the capital invested by the producer is achieved. This allows the producer to have access to growth alternatives for the productive system (Calvi, 2000).

As regards the intervention strategies the question seems to be: What would happen if it is not enough with the adoption of technology? And in that sense it is observed that the production scale, the size of the farm and the lack of management affect the potential change of the system.

An innovation in cattle raising business, like the proposal presented here, is understood in a wide sense as a paradigm change. It affects the institutional, organizational and technological environment with a strong commercial characteristic: access to markets and to cover potential customer demands as it is pointed out by Ordoñez, cited by Maldonado Vargas, 2003.

The institutional innovation should take place in the change of the game rules and the culture. This will finally enable the rest of the innovative process to take place in order to be the framework of the new reality of cattle raising business in which the buffalo will have a great potential for the province and the region.

The organizational innovation will be given by tools for institutionalization, organization and the starting of coordinated groups of buffalo producers in the region. These groups will privilege the management of processes , the origin and quality supported by ordinary technological aspects and focusing on commercial aim.

The technological innovation implies to apply scientific and technological knowledge to improve and standardize the management of processes and products, aiming mainly at a continuous betterment to increase the cattle quality and to reduce the process cost to increase productivity.

The standardization of the processes and products is considered essential so as to build a system that guarantees the quality and origin of and outstanding, prestigious and typical product as the Correntinian buffalo.

Commercial innovation implies re-engineering of the buffalo producer business from the strategic and operative marketing sustained in the processes. The origin and quality of the cattle are key elements in the positioning of the differentiation and segmentation of the market as engines of cattle coordination action.

The cattle raising strata of the Northeast region of the Province, defined in previous paragraphs of this Chapter can undertake these intervention proposals, in a process of changing the attitude of the traditional cattle raising paradigm (Maldonado Vargas, *et al.,* 1999).

It implies the building of a new productive alternative for the farming business of the province. As in an area with productive indexes below the provincial mean, a group of enterprises will be able to rationalize their resources, they will contribute to the creation of added value in knowledge and information and they will have the power of negotiation in their hands.

Agreeing with Ordóñez, (1998) the contractual system of certification and insurance of the processes and productive management is based on the centralization of management and on the collective adoption of a group of enterprises devoted to cattle raising practices, in this case for buffalo production, which are identified, registered, controlled and certified. Thus they represent a group of register-document data and parameters of objective measurement in Productive Protocols.

It is important to be able to achieve the structural change of the farms that are object of this study, to offer a critical mass of cattle and beef buffalo to the market; to be able to show the productive processes carried out, the origin and the product quality. This is to sell meat plus information according to the current demands of the market.

In this way it will be possible to participate more actively in the price formation, changing in part the power of the present market, focusing on adding value and receiving a price plus for what has been done, generating extra income in the buffalo production systems.

It is also established that in a background like the one we live in, proposals similar to the ones analyzed in this work are confronted to a number of restrictions and limitations due mainly to the links with the past and the highly structured and individual idiosyncrasies.

It is important to plan a future agenda to prioritize the dynamic of the producers' collective actions. They should be oriented to a shared vision for buffalo production in the province and in the country with tools, collective missions and common aims.

Something I would like to add is an analogy to a phrase given by President Kennedy: "…in the farming business there are three kinds of producers, the ones who make things happen, the ones who look at the things to happen and the ones who even did not know that the things happened". **The election is ours**.

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CHAPTER 5

BUFFALO MILK

Exequiel M. Patiño

Buffalo milk production is without doubt a very important activity in various countries of the world.

It has the second place in importance in the world as regards the volume produced after bovine milk and followed by caprine and ovine milk. (Chart 33)

Chart 33: World production of milk per species (millions of tons)

Animal	Years				Increase in the period (%)
	1970	1980	1990	2000	
Bovine	359.3	422.5	479.1	487. 2	35.6
Bubaline	**19.6**	**27.5**	**44.0**	**71.8**	**266.3**
Caprine	6.5	7.7	9.9	11.4	75.4
Ovine	5.5	6.8	8.0	7.8	41.9
Others	0.9	1.2	1.3	1.2	33.3
Total	391.8	465.7	542.6	579.7	48.0

Source: FAO (2003)

In the year 2002 according to FAO (2003) the milk production of all the species reached 598.6 millions of tons (tn) from which 12.6 % i.e. 75.4 millions of tn were buffalo milk.

Between 1970 and 2000 the increase of bubaline milk production was of 266.3%, on the other hand the bovine one in the same period hardly reached 35.6%.

The principal countries producers of buffalo milk in the world (expressed in tons) are: India (46.7 millions), Pakistan (22.5 millions), China (2.6 millions), Egypt (2.0 millions), Nepal (806,694), Iran

(225,950), Italy (140,000), Myanmar (ex Burma) (116,018), Sri Lanka (68,240) and Turkey (63,327) (FAO, 2003).

In the American Continent, Venezuela is the country of major production, followed by Brazil (Zava, 2000).

In Argentina buffalo milk production started in 1992, and from that time it has been increasing constantly. Nowadays, it is in free expansion with places devoted to lacteal production in the provinces of Corrientes, Misiones, Formosa, Santa Fe, Buenos Aires and Tucumán. (Crudeli, *et al.* 2002)

The bubaline dairy in our country is a promissory livestock industry not only for important producers but for small and medium ones as well. It is essential for technicians, producers and industrialists to know the physic-chemical milk composition of the different breeds in Argentina and the factors that affect it, especially fat components, proteins and total solids, which influence the manufacturing of derivatives that are of great importance for the lacteal industry and commerce.

The milk buffalo, as it is notably different to the cow one as regards its composition, presents several technological problems of manufacturing to obtain lacteal derivatives, so many that 20 years ago this milk was considered inappropriate for producing them.

Nowadays and thanks to technological development, cheese, butter, powder milk, mothering quality milk (for babies), fermented milk, ice cream, "*dulce de leche",* are manufactured, among others.

The milk buffalo has a high nutritive value. It is excellent for preparing derivative products and has a great yield in the manufacturing of them.

It is noticeable the economical use of raw material in the manufacturing of derivatives such as yogurt, Mozzarella, *dulce de leche*, butter and Provolone cheese, when using buffalo milk, as it can be seen in Chart 34.

Chart 34: Yield of derivative products of bubaline and bovine milk

Product	Yield per 1 (one) kilogram of product		Economy of raw material (%)
	Buffalo (liters)	Cow (liters)	
Yogurt	1.2	2.0	40
Mozzarella	5.5	8.0 a 10.0	39
Dulce de Leche	2.5	3.5	29
Butter (*)	15	20	25
Provolone cheese	7.43	8.0 a 10.0	20

Source: Hühn *et al.* (1984) and (*) Furtado (1979).

The taste and aroma are less marked in products manufactured with bubaline milk than with the ones manufactured with bovine milk (Ganguli, 1979).

The hydrolysis during the maturation of derivative products of buffalo milk is slower, not only in the lipolytic activity but in the photolytic one as well, principal responsible of taste and aroma and characteristic of already made products (Hühn, *et al.* 1984).

The buffalo milk is opaque white due to the absence of carotene pigments and presents sweet taste. The absences of these pigments results in a white butter, crystalline and more consistent than the one obtained from a cow (Hühn, *et al* 1982).

The fat corpuscles of buffalo milk are bigger (4.1 – 4.8 microns) than those of the cow ones (3.6 – 4.0 microns) (Furtado, 1979).

The fat has more density, more fusion temperature (32.0 – 43.4 ° C) and less iodine value (29.43) than the cow.

The casein in the bubaline milk is present principally in micellar form and the electronic microscope has demonstrated that these micelles are bigger than the ones of the bovine milk and are opaque. They contain less nitrogen and less sialic acid, but more calcium and phosphorus (Ganguli, 1979).

Studies done by Sandhu (1985) demonstrated that the bubaline milk has 39.9 % more total solids, 95.9 % more fat, 25.6 % more protein and 1.7 % more lactose than the bovine milk and has 33.5 %

more total solids, 53 % more fat, 37.1 % more protein and 5.2 % more lactose than the zebu milk (Chart 35).

Chart 35: Comparison of the chemical composition of bubaline, bovine and zebu milk.

Species	Total solids	Fat	Protein	Lactose
Buffalo (*Bubalus bubalus)*	17.96	7.64	4.36	4.83
Bovine *(Bos taurus)*	12.83	3.90	3.47	4.75
Zebu *(Bos indicus)*	13.45	4.97	3.18	4.59

Source: Sandhu (1985)

PHYSICAL CHARACTERISTICS AND CHEMICAL COMPOSITION

The milk composition in the majority of species is constant, but from the qualitative point of view presents variations in its composition. These variations may be due to genetic causes (species, breed, individual), physiological (lactation period, number of parturitions, gestation) and environmental such as food and climate (Alais, 1984; Walstra *et al.,* 1987).

The physic-chemical composition of the buffalo milk has been studied principally in countries such as India, Italy, Bulgaria, Turkey, Thailand, Brazil, Venezuela, Cuba and Argentina.

In our country since the middle of the 90s, researchers of the Veterinary Sciences School from the National Northeast University carried out studies about buffalo milk in the Province of Corrientes.

The results of the different works published about buffalo milk composition reveals that variability exists, not only in its physical characteristics but in its chemical composition as well, within the same breed and country (Patiño, *et al.,* 2000).

The period of lactation, the number of parturitions, food and environmental conditions are some of the factors that can affect the physic-chemical composition of the bubaline milk.

This variation may be the result of the different conditions in which some activities were done such as use of pure female buffalos and with different degrees of crossing, samples taken in one or two milking, analysis conditions, transport and proof design.

As reference and taking into account the figures published by different authors (Charts 37 and 38), some mean values of the physical characteristic and the chemical composition of milk buffalo were established (Chart 36). Undoubtedly, when checking the amplitude that is manifested by its range, the necessity to continue and develop the studies of the physic-chemical composition of the bubaline milk is confirmed.

Chart 36: Mean values and range of the physical characteristics and chemical composition of the buffalo milk.

Variable	Mean	Range
Density (g/ml)	1.032	1.026 – 1.037
Acidity (° Dornic)	18.50	17.70 – 21.00
PH	6.69	6.61 – 6.78
Total solids (%)	17.97	14.22 – 21.54
Fat (%)	7.58	4.58 – 10.56
Protein (%)	4.30	3.04 – 5.88
Lactose (%)	4.77	3.83 – 5.52
Ashes (%)	0.81	0.72 – 0.91

Source: Patiño (2003)

Chart 37: Physical Characteristics of buffalo milk according to different authors.

Breed	*Country*	Density *(g/ml)*	*Regular Acidity (°Dornic)*	*PH*	*Authors*
Carabao	Thailand	1.032	---	---	Buranamnas (1963)
Jafaradabi	Brazil	1.032	17.46	---	Faria *et al.,* (1997)
Mediterrnean	Italy	1.031	---	6.63	Alborico *et al.,* 1967-1968, cited by Kay (1974).
"	Italy	---	---	6.78	De Franciscis *et al.,*(1963)
"	Italy	1.026-1.035	---	---	Perrillo (1975)
"	Italy	---	---	6.67-6.77	Tripaldi *et al*., (1997)
"	Bulgaria	1.033-1.034	---	---	Polihronov y Aleksiev (1979)
"	Brazil	1.031	---	---	Rudge *et al.,* (1979)
"	Brazil	1.032	---	6.61	Bonassi *et al*., (1979)
"	Brazil	1.032	17.56	---	Hühn *et al.,*(1982).
"	Brazil	1.035	19.52	---	Faria *et al.,* (1997)
Murrah	Bulgaria	1.032	---	---	Shalichev and Polihronov (1969)
"	India	---	---	6.74	Rao and Dastur (1955 – 1956)
"	India	---	---	6.64	Dubey *et al.,* (1998)
"	Brazil	---	15.70	---	Faria *et al.,* (2002)
"	Argentina	1.031	19.86	6.74	Patiño *et al*., (2003)
Crossbreed	Brazil	1.033	21.00	6.61	Furtado (1980)
"	Argentina	1.031	19.82	6.69	Patiño *et al.,* (2003)
"	Venezuela	---	17.57	6.75	Briñez *et al.,* (2000)
"	Cuba	1.032	---	---	Capdevilla *et al*., (2001)
Jafarabadi, Mediterranean Murrah, Crossbreed,	Brazil	1.032-1.037	15.70-19.01	---	Faria *et al*., (2002)
Average		**1.032**	**18.50**	**6.69**	

Source: Patiño (2003)

Chart 38: Chemical Composition (%) of buffalo milk according to different authors.

Breed	Country	*Total Solids*	Fat	Protein	Lac-tose	Ashes	Authors
Carabao	Thailand	18.16	9.19	4.67	---	---	Buranamnas (1963)
"	Filipinas	20.36	9.65	5.26	5.29	...	FAO (1977)
"	India	21.54	10.35	5.88	4.32	0.84	Rao *et al.* (1977)
Jafarabadi	India	16.92	7.40	4.01	---	---	Sharma *et al.* (1980)
"	Brazil	17.00	8.16	4.50	....	0.70	Verruma and Salgado (1994)
"	Brazil	---	6.8	3.96	---	---	Tonhati *et al.* (2000)
"	Brazil	...	6.11/ 8.15	----	----	----	Faria *et al*. (2002)
Mediterra-nean	India	18.06	7.85	4.28	---	---	Rao and Nagarcenkar (1977)
"	Bulgaria	18.51	8.22	4.71	4.75	0.83	Polihronov and Aleksiev (1979)
"	Italy	18.9	8.5	---	4.6	---	Alborico *et al.* 1967-1968, cited by Kay (1974).
"	Italy	17.50	7.80	4.00	4.90	0.80	Intrieri, cited by Perrillo (1975)
"		18.90	8.50	4.50	4.60	0.84	FAO (1991)
"	Italy	17.12	8.55	4.27	5.15	0.89	Spanghero and Susmel (1996)
"	Brazil	17.0	6.5	4.3	---	---	Macedo *et al.* (1997)
"	Brazil	---	6.12	3.80	---	---	Faria *et al.* (1997)
"	Brazil	16.12/20.35	6.10/10.33	3.52/4.76	---	---	Hühn *et al.* (1981)
"	Brazil	17.50	6.85	3.68	3.83	0.83	Hühn *et al.* (1982)
"	Brazil	...	6.1	3.83	....	...	Tonhati *et al.* (2000)
"	Brazil	...	5.5/7.44	....	....	...	Faria *et al*. (2002)
Murrah	Bulgaria	18.31	8.03	4.51	4.75	0.91	Shalichev and Polihronov (1969)
"	India	17.02	6.96	---	---	---	Basu y Rao (1979)
"	India	16.79	7.40	3.94	---	---	Sharma *et al.* (1980)
"	India	17.24	7.38	3.60	5.48	0.78	Rao y Nagarcenkar (1977)
"	India	17.01	7.65	3.81	4.83	---	Dubey *et al.* (1997)
«	India	23.76	10.56	5.34	4.33	---	Suman *et al.* (1998)

Breed	Country	*Total Solids*	Fat	Protein	Lac-tose	Ashes	Authors
«	Thailand	---	7.57	4.21	4.93	---	Na-Chiangmai (2003)
«	Brazil	---	7.1	4.42	---	---	Tonhati *et al*. (2000)
"	Brazil	...	6.26/8.3	---	---	---	Faria *et al*.(2002)
"	Argentina	16.58	7.04	3.73	4.57	0.85	Patiño *et al.* (2003)
Crossbreed	Brazil	17.09	6.60	4.79	5.52	0.72	Furtado (1980)
"	Brazil	14.22/19.33	4.58/9.63	3.04/5.16	---	---	Hühn *et al.(*1981).
"	Argentina	16.81	7.60	3.73	4.51	0.80	Patiño *et al.* (2003)
"	Venezuela	18.89	7.06	5.34	---	...	Briñez *et al.* (2000)
"	Venezuela	17.50	7.48	4.98	---	---	Montiel Urdaneta (2000)
"	Cuba	17.90	7.36	---	---	---	Capdevilla *et al*.(2001)
Mediterranean Crossbreed, Murrah, Jafarabadi	Brazil	---	6.97	3.81	---	---	Tonhati *et al*. (2000)
"	Brazil	15.75/18.99	5.5/8.84	3.4/4.5	---	---	Faria *et al*. (2002)
Average		**17.97**	**7.58**	**4.30**	**4.77**	**0,81**	

Source: Patiño (2003)

BUFFALO MILK COMPOSITION IN ARGENTINA

There are few studies done and published about the physic-chemical composition of the buffalo milk in our country.

Most of them were carried out in the Province of Corrientes (Patiño, *et al.* 1999; Patiño, *et al.* 2000; Patiño, *et al.* 2003; Patiño, 2003). Corrientes is situated in the northwest in a humid subtropical climate with annual rains from 1200 to 1400 mm, temperatures and humidity of 21.5 °C and of 75% respectively.

One of the last studies, carried out in July 2001 and June 2002, about 40 milk buffalos (20 Murrah and 20 crossbreeds) demonstrated that there were non-significant differences between physic-chemical components in both milks. This study was done on 20 buffalos of Murrah breed and 20 crossbreeds -with grades of blood ½ Murrah and ½ Mediterranean – from second to fifth lactation, making as a whole 960 sample, which were fed in natural pastures. (Patiño, 2003). Therefore, a general mean was established for the physic-chemical composition of the bubaline milk obtained in Corrientes, what is enumerated in Chart 39.

Chart 39: Physic-chemical composition of the bubaline milk from Murrah breed and Crossbreeds (Murrah x Mediterranean) obtained in Corrientes, Argentina

VARIABLE	Mean	SD
Density (g/ml)	1.0307	0.0039
Acidity (° Dornic)	19.65	2.96
PH	6.71	0.16
Total Solids (%)	16.35	2.42
Fat (%)	7.22	1.89
Protein (%)	3.85	0.92
Lactose (%)	4.49	0.24
Ashes (%)	0.83	0.08

Source: Patiño (2003)

Physical characteristics

Among the physical characteristics of the bubaline milk studied in Corrientes, the one that presents the greatest variability was the regular acidity (19.65 ± 2.96 ° Dornic). The results obtained may be due to the different stages in lactation that affect it, increasing it as long as the productive cycle advances, as it was tested by Briñez (2000) in Venezuela with Crossbreeds, Murrah x Mediterranean, Mehsana and Nili-Ravi.

It is important to highlight that the greater regular acidity that the bubaline milk possesses comparing with the bovine one, is because the first has greater quantity of casein (Furtado, 1979). Therefore, the parameters considered normal for bovine milk (13 ° to 18 ° Dornic) in our country should not be applied to measure the normal acidity of bubaline milk.

Chemical composition

The fat (7.22 ± 1.89 %) and the solid totals (16.35 ± 2.42 %) were the chemical components that presented the greater variability. They can change not only during the lactation stages but also in the blood grades of the animals studied, as it is demonstrated by the study done by Hühn *et al*. (1981) in Brazil with crossbred buffalos, Murrah x Mediterranean with different crossbreed grades. He points out that as long as the grade of Murrah blood is increased, a tendency to decrease the average of fat and total solids is manifested and that with advances in lactation a gradual percent increase in both components is produced. Dubey *et al*. (1997) demonstrated, with Murray buffalos in India, that the number of parturitions and the lactation period may make the percentages of fat and total solids change, reaching both, the greatest figures during the first parturition. These percentages decrease from the first to the fourth lactation month and then they increase from the fifth until reaching the maximum value during the last, which is significantly greater than in all the other months.

FACTORS THAT VARY MILK COMPOSITION

Season of the year

Significant differences were not found among its physic-chemical components during the four seasons of the year (Chart 40), except the regular acidity that presented significant differences ($p < 0.05$) in winter in relation to spring and summer and in spring and summer in relation to fall.

In spring and summer, the greatest season figures of temperature and in summer figures of rains were registered, which produce unfavorable environmental and sanitary conditions that increase the bacterial load. This produces lactic acid from the lactose fermentation, which in a way may explain the increase of the regular acidity.

Chart 40: Composition according to the seasons of the year.

VARIABLE	Winter	Spring	Summer	Fall	
Density (g/ml)	1.0311 ± 0.0025	1.0320 ± 0.0038	1.0282 ± 0.0058	1.0297 ± 0.053	NS
Acidity (°Dornic)	18.00 ± 2.70[a]	21.54 ± 1.71[b]	21.75 ± 2.01[c]	17.17 ±2.25[a]	*
Ph	6.63 ± 0.15	6.79 ± 0.10	6.69 ± 0.20	6.72 ± 0.13	NS
Fat (%)	7.22 ± 1.67	7.35 ± 1.42	8.03 ± 2.75	6.26 ± 1.10	NS
Protein (%)	3.08 ± 0.72	4.33 ± 0.31	3.81 ± 1.28	4.13 ± 0.65	NS
Lactose (%)	4.53 ± 0.22	4.55 ± 0.23	4.46 ± 0.22	4.44 ± 0.28	NS
Total Solids (%)	16.58 ± 2.98	16.77 ± 2.17	17.15 ± 2.25	14.85 ± 1.75	NS
Ashes (%)	0.80 ± 0.05	0.85 ± 0.05	0.84 ± 0.10	0.83 ± 0.11	NS

*Significance < 0.05, NS: Non- significant. Different letters in each row differ significantly.
Source: Patiño (2003)

Stages of lactation

As regards the mean physic-chemical composition and according to the stages of lactation (Chart 41), no significant differences were observed through the three stages except the regular acidity, the fat and the total solids. They manifested significant differences ($p < 0.05$) in the third period in relation to the first and second ones, which do not present differences among each other.

The increase in the regular acidity in the third period of the lactation coincides with the decrease in lacteal production and with the increase of solids concentration because of the reduction in the volume produced. When the production decreases, proteins are concentrated, increasing the regular acidity as it was tested in the research work done by Briñez (2000) in Venezuela with crossbred buffalos of Murrah, Mediterranean, Mehsana and Nili-Ravi breeds.

The increase in regular acidity, fat and total solids of the current work coincide with the values observed by Faria *et al*. (2002) in Brazil who worked with female buffalos of Murrah, Mediterranean, Jaffarabadi and Crossbred breeds.

Chart 41: Composition according to stages of Lactation.

VARIABLE	THIRDS OF LACTATION			
	First	Second	Third	
Density (g/ml)	1.0298 ± 0.0055	1.0306 ± 0.0044	1.0303 ± 0.041	NS
Acidity (°Dornic)	17.75 ± 2.32[a]	19.53 ± 2.72[a]	22.06 ± 1.84[b]	*
PH	6.68 ± 0.14	6.68 ± 0.15	6.78 ± 0.16	NS
Fat (%)	6.45 ± 0.93[a]	6.85 ± 1.33[a]	8.38 ± 2.41[b]	*
Protein (%)	3.97 ± 1.08	3.73 ± 0.71	3.84 ± 1.02	NS
Lactose (%)	4.45 ± 0.20	4.55 ± 0.26	4.48 ± 0.25	NS
Total solids (%)	15.40 ± 1.80[a]	16.22 ± 2.71[a]	17.54 ± 2.27[b]	*
Ashes (%)	0.85 ± 0.10	0.81 ± 0.05	0.84 ± 0.09	NS

*Significance < 0.05, NS: Non- significant. Different letters in each row differ significantly.
Source: Patiño (2003)

FATTY ACIDS, MINERALS AND VITAMINS

Studies of the characterization of fatty acids, minerals and vitamins in milk buffalos Crossbred (Murrah x Mediterranean) carried out in Corrientes by Patiño *et al.* (1999) gave results that can be observed in Chart 42.

Chart 42: Fatty acids in buffalo milk according to different authors.

	Length of Carbon chains												
	C4:0	C6:0	C8:0	C10:0	C12:0	C14:0	C14:1	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3
Other authors	1.7-3.9	1.3-1.6	0.8-1.6	1.3-2.9	1.8-4.6	10.8-12.7	0.4-0.7	33.0-38.3	2.2-2.3	11.0-16.3	17.5-27.2	1.2-1.7	4.7
Patiño *et al.* 1999	1.2	1.2	0.7	1.3	1.9	9.7	0.8	28.8	2.1	17.5	30.7	1.0	2.6

Source: Patiño *et al.,* (1999)

The fatty acid values found were: butyric (C4:0) 1.29 %; caproic (C6:0) 1.23 %; caprylic (C8:0) 0.70 %; caprid (C10:0) 1.33 %; lauric (C12: 0) 1.92; myristic (C14:0) 9.77 %; myristoleic (C14:1) 0.82 %; palmitic (C16: 0) 28.86 %; palmitoleic (C16: 1) 2.14 % ; stearic, (C18:0) 17.50 %; oleic (C18: 1) 30.78 %; linoleic (C18:2) 1.05 %; linolenic (C18: 3) 2.61 %.

The fatty acids butyric, caproic, caprylic, palmitic, palmitoleic, linoleic and linolenic, present minor values to the ones found by other authors (Ganguli, 1974; Kay, 1974; Jandal and Al-Amiry, 1977; Verruga and Salgado, 1994; Macedo *et al.* 1997). On the other hand, the caprid and lauric acids presented similar values and the myristic, stearic and oleic acids presented superior values (Chart 42).

It is worth mentioning that studies carried out in Brazil by Verruma and Salgado (1994) showed that this milk comparing with the cow milk is richer in fatty, caprid, myristic, palmitic, stearic, palmitoleic and linoleic acids. On the other hand, it presents minor concentrations of butyric and oleic acids.

As regards minerals, the results were Calcium: 0.14 mg %, Phosphorus: 0.13 mg %, Iron: 84 ug %. Calcium and iron presented minor values to the ones described by other authors (Ganguli, 1974; Kay, 1974; FAO, 1977; Huhn *et al.*, 1982; Spanghero and Susmel, 1996). However, Phosphorus was within its range (Chart 43).

Chart 43: Mineral composition in buffalo milk according to different authors.

	Calcium (mg %)	Phosphorus (mg %)	Iron (ug %)
Other authers	0.18 - 0.27	0.12 - 0.30	97.5 – 126
Patiño *et al*., 1999	0.14	0.13	84

Source: Patiño *et al.,* (1999)

Studies published by FAO (1977) demonstrated that the buffalo milk has bigger values of calcium (0.18 mg %) and phosphorus (0.12-0.13 mg %) than those of the cow, which gives values of (0.12 mg %) for calcium and of (0.10 – 0.12 mg %) for phosphorus.

As Ganguli (1979) assures, because of the great amount of calcium in the buffalo milk, its stability at high environmental temperature is less, the junket tension is more and the rennet coagulation slower than the cow milk.

The vitamin values found in the buffalo milk in Corrientes were A (Retinol) 90.35 UI % ml; E 1.48 mg % ml; B_1 (Tiamina) 0.0899 mg % ml; B_2 (Riboflavina) 0.157 mg % ml; B_6 less than 0.05 mg % ml.

The values found for vitamins A and E were minor to the ones reported by Kay (1974) who presented 225 UI % ml for vitamin A; 1.97 mg % ml for E and 0.157 mg % ml for B_2. On the other hand, the values showed by Kay (1974) were for vitamin B_1 (0.080-0.081 mg % ml) and for B_6 (0.023 – 0.025 mg % ml).

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CHAPTER 6

BUBALINE DAIRY

Javier González Fraga

"LA SALAMANDRA" DAIRY

The initial project of a buffalo dairy was designed by a group of well known buffalo producers. It was called *PROLEBU* (Bubaline Milk Project). It consisted of 100 females of Murrah and Mediterranean breeds from Brazil, which were imported in 1991. Some years later, the project is abandoned and the female buffalos are distributed among the associates. In 1995, the first 40 female buffalos arrived at *La Salamandra* Dairy whose owner was the González Fraga family, situated in *Torres, Partido de Exaltación de la Cruz*, Province of Buenos Aires. Up to that moment, it was a bovine dairy exclusively and supplied milk to the factory of the same name to manufacture *dulce de leche.* From the beginning of the lacteal project, in 1991, Mozzarella made of buffalo milk was included.

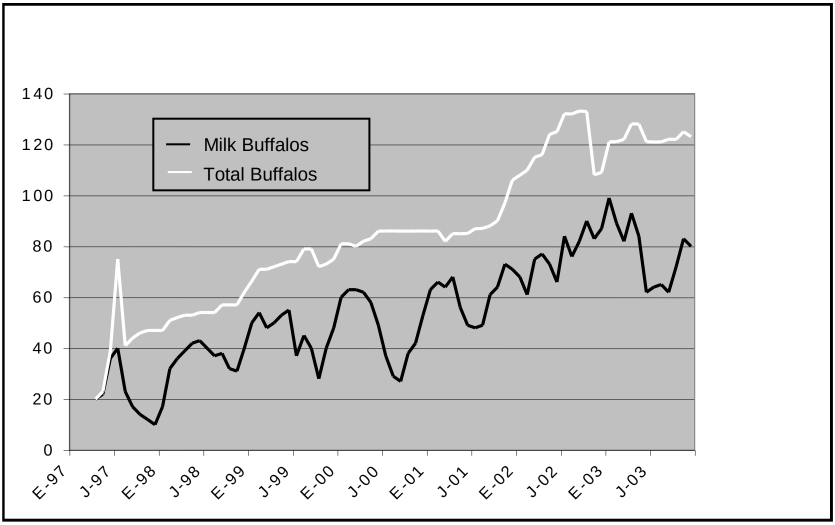
In 1996, buffalo milking started in *La Salamandra* followed by the process of manufacturing the famous *Bufarella,* cited by (Zava, 2000). From that time there has been a permanent increase in the production of this cheese and its diffusion in the Argentine market and an incipient business of exportation. Nowadays, the dairy is exclusively bubaline and has official milk control since the middle of 1997. Since two years ago, *La Salamandra* selects the best males to offer them to producers who want to start a milk project with the best Argentine Genetics.

Surface

Nowadays, the place has 80 hectares of their own and 20 rented with the following distribution:

- 26 hectares of natural grass pastures.
- 7 hectares for milking service.
- 11 hectares of cattle paths rented for female dry buffalos.

The herd is constituted by 206 females and 41 males, whose evolution is appreciated in Picture 22.



Picture 22: Evolution of the bubaline herd from the dairy *La Salamandra*.

Herd

The female herd is formed by:

- 104 milking and dry buffalos
- 38 buffalo heifers of 10 to 18 months
- 22 female buffalo calves of 5 to 10 months
- 17 female buffalo calves of 4 to 5 months

- 9 little female buffalo calves of 2 to 4 months
- 8 pregnant female heifers and in service
- 8 little female buffalo calves of up to 60 days

The male herd has the following components:

- 3 buffalos in service
- 2 medium buffalos of 18 months
- 7 buffalo steers of 5 to 10 months
- 13 buffalo calves of 4 to 5 months
- 5 buffalo calves of 2 to 4 months
- 11 little buffalo calves of up to 60 days.

As regards sanitary conditions, the herd is free from Tuberculosis, Brucellosis, Leukosis and Aftosa (with vaccination). It is important to point out that surprisingly the presence of Leukosis was reduced, that is why it was eradicated completely, what allows the herd to be exported from time to time.

The milking is mechanic and it takes place twice a day, in a similar way and in the same places where the cow milking was done.

Lactation and Production

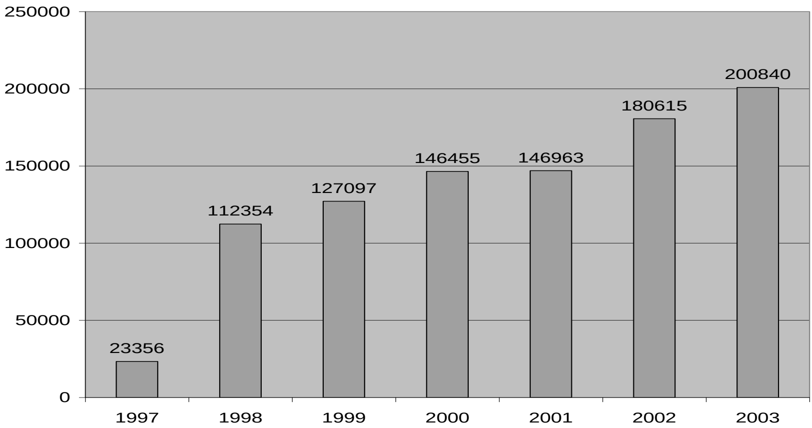
The female buffalos have an average of 300 days of lactation. They produce 2,232 litres of milk in that period, with 7.76 % of fat and 4.58% of protein (Picture 44). These levels of production are the greatest of the country and probably among the greatest of Latin America compared with the ones cited by Montiel Urdaneta (2000). Nevertheless, they are even less than the good Italian averages, which one day can be reached with the selection processes, genetics and corral feeding incorporation. This rodeo presents better sanitary indexes than the herds of high production in Italy, especially because we have not cases of uterine prolapse that affects most of the female Italian buffalos.

Chart 44: Data lactation from *La Salamandra*

LACTATION	BUFFALOS	MONTHS	DAYS	LITERS OF MILK	FAT	PROTEINS
					%	%
1st	43	41	343	2391	7.93	4.61
2nd	11	58	271	2069	7.62	4.59
3rd	10	82	223	1774	7.86	4.66
4th	14	95	263	2021	7.95	4.53
5th	26	105	291	2327	7.41	4.53
Total	104	70	300	2232	7.76	4.58

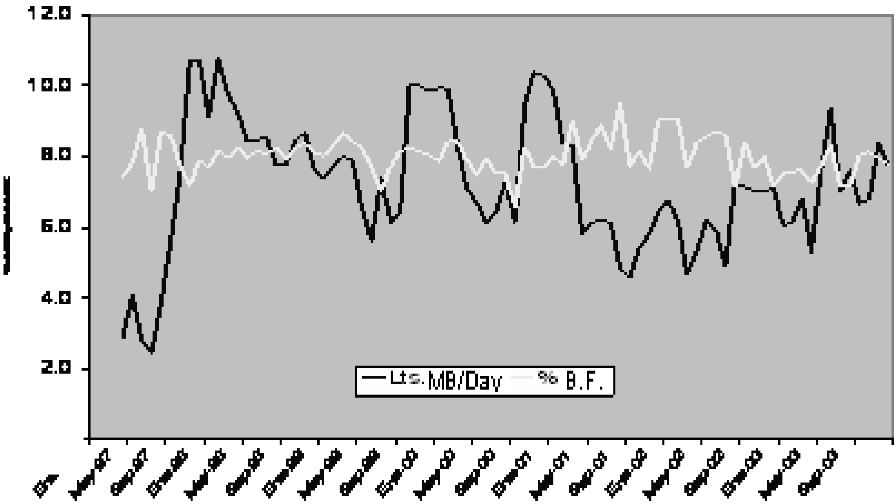
Source: González Fraga, J. (2004)

The total production of the dairy had an annual growth of 12.2 % between the years 1998 and 2003, obtaining in this last year the 200,840 litres (Picture 23)



Picture 23: Evolution of the total production

The yield per milked buffalo and percentage of Butyrometric fat can be appreciated in Picture 24.



Picture 24: Yield per milked buffalo and Butyrometric fat.

The production obtained is destined to manufacture Mozzarella cheese, for which different mix proportions with cow milk are used. They go from a minimum of 60% of buffalo milk up to 100% pure. This last proportion is used for especial cases that are destined to clients who know the fragility of *Bufarella.* The presence of cow milk gives stability and durability to the final product. These formulas were certified by an agreement between the manufacturing enterprise and the IRAM, in 1998.

The principal problems in the production of bubaline milk are the following:

- The seasonality of the parturitions. This generates a low index of BO/BT. (Zicarelli, 1997)
- The semen cost and the absence of Genetics in the country, with the consequent inbreeding. Crudeli *et al.*, 2000
- The tameness necessary for the milking process and consequently the difficulty to incorporate new female buffalos

with high sensibility to the environment.

- The quality of feed which results crucial for the Mozzarella cream.
- The lack of development of a local market for *Bufarella* and the difficulties of exportation to far away places.

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CHAPTER 7

BUFFALOS REPRODUCTION IN THE ARGENTINE NORTHEAST

Gustavo Crudeli, Pablo Maldonado Vargas, Gabriela Pellerano y Sebastián Flores Barbarán

INTRODUCTION

The bubaline species (*Bubalus bubalis*) originated in Asia and spread to practically all the continents representing in 1999 according to FAO (Food and Agriculture Organization) a total of 164.3 million animals. According to this source, there was a growth of 53% in the buffalo population between 1970 and 1998 while in the bovine population there was a growth of only a 21.5%.

The Argentine buffalo population, of about 57,000 animals (Crudeli *et al*, 2002), presented in the last 10 years an annual growth of 8% (Zava, 1994). This growth shows the future possibilities of bubalineculture as an emergent activity in the country. The buffalo could produce more and more beef and milk to cover the national market necessity, providing a great contribution in feed demand.

Research works carried out by different groups from our country as well as from Brazil show that the bubaline cattle present a great productivity and adaptation capacity to the difficult conditions in which both countries are (Nogueira *et al*. 1989b; Baruselli *et al*. 1993; Oliveira *et al*. 1994; Villares, 1994; Crudeli *et al.*1997). The bubaline zootechnical exploitation is characterized by a good reproductive efficiency and rapid body development (Villares *et al*. 1979; Nogueira *et al*. 1989a).

Nowadays, there is a reduced number of selected buffalos for milk and beef production in our country. Brazil has buffalo cows that produce 5,200 liters of milk per lactation as well as animals of proved attitude for beef production. This genetic potential can be multiplied more rapidly through biotechnologies such as artificial insemination (AI), embryonic transference (ET) and In-Vitro fertilization (IVF).

Until some years ago, the use of these bio-techniques was difficult due to the lack of knowledge of the estrous (heat) characteristics in this species, adding this to the reproductive seasonality, the pregnancy rate was very low (Baruselli, 2001). With the evolution of the studies in this species, it was observed that the animals had a low frequency of homosexual behavior during estrous (Baruselli, 1997).

In the last 50 years the bovine production developed significantly, thanks to the use of reproduction biotechnologies by producers in the entire world. The increase in the use of these tools is due to the research oriented to the physiologic mechanisms that control the ovaries, with especial emphasis in the follicular growth, to the amount of ovocytes and the development of luteal corpus. The knowledge of such aspects allowed controlling precisely the estrous cycle, guaranteeing greater efficiency in the use of AI and ET (Mapletoft *et al.*, 2000; Bó *et al*, 2002; Thatcher *et al*, 2001). Despite the efforts of some researchers, the knowledge about the use of reproduction biotechnologies in the bubaline species is still unknown, making it difficult for the producers to have access to reproductive techniques which accelerate the genetic improvement of their herds (Baruselli, 2000).

Comparing the results found in bovines, the bubaline presents specific problems related to heat detection such as identification of the ovary structures through gynecologic exams, standardization of the super ovulation pattern, determination of the ideal moment for AI and the low recovering of embryos (Misra, 1993; Drost, 1996; Baruselli, 1997; Baruselli, 2001). In spite of the researchers' great effort, who worked with ET in buffalos, the results show low efficiency in the recovering process of viable embryos by treatment per animal, which compromises the economic viability of the ET technique in this species.

The objective of this chapter is to describe the reproductive physiology of the bubaline female and to show the data obtained in our country of AI techniques with heat and super ovulation synchronization done in buffalo cows from the region.

REPRODUCTIVE PHYSIOLOGY OF THE BUBALINE COW

Reproductive Anatomy

The reproductive organs of the buffalos are in general equal to the bovines.

Ovaries: the buffalo ovaries are small and they are firmly fixed, it was found that the right ovary (RO) is more active than the left ovary (LO).

An ovary with a corpus luteum (CL) in the middle of the cycle is about 4 g while the other is about 2.5 g, during pregnancy the ovary becomes more active reaching 4.20g (with CL) and 2.70g (without CL).

During anestrous the ovaries reach to a weight of 1.68 g the RO and 1.66 g the LO and the consistency becomes firm.

The mean sizes in the different races and in the bovines are observed in Chart 45.

Chart 45: Ovary size according to species.

RIGHT OVARY					LEFT OVARY			
	Length (cm)	Width (cm)	Height (cm)	Weight (gr)	Length (cm)	Width (cm)	Height (cm)	Weight (gr)
Jafarabadi	3.12	1.49	1.19	4.01	3.13	1.44	1.15	3.87
Murrah	2.91	1.39	1.17	3.81	2.87	1.37	1.13	3.66
Bovine	4.50	2.50	2.00	20.00	3.50	2.00	2.00	15.00

***Source:** Bhosrekar, M.R., 1993.

Oviducts: they are short and are deeply located in the ovaric ligament.

The mean sizes in the different races and in bovines can be observed in chart 46.

Chart 46: Oviduct sizes in cm according to species.

SPECIES	Cm
Jafarabadi	24.5
Murrah	22.5
Bovine	25.5

***Source:** Bhosrekar, M.R., 1993.

Uterus: the uterine horns are small and firm, varying the size according to the race and age (Chart 47). The uterus body is small, the cervix is short, thin and lax, it is so thin an lax that in first service heifers AI is very difficult.

Chart 47: Uterus size according to species.

	RIGHT HORN		LEFT HORN			
	Length (cm)	Diameter (cm)	Length (cm)	Diameter (cm)	Body (cm)	Cervix (cm)
Jafarabadi	51.38	2.87	57.28	2.73	1.49	9.95
Murrah	39.13	2.41	38.75	2.62	1.38	2.79
Bovine	53.0	----	51.0	-----	4.0	6.35-12.7

***Fuente:** Bhosrekar, M.R., 1993.

Reproductive Physiology

Shalash (1994) from the Dokki Investigation Center, in The Cairo, Egypt, studied the role that physiology has in the buffalo adaptation in different environmental conditions. He related it with the physiology of the environment and focused the study on the thermo regulation mechanism. As the buffalos belong to the "homoeothermic" group, they have to keep a narrow breach between heat production (thermo genesis) and the loss of heat (thermolisis). Thus in animals selected under high temperature regimens the physiologic processes will be directed to dissipate the heat. They differ anatomically and physiologically from animals raised and selected in environments of low temperature in which they should not only keep the heat but generate extra heat to maintain the organic functions.

There is a narrow band of temperature in which both carry out their body processes more efficiently and optimize their productive performance with a minimum metabolic coefficient i.e. the body temperature is well adjusted to the environment. This band is denominated “comfort” or “thermo-neutrality”. There are not many precise data to determine which is the buffalo comfort temperature, but it is estimated around 21° C. Goswami and Narain (1962) determined that the buffalos would be in thermo stress with temperatures over 30°C and Misra *et. al.* (1963) measuring the breathing coefficient, determined that at 36° C the buffalos reached to a critical limit for the thermoregulation mechanism and it would be necessary alternative means such as water, mud, shadow, etc. With high temperatures, the main ways of thermoregulation are the “evaporation, radiation and conduction” to dissipate the additional heat absorbed in the environment as well as the heat produced as a result of the metabolic processes. When the temperature and the humidity of the air increase, the dissipation normal channels are blocked, so they rely on the breathing system. This characteristic differentiates them from other animals which are not adapted to the heat.

The relative air humidity acquires greater importance when the temperature of the environment is near the body temperature. The saturation deficit is low as it determines the amount of water to be evaporated through the skin. Goswami and Narain (1962) observed that the relative humidity at a constant temperature had almost no effect on the breathing coefficient, pulse and body temperature in buffalos.

On the other hand, the black color of the skin is a defense against the ultraviolet rays, but it made them more sensitive to direct solar radiation. Another fact that has a double effect is the disposition of the hair follicles (between 140 and 394 follicles per cm^2 versus 3,000 follicles per cm^2 for Zebu) as on one hand it helps heat dissipation but on the other it does not protect the skin from the direct action of the sun radiation. It also has less density of the sweat glands but in compensation they are bigger and have a greater cooling capacity (Cockrill, 1991).

Several experiences were carried out to determine the physiologic answer of the buffalos to heat, taking the pulse, breath and rectal temperature as parameters, three different cooling alternatives were measured comparing with bovines: a) shadow, b) water spray at 18° C for 10' and c) immersion in a pool with water at 25° C for 20'; after being exposed to heat for 2 hours. From this experience it resulted that in both species the three curves were raised in a lineal way although more rapidly in the buffalos when the animals underwent the heat action and when they went to the cooling phase the decrease in the curves of the three parameters was more rapid in the buffalos. The water spray proved to be more efficient than the shadow and the immersion was the most efficient one. After the heat exposition (2 hs) it took the buffalos 60' to return to normal parameters once the immersion finished and another 30' while they were laying to recover completely (Shalash, 1994).

This shows that even when the buffalos are more sensitive to the direct action of the sun radiation, the physiologic answer of accommodation is faster when they have water or a shadow to shelter so that the thermal stress is lesser and they have more time to feed and reproduce.

Puberty

Puberty is defined as the period in sexual development in which the organs start to function. In the female it starts with the first ovulation accompanied or not by visible heat. It finishes once the cyclicity proper of the species is acquired and it reaches the sexual maturity when the female has the maximum reproductive capacity, i.e. when the buffalo cow is able to finish a gestation and to rear the product.

In reference to several studies carried out in different countries, it was evidenced that the buffalo female reached sexual maturity later than the bovine female, at about 24 months for the milk biotype. The Carabao could take up to 36 months (Cockrill, 1991).

In heifers raised under optimal nutritional contributions, in breeding conditions in Egypt, it was shown that they could reach puberty at 15 months with a weight of 271 kg (Cockrill, 1991). In this work the 80% of the females studied reached puberty before 17 months with a weight range of 260 to 290 kg and sexual maturity at 24 months. In general it is said that sexual maturity is reached when the 65% of the adult weight is achieved and for the female type in the region (of 525 kg average) it would be about 340 kg. A work in Argentina has been reported where every year the pregnancy of heifers ranged from 40% to 55%, depending basically of the year effect during fattening (Crudeli *et al.,* 1996).

Seasonality

The bubaline animals are considered a species with a reproductive season, even when they are fertile during all the year, their sexual activity increases when the daily hours of light decrease, this is also valid for the males in which there is a drop in the libido and in the seminal quality. Nevertheless the reproductive efficiency remains high even when the daily hours of light start to increase provided that they are shorter than the hours of darkness. If we consider that the buffalo is native of tropical areas to the North of the Equator, where the food availability coincides with the decrease of the daily hours of light, the animals calved in summer (humid season) and weaned in fall and winter have an advantage by natural selection. It is probable that this characteristic had been set, kept and transmitted through generations even when the buffalo was transferred to places in which there were no problems of food availability as in Italy, or to places where the food availability tends to decrease together with the hours of light as in San Paulo (Brazil) or the Argentine northeast.

The importance of the day duration in the reproductive seasonality is clearly seen where the photoperiod acts through a signal of the pineal gland (melatonin) activating the secretion of the LH tonic hormone (Zicarelli, 1994).

The tonic secretion of LH is responsible, together with FSH, of the estradiol secretion of mature follicles, relationship that is maintained by a positive feed back. When the hours of light increase, the tonic center of LH in the hypothalamus increases its sensitivity and the feed back system is inverted. From the hypothalamic tonic center less amount of LH is liberated thus there will not be enough estradiol to stimulate the pre-ovulatory center of LH so there will not be ovulation.

The role and effect of the Melatonin hormone was studied as an endocrine signal that shows the alternation of the day in darkness-light, it was shown that this hormone is in high levels during the dark hours especially in fall and winter (Zicarelli, 1994). This made us classify the buffalos in two big circadian groups in the Melatonin patterns. According to Zicarelli (1994) the two groups would be: a) animals very sensitive to the photoperiod which presented high peaks in the level of this hormone two hours after sunset especially in winter and spring and b) animals not very sensitive to the photoperiod, which showed a curve without a peak two hours after the sunset. This technique called O.B.S.M. (Out off Breeding Season Mating), made the Italians choose animals according to the melatonin curve and to have cow herds which calve out of the natural season (spring) because in this country buffalo breeding is mainly carried out for milk production and it reaches the greatest commercial value in summer when mozzarella is greatly demanded. In the north of Corrientes, the natural mating period takes place between March and June Crudeli *et al.* (1995).

Sexual Cycles

Outside the reproductive season and in pre-puberty animals it is observed in the ovaries a growth of follicular waves without reaching ovulation at about every 10.3 days (in cows with two waves) neither with visible heat manifestations nor modifications in the uterine tone (Singh *et al.*, 1984). The pubescent heifers and cows that have not calved during the mating season will start their reproductive cycles with the presence of non ovulatory cycles without corpus luteum. The cycles will be repeated between 7 and 9 days, then silent short estrous are presented in which the corpus luteum has a short mean life of 6 or 7 days (Cockrill, 1991).

Once the typical cyclicity of the species is established the sexual cycle of the buffalo cow lasts an average of 21 days with variability in 58.6% of the cases from 18 to 25 days, in a 4.3% between 10 and 12 days and in a 36.9% more than 25 days (Barusselli *et al.*, 1993). For other authors the cycle duration is of 21.2 days with a range of 18 to 29 days (Jacomini *et al*., 1989).

Several authors divided the sexual cycles in four phases according to the shape and consistency of the corpus luteum (Ireland *et al.*, 1987):

-Stage I: Early luteinizing phase (Metaestrous) characterized by a structure of neo-formation, generally hemorrhagic.

-Stage II: Luteinizing phase (Diestrum), at this time the corpus luteum is well developed, the consistency is firm and the color is brownish.

-Stage III: Luteinizing phase in regression (Proestrous), the corpus luteum is small; the consistency is very firm of a whitish grey color. It can be palpated only follicles not bigger than 10 mm.

-Stage IV: Follicular phase (Estrous), a scar is observed in the place where the corpus luteum developed, by means of rectal palpation the presence of follicles with a diameter superior to 15 mm, with a very thin wall surface can be felt.

Nowadays, the sexual cycle is divided in three phases: follicular phase, pre ovulatory phase and luteal phase.

Follicular phase: it starts with the luteinization. The progesterone concentrations in blood decrease significantly to levels under 1 ng/ml, consequently, the pulse frequency of LH increases and in a lesser degree the FSH increases too (Schams, 1987). The follicular development is completed and the estradiol is produced to start the heat and the pre-ovulatory LH discharge (Ireland, *et al.*, 1987).

Periovulatory phase: it is produced at the start of heat and ovulation. The estradiol levels increase until they reach maximum levels a day before the heat starts. This provokes the typical behavior of heat and induces the preovulatory discharge of LH which causes ovulation (Hurnik, 1987).

Luteal phase: after ovulation the CL is formed. The progesterone concentrations start to increase in the 3rd or 4th days. They reach a peak between the 8th and 12th days (Fitz, *et al.,* 1982) and then decrease until basal concentrations before the next estrous, as an answer to the uterine secretion of $PGF_{2\alpha}$ and in absence of a viable embryo in the uterus.

The heat is within the follicular phase and we could define it as the period within the first mounting acceptance and the first mounting denial.

The changes in the hormonal balance of progesterone-estrogen determine morphological changes in the reproductive tract and behavioral changes which make buffalos different from bovines. The frequency of the heat clinical symptoms is very varied, depending on the age, the hour of the day, the temperature, the environmental humidity and the nutritional status. Vale *et al.* (1984) observed that an 84% of the animals manifested heat between 5:00 pm and 7:00 am; the 10.6% between 7:00 am and 12:00 am and the 5.3% between 12:00 am and 5:00 pm.

The range duration of heat is very wide, heats from 4 to 30 hours have been observed, the means varied according to different authors; 20.5 h (Hafez, 1954); 48 h (Bhattacharya *et al.,* 1988); 36 h (Rao *et* *al.,*1970); 19.20 h (Kanai & Shimizu, 1983); 21.7 h (Vale, *et al.,* 1984); 13.16 h (Jacomini, 1989); and 14.78 h (Barusselli, 1992).

The ovulation is produced after the mounting acceptance stage is finished and this is the symptom that is taken into account to determine the AI moment. This period has an important variability studied by several authors, establishing an average of 16.92 h (4 to 48) with a great percentage (46.42%) which ovulated at 18 h, (Barusselli *et al.*, 1992); previously Rao *et al.* (1970) determined an average of 20 h (12 to 24)); for Luktuke & Ahuja (1961) it was of 10.l9 hs (5 a 24); Kanai & Shimizu (1983) found an average of 13.9 (6 to 21); Vale *et al.* (1994) 19.8 h (9 to 30) and for Jacomini *et al*. (1989) it was of 22.33 h (12 to 36). While in Argentina Crudeli *et al.* (2002) when carried out the heat synchronization with GnRH and Prostaglandins found that the interval between the second application of GnRH until the ovulation was of 39 h (31 to 48 h).

Gestation

The gestation period varies depending on the breed, thus we say that for the Murrah breed it would be of about 300 to 306 days, while for the Mediterranean it would prolong until 311 to 315 days and for the Jafarabadi one it would reach to 330 days (Cockrill, 1991).

ARTIFICIAL INSEMINATION

The AI in buffalos is a technique that has evolved with the passing of time and has given very good results when dealt with sense and knowledge of the reproductive physiology of the species. More over when it has been assumed as an applicable technology once all the other factors that affect reproduction have been controlled.

In the 50s Polge showed the possibility of preserving frozen bovine sperm cells in liquid nitrogen. Bhatacharya & Srivastava were the pioneers in the freezing of buffalo semen and from this event the AI with frozen semen has been improving the genetics of the most important herds in the world.

The fertility index has improved with the passing of time, thanks to the contribution of the different researchers from all the world, Oloufa (1955) working with AI obtained a 36.6% of pregnancy; Rao & Rao

(1968) 40.7%; Fluekiger (1976) 35%; Kotaya *et al.* (1978) 44.8%; Chaudary & Wierzbowsky (1979) 45.3%; Vasanth (1979) 50%; Heuer (1980) 54.9%; Vale (1986) 56.7%.

In Brazil the technique showed positive results both in works carried out in conditions of extensive breeding according to the Amazon Valley conditions (Vale, 1986) and semi intensive breeding according to the south of the Sao Paulo state conditions in Vale do Ribeira. Baruselli (1996) obtained on 201 inseminations 53.2% in 1993; in 1994 from 370 inseminations 52.7% and in 1995 form 263 inseminations 51.3%. He always worked with multiparous cows.

In Argentina, between April and June 1982 in *Santa Rosa* ranch (Esquina, Corrientes) 18 females were inseminated and later in 1989 another 8 from which 5 were pregnant (Zava, 1994). In May 1996 in *Tres Marías* ranch in the northeast of Corrientes a group of 13 females (9 heifers and 4 adult cows) were inseminated, 3 cows were pregnant but no heifer, this confirms the inconvenience of applying this technique to this category. To start developing this technique when there is no experience in the reproductive management of the species it is necessary to bear in mind some critical points that influence directly on the fertility (Crudeli, *et al.*, 1996[a]).

Tips for animal management

-Work with tamed animals or tame them with good treatment and patience as they are very intelligent animals and have good memory.

-Work with the suitable kind of animals according to the productive objectives (beef and or milk production) and choose a genotype and a phenotype of the best animals for a program of AI.

-Carry out sanitary controls regularly.

-Carry out gynecologic control, mainly cervix permeability and general conformation of the genital apparatus.

-Individualize each animal and carry out reproductive controls in numbered cards: date of the first parturition, interval between parturitions, production in kg of milk or calf, breed, weight, illnesses, etc. In another card with special data include: date of heat presentation, heat duration, type of symptomatic manifestations of heat, body condition at parturition, number of inseminations per pregnancy, etc. In a third card include data such as difficulty found in the application of the technique, management of semen and other parameters that can influence the results.

Tips for the staff

-The staff should be predisposed to work with this species.

-They should manage the animals within the corral on foot and without dogs.

-One or two workers should be designated to work daily with the lot of AI carrying out the night confinement to accustom both the staff and the animals to the heat detection management at least a month before.

-The technician who carries out the insemination should be prepared to work with buffalos.

Tips for the facilities

-Safe corrals, chute and wooden animal trap.

-Water and / or shadow availability the entire year.

-If it is possible work with electric wire.

-It is important to work with well fed animals, with a body condition at labor that favors a short puerperium, therefore there should be food and mineral supplementation in the corrals.

Preparation and management of the buffalo cow herd

It is possible to work both with post-labor cows and empty cows; it is advisable not to work with heifers as they have a very thin and flexible cervix which makes it difficult the entrance of the applicator and the semen deposition in the right place. Vale, *et al.* (1984) advises not to inseminate after the first heat post-labor but after the second one.

Teaser Preparation

It is advisable to work with an androgenized cow and with a teaser male every 25 to 30 cows.

The male can be obtained by means of any surgical or medical method or by the use of any device which prevents penetration (e.g. Penekit, apron, etc) but in general it is advisable the performance of caudoepidectomy (Lopez *et al.,* 1999). This technique consists of the resection of the epididymis tail together with a portion of the epididymis and deferent duct, this is a quick and simple operation without great risks for the physical integrity of the bull.

The female is obtained through androgenization with deposit testosterone (e.g.: propionate) of human use, this can be found in the market in 250 mg ampoules. Eight ampoules (2000 mg) are used as inductive dose, which are applied 1000 mg S.C and 1000 I.M; it is recommended to reinforce the androgenic tenor every 15 days with 1000 mg, 500 mg S.C and 500 mg I.M.

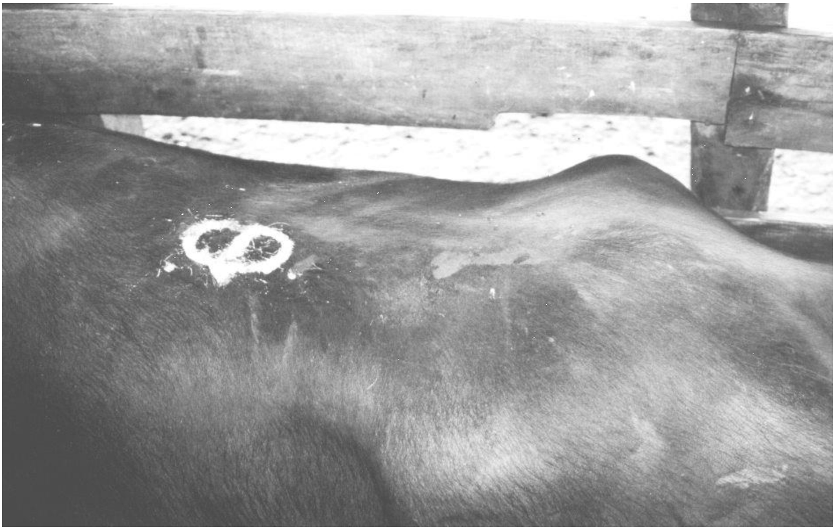
The animals which are used for this purpose, should meet some minimum characteristics to work efficiently and to meet the role they have been destined. First and mainly they should dominate in the herd; therefore they should be big animals, obedient in particular the male as this will be exposed to a special management for heat detection. As regards the age young males (2 to 4 years of age) are preferred to avoid dominance problems and interference in heat detection.

Heat detection management

The detection should be daily, never less than twice a day (6^{00} to 7^{00} and 18^{00} to 19^{00}) and if the type of exploitation allows, it is advisable to carry it out every 8 h to be able to detect short heats. The time devoted to heat detection should never be less than 1 hour each time. It should be carried out in a quiet place without noises which could distract the teasers attention as they are very curious animals easily distracted.

The androgenized cow should have a marking muzzle (Picture 25) and it should be with the herd all the time as its work is more efficient at night and in the moment when the herd is grazing. The next morning the cows marked by the teaser are observed and separated for AI (Picture 26).

Picture 25: Teaser marking a cow in heat.



Picture 26: Cow marked by teaser.

The male will only stay with the herd during the detection moment, thus the teaser realizes that it has only 1 hour to be with the cows and does not waste time. The teaser work should be evaluated daily and they should be immediately relieved if there is any suspicion in the efficiency of their work.

HEAT SYNCHRONIZATION AND ARTIFICIAL INSEMINATION

Almost a century has passed since a few specimens from the Marajó Island, Brazil, were introduced in the country. Nowadays, there are in the national territory more than 50,000 buffalos. The buffalos have faced adverse factors in their development such as the little attention the species was given, the lack of channels for the carcass commercialization and the lack of real scientific knowledge about the nutritional and reproductive physiology. All this negative elements influenced the producers. They showed a lack of interest to carry out a productive improvement especially on the genetic quality of the herds. This situation made the herds to reproduce with high levels of consanguinity; as a result the new generations had less body weight and had fertility impairments such as a smaller scrotal circumference and ovary size among other relevant indicators. In Corrientes (Crudeli *et al.*, 1995; Crudeli *et al.*, 1996[b]; Crudeli *et al.,* 1996[c]) a 60% of the total existence of the country is concentrated representing a 0.80% of the existing cattle heads in the province. AI is considered, as it has been in the entire world, the most adequate and economic way to make a genetic change in the short term (Vale, 1988). The first works were carried out to increase the knowledge of the reproductive behavior of the buffalos, to be able to establish an AI management pattern at field level.

As time passes, and even though the use of AI in buffalos had been done in the open field, the technique presented certain difficulties in the identification of the estrous manifestation and the right moment to carry out the AI, basically due to the low incidence of a homosexual attitude during heat. This behavior decreases the external view of heat and it shows that it is necessary the use of teasers for heat detection in this species. This characteristic, associated to the great variation in heat duration, with a range of 6 to 48 hours, makes the heat detection more difficult and inefficient and it obstructs the use of AI (Baruselli *et al.*, 1998).

The use of ovulation synchronization by hormonal methods in bovines has presented encouraging results for the use of Artificial Insemination at Fixed Times (AIFT). The study of the follicular dynamics during the estrous cycle has cleared some of the phenomena which interfere in heat and ovulation synchronization. The “Ovsynch” system allows the recruitment of a new follicular wave, independently of the state of the estrous cycle, the manipulation of the luteal phase and the precise synchronization of the future ovulatory follicle (Driancourt, 2000).

Studying the follicular dynamics during the “Ovsynch” treatment it was verified that after the first application of GnRH the ovulation occurs and / or the starting of a new wave of follicular growth, which results in the presence of a dominant follicle 7 days after, the day of the PGF2α application, the luteinization provoked by it makes that all the animals treated ovulate between 24 to 32 hours after the second dose of GnRH. Those results show a great efficiency of the “Ovsynch” method in the ovulation synchronization in bovines (Pursley *et al.*, 1995). The existing protocols of synchronization allow us to carry out AIFT (Thatcher *et al.*, 1993; Pursley *et al.*, 1995) without the need to observe the estrous, making herd management easier and optimizing the use of this biotechnology in the open field. Thus the second problem to elucidate in the second work (W2) was the answer of the buffalos to the hormonal protocols which use GnRH and prostaglandins, in an AIFT pattern (Ovsynch + Resynch) compared with a synchronization and insemination system at detected heat. Evaluating in the third work (W3) the use of the “Ovsynch” system where the results obtained were related with variables such as the number of parturitions, difficulty at AI and the presence of mucus, correlated with the pregnancy rate obtained at prime AI in 85 breeding cows of a farm in the north of Corrientes.

W1 was carried out between 16th May and 20th June, 1987 in a farm located 70 km to the south of the city of Corrientes in Empedrado at 8 km from National Road N°12 to the east. During the experiment the animals stayed in a paddock of 70 ha of natural field with the characteristic that more than 50% of the surface is flooded.

A herd of 36 adult pluriparous cows with a minimum 60 days of post-labor, most of which belonged to the original herd imported from Brazil in 1990 were selected according to the following parameters: general build and body condition (BC). Afterwards the gynecologic status, uterus tone and the ovary structures present were evaluated.

Two marker males of 2 (two) and 3 (three) years of age were used. They were obtained by means of a technique of bilateral caudoepididectomy (Lopez *et al.*, 1999; Vale, 1994[a]). One of them had a marker muzzle (chin-ball) filled with yellow ink which stayed with the buffalo cow herd.

The other teaser stayed in a pen joining the herd only during the shift of heat observation, moment in which the other was separated. Two shifts were done (AM/PM) for heat detection of 90 minutes each one. This was managed according to the system of two confinements and two separations. The lot was taken to a corral before the PM detection shift, once it was performed the lot was taken to a pen with enough water and grass to spend the night until the next day when they return again to the corral and after the AM shift detection they returned to the original paddock.

The heats were evaluated according to their behavioral and anatomic manifestations.

The AI moment was determined by the end of the external heat symptom, considering the first denial of the female to the mounting of any of the makers.

The females that were already marked and did not accept being mounted by the markers were inseminated immediately.

From 36 animals selected 86.1% were detected in heat by means of the marker teasers. The pregnancy percentage obtained by rectal palpation at 60 days was of 74.2% (n=23). The results of AI-heat interval less than 12 h was of 3.03% (n=1); between 12 and 24 h =87.87% (n=29) and between 24 and 36 h = 9.09% (n=3) with a mean of 18.8 h of duration. The females that did not enter in heat 13.9% (n=5) showed to have a longer anestrous post-labor, even though when they had started with ovary activity (n=3), and ovulation (n=2), did not show external heat symptoms.

The mean BC of the cows that were gestating was 3.5 points vs. 3.4 points of the cows that did not gestate. As regards the BC Hegazy (1994) found significant differences among those cows which had BC

2 vs. those with BC 3 observing 80.9 vs. 59.3 days respectively, from the parturition until the first detectable heat, these data coincide with what was recorded in our work. Baruselli (1995) finds interference of the BC at parturition in the moment of the appearance of the first post-labor heat, such as percentage of cows in anestrous during the reproductive season, number of doses per pregnancy, the service periods and the percentage of pregnancy at the end of the reproductive season.

From the total cows inseminated the degree of difficulty to AI was high: 6.1% in (n=2), medium: 15.2% in (n=5) and low: 78.8% in (n=26), obtaining 0%, 80% and 73.1% of pregnancy respectively in each one of the frequency intervals.

As regards the fertility indexes obtained in prime insemination Barnabe (1994) got a 56.8 %, while Baruselli (1994) obtained in prime insemination 48.3 % with a general pregnancy after two inseminations of 71.8%. In the north of Brazil, Ribero (1994) in three different groups of cows obtained 55.5%, 50% and 38.1% and a birth percentage after three inseminations of 67.1% and Barnabe (1995) got a 52.7% after inseminating in three consecutive cycles. In Argentina, Crudeli (1996[a]) obtained a general pregnancy 28.5%, but we have to consider that this work was carried out with adult females and heifers, this last category is not recommended for AI, due to the difficulty of passing through the cervix. Vale (1988) observed an interval at the beginning of heat-AI of 21.7 h, for Jacomini (1989) this period was of 13.1 h similar to what Baruselli (1992) recorded with 14.7 h in average. Crudeli (1996 [a,b,c]) observed a mean duration of 17.6 h, intermediate data when considering the authors previously mentioned.

In previous experiences Crudeli, *et al.* (1996 [a]) did not obtain gestations in the frequency interval of high difficulty, getting good results in the moderate and low degrees of difficulty, which coincides with what was obtained in this work. As regards the characteristics observed in the heat manifestations, it can be observed the same in Chart 48:

Chart 48: External and internal characteristic in heat manifestations according to different authors.

Characteristics	Jacomini (1989)	Barusell (1992)	Vale (1994)	Crudeli (1996)	Crudeli (1997)
Mounting acceptance	100	100	100	41.6	86.1
Vulva oedema	87.50	79.1	67.0	66.6	80.7
Spontaneous mucus discharge	12.90	13.79	76.1	16.6	6.6
Frequent urination	19.35	72.41	67.0	75	30.0
Flehmen	----	----	----	46.1	10.0
Augmented uterine tone	83.88	93.10	----	71.4	95.0
Vulva Hyperemia	96.42	79.31	65.9	85.7	88.9
Flux discharge in palpation	96.77	68.96	----	66.6	40.0
Homosexual mounting	6.45	3.44	32.9	16.6	9.6

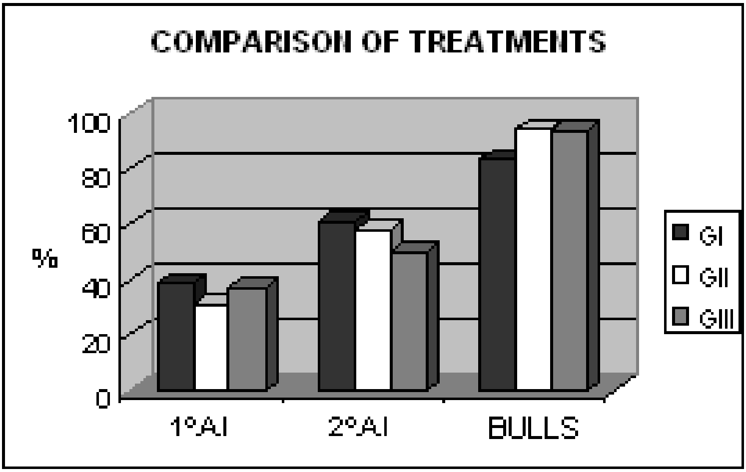
To compare two different protocols of AIFT, versus a system that uses heat detection, the second work (W2) was carried out in a farm located near Esquina, province of Corrientes. In this opportunity, three groups were formed, each group had 20 adult cows, which belonged to the Murrah, Mediterranean or their crossbreeds. In Group 1 (G1) an "Ovsynch" protocol was performed plus an auricular implant of Norgestomet (Crestar®, Intervet Argentina), which was placed on the day 0 together with a dose of 10 μgr of GnRH. (Receptal® Hoescht). On the 7th day the implant was removed and a dose of 150 mg of prostaglandin F2α, (Preloban ® Hoescht) was applied and on the 9th day the second dose of GnRH and 16 h later all the cows were inseminated.

In Group 2 (G2) the "Ovsynch" protocol similar to the previous one but without the auricular implant was used. On 18th day post AI a dose of GnRH (resynch) was applied and on 25th day the early diagnosis of gestation was done by ultrasonography using PIE MEDICAL® 485 vet equipment with transrectal transducer of 8 Mhz. To the empty cows of G1 and G2 a dose of prostaglandin F2α was applied and on 27th day the second dose of GnRH and 16 h later all the cows were inseminated.

In Group 3 (G3) GnRh was injected on the 0 day, prostaglandin F2α the 7th day, at similar dose applied to the previous groups and then heat was detected and the cows were inseminated. The heat detection was carried out in the same way as in W1, with two marker teasers. The second heat detection and artificial insemination was carried out from the 17th day and up to 24th day post AI. After 15 days of the second insemination bulls in natural service for 45 days were incorporated. Thirty days after the removal of the bulls, the echography was performed, determining in that moment the pregnancies corresponding to the 2nd AI and to the bull.

The pregnancy obtained in prime insemination was of 38.8 %, 31.5 % and 37.5 % for GI, GII and GIII respectively. For the second AI the pregnancy cumulative 11/18 – 55%, 11/19 – 55% and 8/16 – 50 % for GI, GII and GIII respectively. The final pregnancy with natural service was of 83.3, 93.7 and 93.7 % for Grups I, II and III, respectively. They are observed in Picture 27. The low values at the second insemination, could have been due to an important loss of BC during this period. The results show that it is possible in buffalos the use of synchronization protocols at fixed time, shortening the excessive time that heat detection demands. The values of the pregnancy obtained at prime and second AI, at fixed time as well as at detected heat, even though they can be considered reasonable, can be improved.

Chart 27: Treatment comparison according to groups.



Considering the results obtained in (W2), a third work was designed (W3) which was carried out in a farm located in Empedrado, Corrientes. The herd selection was done evaluating the following parameters: Body Condition, Breed, and Age. The buffalo cows were of Mediterranean Breed and /or Murrah crossbreed. In relation to the age, they were divided according to the number or parturitions achieved by each female, in cows of one, two and three or more parturitions. A total of 85 cows were used to which the “Ovsynch” protocol was applied for synchronization.

In the moment of AI other variables were evaluated such as: Vulva oedema, mucus presentation and insemination ease, this last one was classified as 0 (without difficulty) 1 (medium difficulty) and 2 (high difficulty).

From the total cows inseminated at fixed time, 49 were pregnant, which implies a 56.3%. This result is superior to what was obtained in W2 and slightly greater than the average obtained by Baruselli a 50.2%, making it clear that this last work was with diary animals, with controlled nutrition and daily management, while our work was done with animals of the general herd. These animals suffered a greater stress, as their management is inferior to a daily worked animal making the result even more important. The results of the number of parturitions and pregnancy rate are shown in Chart 49:

Chart 49: Number of parturitions and conception rate of AIFT.

Number of Parturitions	Number of animals	Conception rate % (n)
1 parturition	25	44.0 (11)
2 parturitions	25	64.0 (16)
> 3 parturitions	35	60.0 (21)
Total	85	56.5 (48)

As it is observed in Chart 49, the behavior of the primiparas was inferior to the females bearing a greater number of parturitions, without differences between the ones with two or more parturitions. Statistically there were no significant differences, probably due to fact that the sample was not so big.

Chart 50: Presence of mucus and conception rate of AIFT.

Presence of Mucus	Number of animals	Conception rate % (n)
With mucus	11	100.0 (11)
Without mucus	74	50.0 (37)
Total	85	

In relation to the presence of mucus at the moment of AI, it can be observed in Chart 50 that only the 12.9% presented this characteristic which though is a low percentage; it is worth mentioning that all the ones which presented mucus were pregnant. As regards the difficulty found at the moment of inseminating the following results can be observed in chart 51.

Chart 51: Index of difficulty at AI and conception rate at AIFT.

Index of difficulty	Number of animals	Conception rate % (n)
Difficulty 0	65	76.9 (42)
Difficulty 1	16	37.5 (6)
Difficulty 2	4	0 (0)
Total	85	

The same result as the one obtained in (W1) is seen here, for the cows with difficulty 2 where no pregnancies were recorded. Cows with difficulty 0 and 1 obtained a 76.9 and 37.5% respectively, showing differences with the results of the first work, even when the number of animals was not high for both experiences. Thus, the results are not conclusive.

The management used with the teaser bulls, the plan developed for detecting heat and the right time chosen for AI proved to be the appropriate ones, having as a result a good percentage of pregnancies with a high index of conception.

The 87.87% of the heats presented were concentrated from 12 to 24 h range.

The AI technique is of good fertility in those females in which the application of the technique has a low or moderate degree of difficulty.

As a conclusion it is possible to use protocols at fixed time with good results in buffalos, avoiding in this way the waste of time and difficulties during heat detection.

SUPEROVULATION

The use of Embryonic Transference (ET), together with AI, in the genetic improvement programs are methods that have been used in an increasing way during the last 20 years. Nevertheless, the technologies that have an enormous potential as regards genetic improvement, have not had the massive diffusion that they deserve in relation to their potentiality. The limitations have been not only the high costs of them but also the enormous variability in the answers of the animals destined to produce those embryos. This situation seems to establish the economic and biological boundaries in technology that could not be overcome and that limits its development.

The use of ET in bovines has been thoroughly studied and used with success in rural places of the entire world, allowing the genetic improvement to be quicker and more efficient. Meanwhile, in bubaline cattle this bio technique has deserved minor quantities of studies and has been less employed by the breeders due to certain difficulties in the identification of the estrous manifestation and the appropriate moment to do the AI. As it has been mentioned before, compared with the results found in bovines, the bubaline cows present specific problems related to the heat detection, identification of ovary structures by the gynecologic exams, standardization of the super ovulation pattern, determination of the ideal moment for the AI and low rate of embryos recovery (Misrah, 1993; Drost, 1996; Baruselli, 1997).

The aim of the super ovulation and the ET is to obtain a great number of embryos with a high level of pregnancy. For this, ultrasono graphic studies of the ovary structures during the super ovulation treatment were used in the evaluation of the follicular answer in the bubaline species (Bo, *et al.*, 1995; Bo, *et al.*, 2002). According to these results, it was possible to improve the super ovulation processes and collection of embryos in buffalos (Baruselli, 2001).

Nevertheless, in the literature there exists little information about the follicle genesis and the inter relations of the ovary structures during the super ovulation process in the bubaline species. To analyze the super ovulatory potential of this species, precise evaluations of the follicle answer, the ovulation rate, the formation of corpora lutea and the recovery rate of embryos are necessary. Such evaluations are important because in the bubaline species, the embryonic development takes place more rapidly, which implies the collection of embryos between the 5th and the 7th day post estrous, when the corpora lutea are small and present soft consistency (Singla *et al*., 1996).

Daily ultrasonograpic studies show that there is a reduction of the super ovulatory answer in animals treated in presence of the dominant follicle, when comparing with animals without the dominant follicle at the beginning of the super ovulatory treatment (Bungartz Niemann, 1994).

In other works (Baruselli *et al*., 1997 and Baruselli *et al*., 1998), in which different hormones available in the market for super ovulation in bovines were used, the ultrasonographic tests of the ovaries show that the female bubalines have a good follicle answer to the super ovulatory treatment. The animals presented the development of a follicle pool that reached diameters $\geq$ 0.8 cm in the estrous with super ovulatory treatment. Nevertheless, the number of follicles $\geq$ 0.8 cm on the day of the estrous is less than the results of the literature of the bovines (Boland *et al*., 1991; Shaw *et al*., 1995; Bo *et al*., 1996). The reduced number of follicles in super ovulated buffalos may be related to the minor number of follicles recruited by the follicular growing wave and consequently, to the minor number of follicles in the ovaries (Danell, 1987; Le Van Ty *et al*., 1989).

In the results reported in the bubaline literature (Baruselli *et al*., 1997 and Baruselli *et al*., 1998), the average number of ovulation is of 7.0 ± 3.0 what is related to the number of corpus luteum on the day of the embryos collection (P<0. 01). Meanwhile, in buffalo herds in the north of Corrientes an average of ovulation of 4 ± 2.0 with similar treatment was obtained (Pellerano *et al*., 2003). Danell (1987), by means of the ovarian histology, observed a minor number of essential follicles in the bubaline species than in the bovines (12,636 vs. 50,000, respectively). The author noticed that the bubaline species present the 20 % of the antral follicles than the ones found in the bovine ovaries (47.5 ± 23.8 vs. 233.0 ± 95.8 respectively). The number of follicles > 1 mm also differs between the two species, as the bovines have 90 follicles; meanwhile the female buffalos only present 46.3. Differences in the number of follicles with atresia were also found between the two species, noticing atresia in 66% of the follicles in development in the bubaline species and 50% in the bovines.

In spite of the reduced number of essential and antral follicles in the bubaline ovaries, the development of follicle waves is similar to the bovines. By means of ovarian histology, Danell (1987) observed the existence of two waves of follicle growing during the estral cycle in buffalo heifers. The first wave begins on the 3rd day (Ovulation: day 0), remaining until the 13th day of the cycle, meanwhile the second begins on the 9th day and is kept until the end of the estral cycle. According to the observations of this author, the female buffalos present a follicular behavior similar to the one registered for bovines in the histological studies of Rajakoski (1960), and confirmed by the ultrasonographic studies of Knopf *et al.,* 1989, Savio *et al.,* 1988 and Sirois and Fortune, 1988.

The authors noticed that there is a bigger number of female buffalos with two waves than with three waves of follicular growing during the estral cycle, and that the quantity of waves of follicular growing is directly related to the concentration of progesterone and to the diameter of the ovulatory follicle.

Apart from the follicular development, the bubaline species present an ovulation rate of 62.80 % (Baruselli, 2000), similar to the one observed by some authors in bovines (Desaulniers, *et al.,* 1995; Shaw *et al.*, 1995; Stock *et al.*, 1996). The average number of ovulation is of 6.98 $\pm$ 2.97 follicles (Baruselli, 2000), being inferior to the results found in the literature for bovines where it was discovered that the average number of ovulations in super ovulated bovines is of 15 (Boland *et al.,* 1991; Purwantara *et al.,* 1994a; Purwantara *et al.,* 1994 b; Vos *et al.*, 1994; Bo *et al.*, 1996).

The number of ovulations is highly related to the number of corpora lutea on the day of the embryo collection. These results show that the ovulation is followed by the formation of corpora lutea in the bubaline species (Baruselli, 2000). The data of the bovine literature show similarities and verify the high correlation among these characteristics (Guilbault *et al.*, 1991; Shaw *et al.,* 1995; Bó *et al.*, 1996). Nevertheless, the number of follicles $\geq$ 0.8 cm found in the estrous of super ovulation is not related to the number of embryonic structures. The bubaline species present a low number of embryos (Karainov, *et al.*, 1986; Alvarez *et al.*, 1990; Madan, 1990; Misra, 1993; Oba *et al.*, 1994; Baruselli *et al.,* 1994 b; Drost, 1996; Zicarelli, 1997). The rates of embryos recuperation, in relation to the ovulations (27.4%) and to the corpora lutea (32.1%), were low in super ovulated buffalos (Baruselli, 2000). These rates were lower than the ones described in the literature for bovines (Boland *et al*., 1991; Vos *et al*., 1994; Shaw *et al*., 1995). There are evidences that the ovaries of the super ovulated buffalos have a greater number of pre ovulated follicles than the ones that were not stimulated. Thus, the bubaline reproductive tract is of reduced size (Vale, 1994), and the attraction of ovocytes may be affected by changes in the spatial orientation of the oviductal fimbriae in the ovary surface, as it was mentioned for bovines (Shaw *et al*., 1995). These authors demonstrated that the animals with great super ovulatory answer present difficulties of embryonic recovery. Another factor that may be interfering in the low embryonic recovery is the existence of asynchronous ovulations and luteinization of follicles. On the other hand, it cannot be discarded that a low rate of bubaline embryonic recovery could be associated to difficulties during the collection, even considering that the same technicians have done these procedures.

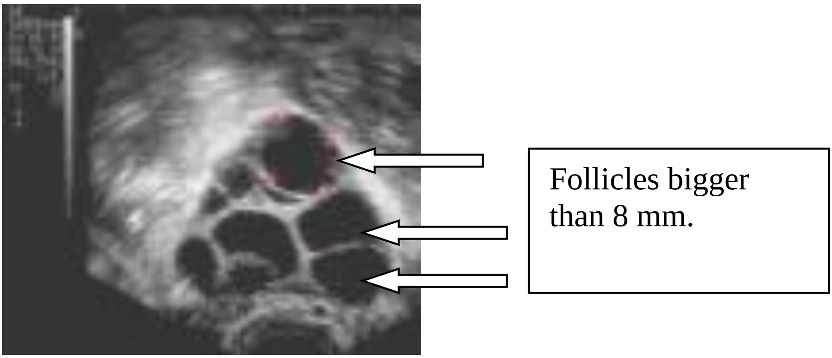
The aim of the following written work was to study the super ovulatory answer of the bubaline species with hormonal protocols which use Porcine Stimulated Follicle Hormone (P-SFH) and Equine Corionic Gonadotrophin (ecG) to heat detected versus a plan with P-SFH and GnRH for AIFT.

The work (W 4) was carried out in a ranch situated 7 km to the north of *Itatí* town, Corrientes, Argentina. For this work, a selection at random of the species used was done, out of an original group of 65 female buffalos. Two groups were formed with 2 female adults each, which were of Murrah, Mediterranean or crossed breeds. In Group 1 (G1), a protocol with P-SFH (Folltropin®, Vetrepharm, Canada), plus an auricular implant of Norgestomet, (Crestar®, Intervet, Argentina) which was placed on the 0 day together with a dose of Estradiol Benzoate (Estradiol®, Over, Argentina) and Progesterone (Progesterone®, Río de Janeiro, Argentina). The 4^{th} day started with the first dose of 4 ml of P-SFH and continued during four consecutive days each 12 hour in decreasing doses of 3, 2 and 1 ml for the 5^{th}, 6^{th} and 7^{th} day respectively. On the 6^{th} day, at midday, a dose of prostaglandin F2α (Prostal®, Over, Argentina) was applied and on the 7^{th} day the implant was removed and on the 8^{th} day a dose of GnRH was applied (Gestar®, Over, Argentina) and after 16 hours the females were inseminated at fixed time.

In Group 2 (G2) a similar protocol to the previous one was used, but without the GnRH dose on the 8th day and after the PGF2α was placed the heat was detected and the insemination was carried out. For doing this, two marker teasers with Chin-ball device were used, with white paint. At the moment the females did not accept the mounting any more, they were removed and inseminated immediately.

Meanwhile in Group 3 (G3) a similar protocol was used, changing the drug used for the super ovulation, employing PMSG (Novormon®, Syntex, Argentina) on the 4th day, in a unique dose, and after the PGF2α, on the 6th day, the same procedure as in G2 was followed, identifying heat and doing insemination (Picture 52).

To evaluate the super ovulatory answer in the different treatments an ovarian ultrasonography was done using equipment PIE MEDICAL® 485 Anser Vet with lineal trans-rectal transducer of 6-8 MHz. In this way, the follicles of ≥ 8 mm diameter were counted on the 8th day in G1 and on the heat day for G2 and G3 (Picture 28). Meanwhile for evaluating the efficiency of the ovulation, an echography of the ovaries 7 days after the AI was done and the number and diameter of the corpora lutea were established. In addition, the body condition was evaluated, measured in the scale of 1 (emaciated) to 5 (obese) and daily echographies were done to determine the evolution of the follicular growing.



Picture 28: Echographical image of a super ovulated ovary.

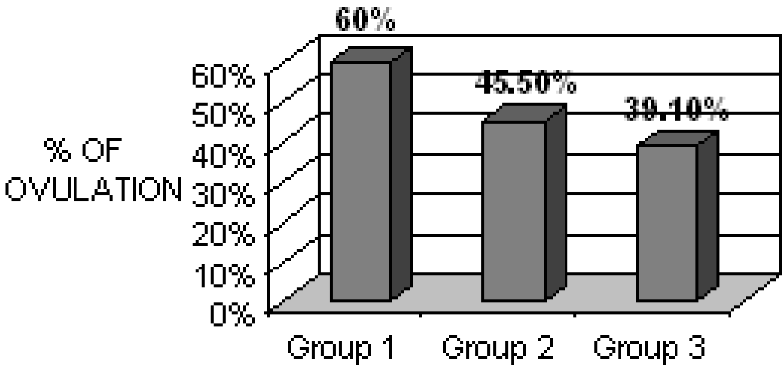
To evaluate the data the Statistix®program for Windows version 1.0, 1999, was used in which proofs of assumptions of normality were done and then the analysis of variation (ANOVA).

Chart 52: Outline of the protocols used per group

D0 =	**Groups 1, 2 and 3**	**Insertion of intra-vaginal device+ BE + P_4 + Echo**	
		MORNING (6:00 h)	AFTERNOON (18:00 h)
D4 = 1st Day of SFH	Group 1 Group 2	*1^{st} dose (80 mg)* + Echo	*2^{nd} dose (80 mg)*
	Group 3	PMSG (2500 UI) + Echo	
D5 = 2nd Day of SFH	Group 1 Group 2	*3^{rd} dose (60 mg)* + Eco	*4^{th} dose (60 mg)*
D6 = 3rd Day of SFH	Group 1 Group 2	*5^{th}dose (40 mg)* + PGF2α + Echo	*6^{th} dose (40 mg)*
D7 = 4th Day of SFH	Group 1 Group 2 Group 3	*7^{th} dose (20 mg)* The device is removed + Echo	*8^{th} dose (20 mg)*
D8 =	Group 1	GnRH + Echo + 1^{st} AI	
	Group 2 Group 3	HD + AI	
D 9=	Group 1	2^{nd} AI	
	Group 2 Group 3	HD + AI	
D14 =	Group 1 Group 2 Group 3	Echo	

The results obtained were 5, 11 and 11.5 follicles ≥ 8 mm, for G1, G2 and G3 respectively (Picture 29). Meanwhile the ovulatory answer was of 3, 5 and 4.5 corpora lutea for G1, G2 and G3 respectively. When the percentages for those three groups were evaluated, the relationship quantity of follicles / quantity of corpora lutea (R: F/CL) were of 60, 45.5 and 39.1 % for G1, G2 and G3, respectively, without finding statistic significant differences (P>0.05). When the answer in relation to the body condition was evaluated, a buffalo from G1 that lost status during the experience was found producing a low super ovulatory answer. Nevertheless, its low production, the R: F/CL was good and similar to the other ones. The results are similar to the ones found in bubaline species in the center of Brazil, by Baruselli, 2000.

He obtained a mean of 8.7 follicles ≥ 8 mm and 6.3 corpora lutea on the heat day, being the ovulation rate 71.8 %. Even though, they are inferior to the ones found by Manik, *et al.*, 1994 in milking buffalos from India. He obtained 26 follicles of 10-14 mm the estrous day and 17 corpora lutea, being the ovulation rate of 65% but superior to the results obtained by Bed, *et al.*, 1996 who found a total of 3 corpora lutea using similar super ovulation protocol. If we compared with the results obtained in bovines by Boland *et al.,* 1991, these were superior to the results obtained in buffalos. The values reached, though they may be considered reasonable, are capable of improvement.



Picture 29: Results obtained in W4

The data obtained show that it is possible in buffalos the use of super ovulation protocols, especially, the ones that make ET and the AIFT possible, with the help of ultrasonography, bridging the excessive time that the detection of heat requires. It is also worth mentioning that G1, and even though there were non significant differences, presented a bigger ovulatory rate, due to probably the GnRH dose, which increases ovulation, in relation to other groups. It is necessary to do new works with a bigger number of animals in order to give a more outstanding conclusion.

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CHAPTER 8

PRODUCTIVE DATA AND MANAGEMENT OF DIFFERENT HERDS OF ANE

Gustavo Crudeli and Pablo Maldonado Vargas

MANAGEMENT AND BREEDING OF BUFFALOS

Management

Experiences of producers of Formosa province are described, for whom buffalos represent a species of great rusticity and plasticity in its adaptation, as it supports great weather diversity with a great efficiency to use forage of variable quality.

However, if an efficient production is required the necessary conditions should be analyzed. As the buffalos possess a great digestive capacity for cellulosic pastures, we should not exaggerate turning them into ‘weeding machines’, if we do not want to affect pregnancy or fattening.

Hertelendy and Hertelendy (2000) supported the idea that the buffalo is rustic but not stupid. If it is placed in a poor pasture ground, it is probable that it decides to look for a better place in spite of the fences.

If it is necessary to smooth by teeth the forage offer available in a pasture ground, an electric fence is indispensable. It should be remembered that it has marked behavioral differences if compared with the bovine for example, though its rusticity requires a greater presence of the man than the bovine. The lack of that presence or the absence of control or stalling of herds may turn the animals difficult for management according to the facts told by the same authors.

As they are animals too attached to their favorite haunt, it is of great help for extensive management, when they adopt an area it is easy to control them. If a change of pasture ground or zone is done, it is advisable to enclose them during the night until they adapt to the new place. It is generally during the night when they move to return to their previous place or to look for another one.

It is necessary to highlight that the water is an essential factor, first as a drinking element, but it is important for them to have a place where to have a bath. This situation makes us think that the water availability is even more important than that of pasture. Hertelendy and Hertelendy (2000) affirm that they have undergone periods of draught where they ‘believed to become crazy’ and thought seriously to stop buffalo breeding.

The problem became worse when the marshes started to dry and only little water remained, as the buffalos tried to take a bath they turned everything into a mud turning the remaining water impossible for drinking. This situation was even worse due to the presence of cows in the paddock.

Hertelendy and Hertelendy (2000) continue describing that when a situation like the one described above occurs, as long as water diminishes the animals become desperate and look for water creating chaos with breaking of fences and herd spreading. Their experience in the *Formoseños* field highlights the importance of the low fields along the banks of Paraguay River.

The bath allows buffalos to regulate the temperature on hot days, preventing them from insect attacks such as flies, gadflies or mosquitoes. They plunged into the water during the time of abundance of insects. In this way, they control ticks and louses while they remain long periods in the water.

As regards internal parasites, the ranches applied a health program similar to the cowherds, covering specially the young animals. The same could be mentioned in relation to illnesses such as brucellosis, tuberculosis, infectious bovine rhinotracheitis (IBR), leptospirosis, etc, for which the same health plan designed for cowherds is followed.

Within management, tameness and electric wire fences should be remarked. It is worth mentioning that for cattle daily management, tameness is of vital importance. It saves personnel, horses, prevents major accidents and in general favors the adoption of process technologies. With the use of electric wire fences, it is possible to reach tameness that is kept during the whole life of the animals. This facilitates the process of learning to eat portions with grains or other concentrates because it is difficult to supplement adults that have never received portions in feeding troughs.

They learn to trust in human beings that feed them and teach them to know and respect the electric wire fence in their first experience when the man marks the animal and it has a determining value in the behavior of its whole life.

The electric wire fences are an unquestionable auxiliary in buffalo management, even more than in cows. They respect more an electric wire working appropriately than a conventional wire fence.

Breeding

The weaned calves, after being in the 'little school' go on with a half intensive management, to continue with the process of taming. The males go to different kinds of fattening and the females go to the natural field.

The female calf is weaned with a weight of 200 kg and reaches the first service when it is near 22/ 24 months of age with more or less 380 kg.

The health program for this period consists of deworming with double dose for gastrointestinal parasites while weaning and then each 90 days with a milky anti-parasite.

In bovines, a selection of females for replacement is done in this stage. In the case of buffalo heifers, there is a minimum refusal because the herd is growing. Nowadays, the cows that are rejected have important defects, because of sub-fertility or because of something that may sound strange to many people, bad temper. It is worth remembering that this defect is highly inherited.

The natural concentration of heat during fall facilitates buffalo management.

Hertelendy and Hertelendy (2000) continue with their experience, affirming that the pregnancy is good if the breeding cows are not demanded with excess. The rusticity and capacity for digesting cellulose should not be abused. If reasonable indexes are to be reached, the herd should be kept in reasonable body condition during the year for giving birth in good status in order to be pregnant again immediately without lengthening the intervals between parturitions. With cows well fed, it is possible to think of weaning fat calves which go directly to be sold.

It is important not to give birth in deep marshlands or difficult access to little calves. There may be important reductions if the conditions for the calves are too extreme. It is important to remember that the female buffalo is in heat with a very little calf nearby and it runs the risk of losing it if running after the male in adverse fields.

In this aspect, Frette (2000) pointed out the difficulties with the recently born calves in the island areas of *Paraná*, in *Esquina*, Corrientes, which in a way produced an increase in calf mortality. The calf normally receives during the first days a dose of Ivermectina and then, if there is an opportunity, a second deworming is done at 4 or 5 months of age. At weaning, a double dose is given to assure that there are no parasites of the Ostertagia type.

The percentage of bulls that are used in herds is between two or three per cent. Males are very aggressive among themselves and it is convenient to have young bulls if possible if the herds have many bulls. On the other hand, if they have only one bull there will be no problems and it is possible to form lots of 50 females with only one male.

The useful life of a buffalo is undoubtedly bigger than for cows; but at certain age the cows’ teeth are checked in order not to have animals with low rate of production. Crudeli (2003) has worked with animals of 22 years of age in the center of Formosa, 10/7 were pregnant and with good teeth, two were CUT (medium tooth) and one discarded because of low tooth.

Fattening

Two alternatives of fattening were compared for the systems of buffalo production. They were compared with a fattening of bovine calves, carried out in the same field and with the following results (Chart 53).

Chart 53: Productive results of Buffalos vs. Bovines in Formosa

	Termination	Feeding		Initial weight	Final weight	Daily gain	Carcass Yield
Buffalo steer in pasture	18 months	*Pangóla* Pasture	Without supplementation	240 kg	480Kg	800 gr	52/53%
Buffalo steer in natural Field	26 months	Natural Field	Without supplementation	240 kg	580 kg	630 gr	51%
Bovine steer in pasture	24 months	*Pangóla* Pasture	With supplementation (0.7% live weight 120 days)	180 kg	400 kg	430 gr	54%

Source: Hertelendy, L. (2000)

This picture gives interesting data of comparison, but we should consider that they were tests done without too scientific precision. They are shown simply in order to see there are good possibilities and they shed light on interesting topics for research work. Supplementing buffalo steers with pastures, important gains in weight were obtained, constituting a highly efficient option for producing proteins in hard fields for other herds, Hertelendy y Hertelendy (2000).

Data of production are analyzed and described from *Santa Rosa* Ranch, located in *Esquina,* Corrientes, where from 1981 up to 1996, a proof of weight gain was done with weight control at weaning and at the slaughtering age. The major efficiency of conversion of the buffalo in those natural fields situated in our humid sub tropic, and the total coincidence with the curve of forage offer have made possible the extraordinary results obtained in this evaluation.

The coincidence of the mentioned curves can be appreciated in chart 54:

Chart 54: Controls of weight gain in *Santa Rosa* Ranch, Corrientes.

Average values with buffalos of Mediterranean breed		
Evaluated parturitions	6 parturitions (1981 a 1986)	10 parturitions (1987 a 1996)
Nº of animals per parturitions	90	220
Sex	castrated males	castrated males
Estimated weight at birth	42 kg	42 kg
Daily weight gain at pre-weaning	0.660 kg./day	0.692 kg./day
Average weight at weaning	240 kg	208 kg
Weaning age	10 months	8 months
Daily weight gain at post-weaning	0.529 kg/day	0.519 kg./day
Average weight at slaughtering (At 27 months)	510 kg	504 kg

Source: Zava, M. (2000)

It is important to highlight that there were years with better daily gains at post-weaning, but they are averaged with years of draught and/ or floods.

The cow, in the same conditions, has in *Santa Rosa* a weight at weaning (with 8 months of age) of 160 kg, a live weight at 27 months of 300 kg and it reaches a slaughtering weight of around 400-450 kg, with 39-42 months of age.

The buffalo gain in weight is almost 100% superior to the cows. In addition, buffalos reach maturity and weight for slaughtering at an earlier age, improving the quality of the carcass.

REPRODUCTIVE INDEXES

Going on with the analyses of production data, reproductive results from herds of the ANE region are added, highlighting 3, corresponding to Corrientes Province.

A rectal palpation was done to determine pregnancy of the evaluated herds and possible pathologies in females. As a whole and during the three successive years a total of 12.17 females were included. In Chart 55, it can be seen the name of the ranch, the total number of females and the pregnancy percentage per year.

Chart 55: Percentage of pregnancy per ranch and year in Corrientes.

Ranch	1998	1999	2000	2001
Santa Rosa (Esquina)	2200 (75 %)	2700 (78 %)	3000 (68 %)	3300 (77 %)
Rincón del Madregon (Empedrado)	250 (72 %)	300 (82,2 %)	327 (83 %)	350 (75 %)
Rincón del Indio (Itatí)	---------	45 (71 %)	55 (66 %)	90 (72 %)

Source: Crudeli *et al.*, 1997.

This shows an important yield, when comparing in the same region with bovines, which suffer undoubtedly the effects of the region marginality, being their results inferior to the ones obtained for buffalos.

As regards the reproductive seasonality, though there is not a stationary service, parturitions are stable between the months of February and June, with high marks between March and April. The scarce pregnancy out of this time is present in heifers that in September or October reach a very good development and so they can be pregnant. They become seasonal since their second parturition takes place among the fall months, together with the rest of the herd.

As regards the age of the first service, it can be observed that in some years the female that reach 300 kg with one year during March, something relatively common in our herds, in a percentage near to 50 % are pregnant each season. This shows, on one hand the excellent and rapid puberty and sexual development, but on the other hand they are left aside of the parturitions of the three years, as regards their development. Therefore, in these herds, it has been adopted the service in heifers of two years, to avoid this inconvenience (Crudeli *et al.,* 1997).

EVALUATION OF BULLS

The evaluation of males is important as they represent the 50% of the population of the herd. In relation to this variable 107 male reproducers of Murrah, Mediterranean, Jafarabadi and their crossings were evaluated, with ages between one and six years bred in extensive conditions in 8 ranches of the Argentine NE.

The characteristics evaluated were the scrotal circumference (S.C.), testicular consistency (T.C.), heart girth (H.G.) and corporal weight (C.W.).

A 3.9% of anomalies of the genital apparatus were found. The work shows the slow evolution in the development of the genitals in this species, comparing with bovines bred in this region.

The animals were managed under an extensive plan, staying the whole year with the female herd and receiving similar health management to the bovines. The bulls evaluated have not been examined before.

The andrologic exam done to each individual consisted in valuing the following parameters:

Scrotal circumference (S.C.), which was measured with a common scrotimeter, in the major diameter of both testicles and expressed in cm;

Testicular consistency (T.C.), evaluated by individual palpation of testicles and expressed as it follows: 1 (very firm), 2 (firm), 3 (moderately soft) and 4 (very soft);

Body weight: (B.W.) it was measured with a common country scale.

Heart girth: (H.G.) it was measured by a measuring tape, surrounding the thorax from the withers to the sternum. The results obtained by S.C., T.C., B.W. and H.G., discriminated according to age are shown in Chart 56.

Chart 56: Average values of scrotal circumference (S.C.), testicular consistency (T.C.), heart girth (H.G.) and body weight (B.W.), according to age.

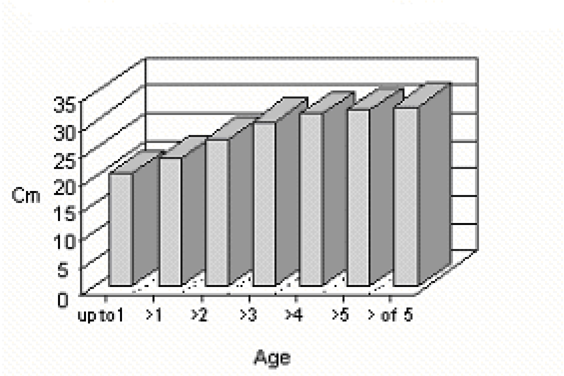
Age (years)	Up to 1 (n:36)	> 1 (n: 38)	> 2 (n: 43)	> 3 (n: 18)	> 4 (n: 5)	> 5 (n: 9)	> de 6 (n: 30)
S. C. (cm)	20.31	23.0	26.5	29.5	31	31.7	32.4
T. C. *	2.7/2.7	--	2.3/2.4	2.5/2.5	2.6/2.7	2.6/2.6	2.5/2.6
H. G. (cm)	162.5	--	183.8	197.5	207.2	211.88	215.92
B. W. (kg)	299.15	291.69	374	508.66	623.33	631.11	670.94

*: left/right.

The data obtained show that the buffalo has a smaller testicular size than the bovine. Nevertheless, its development in body weight considering the same age, is superior in pasture conditions where the bovine cannot produce properly. In bulls belonging to Brahman and Hereford breeds from Corrientes, at 24 months of age, it has been determined, of 337 kg and 27 cm and 285 and 31.1 cm of S.C., with a relation weight/S. C. of 12.5 and 9.1 respectively (Arias *et al*., 1991).

If we compared the results presented at the same age, the buffalo has a relation B. W. / S. C. of 14.1, indicating that it was heavier when it was two years than both breeds of bovine, but with a minor genital development. In picture 30, a curve of testicular growing is observed at the end of the sixth year of age. The testicle length moves between 10 and 12 cm, meanwhile in the bovine species it is from 16 to 18 cm.

Another characteristic is the absence of hair in the preputial ring (Vale, 1988).



Picture 30: Evolution of the scrotal circumference in buffalos in the ANE.

The average of S. C. in adult buffalos was of 32 cm. Nevertheless, there were males with 35 and 36 cm, being these results the same as those of the males used in the Insemination Central in the North of Brazil (Vale, 1994 and Bhosrekar, 1993).

They are different from the results obtained by Ferrari *et al.* (1995). Between 2 and 3 years of age a mean of 29.2 cm with a weight of 518 kg were obtained, both higher than the ones in our registers. In our region these figures are obtained a year later probably due to the level of feeding inferior to the animals bred in our zone.

From the studies carried out it may be concluded that:

1- The scrotal circumference average in adult male buffalo (> 6 years) was of 32.4 cm and the body weight of 670 kg.

2- The rhythm of the increase of the scrotal circumference observed was much slower than in the bovines, finishing its development at 6 years of age.

3- A 3.9% of buffalos with external genital anomalies were detected.

GROWTH AND PUBERTY IN BUFFALO HEIFERS

The development and growing, as well as other indicators that demonstrate that the buffalo heifers have reached puberty were the aims stated in the work done from the Veterinary Sciences School together with the participation of INTA *Colonia Benitez*, Chaco.

The aims stated by Scarnatto (2000) are: a) to have data about growth and puberty of buffalo heifers b) to compare weight gain, age and weight in puberty, between the bovine and the buffalo.

For that reason, growth and access to puberty of 11 heifers and 11 buffalo heifers from 8 months up to 22 months of age were compared in the north east of Argentina.

Pastures were evaluated, establishing the content of dry substance and values of PB, P, K, Na, Ca, Mg and Fe. Blood samples were taken to determine Hematocrit, Hemoglobin and phosphorus. The measurements done were weight, height, body condition and genital score.

To detect the beginning of puberty gynecologic palpation and echo-graphy to all the females were done. The current work was carried out in the ranch *"Rincón del Madregón"* located in Corrientes. It has a sub tropical climate and annual rains that reach an average of 1,200 mm and it is formed by low fields, which are constantly flooded and so drainage is difficult.

11 female bovines and 11 female buffalos were used, considering two groups (bovines and buffalo heifers). They were selected from a herd of bovine and buffalo calves of 8 to 10 months of age, recently weaned with a weight of near 200 kg and 250 kg respectively, which belong to Brangus bovine ½ blood and crossed Mediterranean buffalos. The animal load was of 0.35 CE/ha (cow equivalent) for bovines and of an equivalent load for buffalos assuming that 1 EV for bovines equals 1.5 EV for buffalos, coinciding in part with what Maldonado Vargas has proposed in the Chapter Livestock Models.

Scarnatto (2000) points out that a paddock of a low field was divided with electric wire in two paddocks of 18 and 22 ha, where female bovines and buffalo cows were placed respectively. From the beginning of the test, each 56 days and during a year blood samples were taken with and without anticoagulant to undergo biochemical proofs, weight measurements, height and evaluation of the body condition (BC) on a scale of 1 to 9 for bovines and of the genital Score (GS).

Samples of pasture were taken by means of the "hand plucking" technique- trying to imitate what the animal would eat in order to determine the content of brute protein and minerals; which will be mineralized by humid digestion with acids and heat according to Eden and Green (1940). From the blood samples, it was established: Hematocrit by the capillary tube method with centrifugation to 12,000 rpm during 5 minutes and reading in abacus and Hemoglobin by the colorimetric method of the cianmeta-hemoglobin with a reading of 540 mm. The phosphorous was determined by the colorimetric method.

The proposed variables (body weight, height, Hematocrit) were analyzed as a completely aleatory design, using the animal as experimental unity, that is to say there was no repetition of paddock. The source of variation was the species, date of the sample and the interaction between them. The results are presented in the following Chart 57.

Chart 57: Measures of live weight, heart girth, hip height, body condition, by species and date.

	BOVINE	BUFFALO	EE	Probability
Weight, kg				
09-06-98	203	253	4.2	0.0001
11-08-98	179	257	4.7	0.0001
30-09-98	193	268	4.4	0.0001
01-12-98	243	322	4.5	0.0001
23-02-99	283	374	5.5	0.0001
Heart Girth, cm				
09-06-98	137	153	1.54	0.0001
11-08-98	137	157	1.42	0.0001
30-09-98	138	158	1.41	0.0001
01-12-98	-	-	-	-
23-02-99	155	182	1.69	0.0001
Body condition				
09-06-98	3.13	2.94	0.10	0.19
11-08-98	2.4	2.8	0.08	0.0025
30-09-98	3	3	0.10	0.77
01-12-98	4	4	0.10	0.75
23-02-99	3.6	4.6	0.15	0.0001

Height, cm				
09-06-98	112	118	1.08	0.0002
11-08-98	114	117	0.81	0.0062
30-09-98	114	119	0.96	0.0008
01-12-98	118	122	0.76	0.0006
23-02-99	120	124	1.15	0.029
LWG/kg.	0.309	0.473	0.02	0.0001
Height change	8.2	5.2	1.13	0.075
HG change	17.4	29.5	1.92	0.0002
BC change	0.45	1.67	0.21	0.0005

Scarnatto, R. (2000.

The daily gain in weight was 310 g /day for female bovines and of 480 g / day for buffalo cows. The bovines decreased their weight during winter; probably an outbreak of mange affected this fact, as the buffalos without this problem kept their weight.

All the same, at the end of the experience the female buffalos have 90 kg in favor having started with a difference of 50 kg. The daily gain as well as the weight at two years of age in bovines was satisfactory from the reproductive point of view for the zone, possibly by the low animal load assigned.

In relation to puberty gynecologic palpation and echography were done to all the females observing the follicular activity in 10 buffalos in both ovaries as opposed to the bovines in which only 5 of them have structures in their ovaries. The uterus presented ½ tone in all the female buffalos in the same way as in bovines. This may indicate that the buffalo cows were cycling (10 out of 11), what is reasonable to wait, if we consider their weight, a month before they weighed a mean of 374 kg. We have to consider that there are works in our zone and from Brazil, which are coincident, that female buffalo of over a year and with more than 320 kg can be pregnant. Crudeli *et al.* (1995) and Damé and Pimentel (1994) and with a good feeding Baruselli (1994). Meanwhile, these results are inferior to the ones obtained in Italy by Borghese *et al.* (1994). What calls our attention is that in heifers, even having an acceptable weight and age, 289 kg, only 5 out of 11 would have reached puberty.

The analysis of pasture is present in Chart 58. The minerals P, Na, Zn are deficient; meanwhile Fe and Mn are present in excess. The excess of Fe can interfere with the availability of Cu. The values of Ca and P were inferior to the ones mentioned in the two works done by Cardozo *et al.* (1994) and Cardozo *et al*. (1997).

Chart 58: Analysis of pasture, each media represents 6 samples.

	Bovine Paddock	Buffalo Paddock	Critical evels for bovines
In % of the D S			
PB	10.68	10.75	
P	011	0.11	0.15
K	2.04	2.13	0.6
Na	0.07	0.03	0.06
Ca	0.30	0.29	0.2
Mg	0.15	0.17	0.15
In ppm of the D S			
Fe	1113	1429	50 excess
Cu	11.42	11.45	5 – 10
Zn	18.33	19	30 – 40 def.
Mn	581	628	50 excess

Average of three demonstrations with two samples in each paddock. Scarnatto, R. (2000).

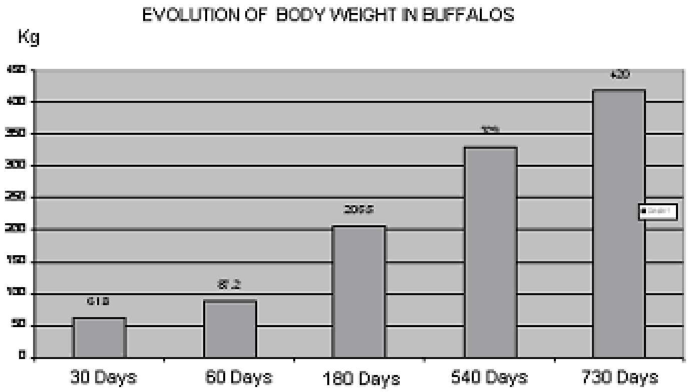
Scarnatto (2000) concludes that the development variables considered show a better behavior in buffalos, highlighting the value of preliminaries to the conclusions obtained. The months for measurement should be increased and this test should be evaluated in other paddocks.

When the data obtained under other conditions were analyzed and incorporated to the samples of the influence zone of the Group of Work, from VSS- NENU the following results can be shown in Chart 59.

Chart 59: Production Data of the species obtained in field conditions in the northeast of Argentina

Age in days	Weight (Kg)	N
30	61.76	324
60	87.22	321
180	205.5	319
365	329	297
730	420	268

What follows is the evolution of weight referred to, expressed as it is shown in Picture 31.



Picture 31: Evolution of body weight in buffalos.

As it can be observed in the previous data, starting from an average weight at birth of 32 kg, the animals gain standing by the mother, up to the day 30, 993 g / day, up to the day 60, 920 g / day, at weaning 963.5 g / day. From there and up to the 540 days the average is reduced to 550 g / day and up to the two years the gain is of 531 g / day.

The common characteristics to all of them is that they are located in the north of the province. It is the ecosystem in which the activity is developed, characterized by soils of little or null drainage, which remain flooded most of the year, accompanied by a high pluviometric regimen and high temperatures, which facilitates the presence of parasitic illnesses. In these conditions, pastures grow rapidly decreasing the digestibility of them.

SERVICE AND SEASONALITY

It was found that females of little more than a year of age and weight superior to 320 kg (weight reached during a good year), are matured sexually, so the parameter of 2/3 of the average weight of the adult cows of the ranch, could be apply to the buffalo cow.

It is worth mentioning that in two ranches there has been a 45% of animals that has undergone fattening pregnant and a 38% in other. These females were pregnant during September and October and were bred in natural fields in the north of Corrientes, as it has been mentioned in the above paragraphs. In the last years, pregnancies of 95% in buffalo cows of 14 to 15 months born by insemination have been obtained.

As regards the reproductive indexes reached in general herds in these conditions according to the different ranches evaluated (Chart 60) we can observe that in all the cases they surpass the provincial media for bovines that is 54%.

Chart 60: Percentage of pregnancy/ parturition according to the ranch.

Ranches	Years						
	94	95	96	97	98	99	00
Santa Rosa	57.7	60.6	67.2	64	75	78	68
Añá Cua	----	88.6	72.4	75	----	---	- - -
Don Carlos	80	72	77	----	----	---	72
Loma Alta	69	53	---	78	---	---	- - -
Monte Rey	----	----	76	67	---	----	---
Rincón del Madregón	68.8	71.6	71.6	72	72	82.2	83

In a ranch to the northeast of Corrientes, the following distribution of pregnancy is observed according to category (Chart 61).

Chart 61: Distribution of pregnancy according to category.

	Heifer 1 year	1st service	2nd service	Adult
Age (months)	14-15	24	36	+48
Weight (kg)	357	423.7	486	525.7
% pregnancy	87	79.2	63.3	90.4

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