BUFFALO LIVESTOCK IN THE WORLD. HOW ARE DEVELOPING MARKET AND SANITARY CONTROLS

Antonio Borghese[1], Antonio Fagiolo[2], Giorgio Saralli[2]

[1] *General Secretary International Buffalo Federation (IBF), Coordinator FAO-ESCORENA Buffalo Network*
antonio.borghese@email.it – antonio.borghese@escorena.net

[2] *Animal Prophylaxis Research Institute for Lazio and Toscana Regions (IZSLT)*
giorgio.saralli@izslt.it – antonio.fagiolo@izslt.it

Abstract

The best dairy purpose breed in the world are represented, from which milk products and developing market for each country are shown.
Meat products and market are discussed too.
Finally the sanitary problems, which represent a strong limit for food and animal free market, have been explained.

Keywords: buffalo breeds, milk products, meat products, market, sanitary controls.

1. Buffalo population trend in the world

The buffalo species (*Bubalus bubalis*) is a very common species, particularly widespread in tropical and subtropical countries with hot and humid climates.

In the most South East Asia countries (India, Pakistan, China) there are the quite whole of buffalo population: 152 million head on total of 182 million (83.5%, Borghese, 2013).

If we add the other Asian countries (Thailand, Indonesia, Philippines, Vietnam, Bangladesh, Nepal, Sri Lanka, Myanmar, Laos, Cambodia, Iran) we have in Asia 174 million head, 95 % of the world population.

In Africa we find domestic buffalo only in Egypt, with more than 5 million head (2.9%); there is also the wild buffalo but it is another species (*Syncerus caffer*).

In Europe the most number and practically the alone product economy is in Italy with about 370,000 head (0.2%) and a very strong market of mozzarella and other quality cheeses, fresh and processed meat, semen of high genetic level.

In America the buffalo are mostly represented in Brazil with more than 3,5 million head (1.9%), but its number and food production is increasing too in Venezuela, Colombia, Argentina, Cuba.

In the most of Asian countries, the buffalo was used for draught power in paddy fields and haulage, so, with the advent of mechanization, its number is rapidly decreasing and buffalo was substituted by dairy bovine cows for milk purposes (Borghese, 2005).

Only Italy, India and Pakistan created dairy purpose buffalo and their number is increasing because of the link with the market economy.

In Italy a dairy purpose animal was selected, Mediterranean Italian Breed with genetic potential until 5,000 kg milk/ 270 days of lactation. All the milk produced from buffaloes is processed in mozzarella cheese and 36,000 tons of mozzarella was produced in 2010 for internal market and for the export, plus ricotta, other cheeses, yogurt, ice cream.

India is working in selection of Murrah breed for dairy purpose. The white revolution achieved the result to increase strongly the milk production for human needs. The fat is separated to produce butter, ghee, cream for human food, and the milk is used for direct consumption.

Pakistan is working to select Nili Ravi and Kundi breeds for dairy purpose too and the milk is used for human needs as in India.

American countries produce mostly meat from buffalo but some farms are working for select dairy animals.

Therefore the buffalo is a priority animal in the world as a source of protein food for human survival and sustainability as it is explained in every detail for each country, where buffalo has a pivotal role in human food sustainability.

In the World, according FAO data (FAOSTAT, 2010), there are 180,702,923 buffalo head, at this moment about 182 million (Borghese, 2011), with a positive trend (+8.3%) in comparison with the value of 168 million reported in a previous book "Buffalo Production and Research" (Borghese, 2005).

In Asia, according to FAO data (FAOSTAT, 2010) there are 174,208,357 buffalo head (95% of total population), with a positive trend too (+8.1%) as 5 years before the Asian population was 161 million (Borghese, 2005) , and the Asian population was the

95% of the global one, as now. This positive trend is due to the increasing population in India and Pakistan, where milk purpose breeds were selected and where the buffalo milk market is very strong, balanced by the decreasing in other countries where draught animals are less required than in the past.

In Africa, where the buffalo is found only in Egypt, there are 5,231,162 head (FAOSTAT, 2010), while 6 years before the Egyptian buffalo population was 3, 717,000 (Borghese, 2004), with an incredible positive trend of 40.7%, passing from the 2.2% to the 2.9% of the total population in the world, as buffalo in Egypt is a basic draught animal in rice fields and irreplaceable for milk production for direct consumption.

In Europe this year, the most of population is in Italy with about 400,000 buffaloes, while the European buffalo population is 459,000 (0.25% on world population), less than the found one 7 years ago (500,000; 0.30%) (Borghese, 2005) for the decreasing trend in many Balkan countries as Romania, Bulgaria, Macedonia, Greece, Albania, Serbia, partially balanced by the increasing trend in Italy, link to the expansion of mozzarella market.

In America we can consider this year 4,227,000 buffalo head, 2.32% of total population, while 11 years ago there were only 3,345,000 (Rocha Loures, 2001), about 2% of the global one, with a very positive trend (+26.4%) due to the enormous availability of land and free pasture in South America, the unique adaptability of buffalo to lagoons and marshy land, the changing from a meat purpose breeding to a double purpose (milk and meat) livestock.

2. Dairy purpose Breeds, milk market and products

2.1. Mediterranean Breed

The Mediterranean buffalo originates from the Indian buffalo. It was introduced into Europe with the advent of Islam and the Arab occupation in the 8th century in Sicily and in the south of Italy, while in the east Europe, buffalo was introduced later with crusaders in the 12th century and after with Turkish invasion during the Ottoman empire (15th century). According other Authors, buffalo was introduced in East Europe by Avars in 6th century during barbarian invasion, coming from Asia through Mongolian steppe: this theory is wrong because buffalo ever followed the river roads, from Indo to Tigris and Euphrates, to Nilo, to Sele and Volturno rivers and because of the chromosome number: European breeds are River with 50 chromosomes coming from India according the previous way; if they came from Mongolia steppe, buffalo were Swamp with 48 chromosomes (Borghese, 2011). Anyway the Italian breed is totally different from the Balkan breeds: as the first one is now classified as Mediterranean Italian breed as it was selected for 60 years for milk purposes and it is clearly a dairy breed (figure 1 and 2). The Balkan breeds as Carpathian (figure 3) or Macedonia (figure 4) are draught animals, used for carriage, smaller in size and with low milk production.

Figure 1. Mediterranean Italian buffalo cow, Tor Mancina, Rome (Borghese photo, 2004)

Figura 2. Mediterranean Italian breed, Tor Mancina farm, Rome (Borghese photo 2006)

Figure 3. Mediterranean Carpathian breed, Romania (Borghese photo 2011).

Figure 4. Mediterranean buffalo cow, Macedonia (Borghese photo, 2008)

The buffalo population in Europe has been dramatically declining since the Second World War, with the advent of Holtein cattle and the progressive mechanization.

The Mediterranean population in Europe is about 459 000 head, but Mediterranean is present in many countries of South America as particularly Brazil, Argentina, Venezuela and Colombia, where it was introduced to increase the milk and meat capacity. In these countries and in many Asian countries (Turkey, Iran, Azerbaijan, China, Bangladesh, Indonesia), Mediterranean Italian semen was largely used to create F1 crossbreds with higher milk potential. Therefore we can find many million head coming from crossbreeding with Mediterranean in the world, from America to Asia.

Description: Black, black and brown, dark grey coat. The horns are flat at the bottom, backwards and slightly outwards pointed, and backwards straightened; the top is pointed inwards. They have a compact conformation with a deep and wide chest as well as a developed pectoral. The back is short. The rump is short. The udder is medium size with squarely placed quarters and halves; the teats are cylindrical. Where machine milking is popular (only in Italy) udders are more regular and better shaped. Size, weight and productivity vary a lot according to the environment and management (Moioli and Borghese, 2005). Average herd size is below five breedable buffaloes in most countries, except in Italy where it is 161,3 (Borghese, 2011). The proportion of breedable females to total buffaloes is about 45 percent.

The body weight of the adult female is 450-650 kg, while the male weight can arrive more than 1000 kg, particularly in Mediterranean Italian, heavier than other European buffaloes. (figure 1 and 2).

Distribution: Italy: 370,000 (Mediterranean Italian breed); Romania: 25,000; Germany: 2,111; United Kingdome: 2,500; Greece: 3,137 (Borghese, 2011); a few hundred in Serbia, Albania, Macedonia, The Netherlands, Switzerland and 900 in Hungary, while there are many thousand in Brazil.

Husbandry: The most common housing system is the one referred to as traditional, consisting of keeping buffaloes indoors at night and confined in fenced areas during the day, particularly in cold climates of Centre Europe. In the favourable season they are allowed to graze during the day. In Italy, they are housed loose in paddocks all year long, with the same modern systems used for dairy cows. One third of Italian buffaloes are also put out on pasture in the favourable seasons, or green forage "cut-and-carry" such as alfalfa can also be used. Maize silage, concentrates and by-products are the basic foodstuffs in Italy.

Performance varies very much depending on the area. There is no common practice to wean buffalo calves. When milking is done by hand, both male and female calves suckle from the dam. In some cases they suckle from a dairy cow. Only in Italy the calves do not receive never the mother milk directly, but after colostrum taken by biberon for 2 day, the calves receive milk replacers until the weaning at about 3 months, while the cows are milked for processing purposes. This results in a wide difference in daily gain up to weaning, as well as weaning weight and age.

Males are now in greater demand as meat producers, therefore increased attention is being paid to their feeding and health.

Average daily milk yield reveals a huge variability, mainly depending on the feeding system. It can range from 3 to 4 kg milk/day for poorly fed animals to 15 kg/day in intensive management systems. In Bulgaria, Romania, Macedonia, Greece and Albania, extensive management systems are employed, while Italy applies only intensive system.

Average slaughter weight is 250-400 kg, at the age of 12-15 months.

Dairy performance:

Lactation duration	270 days
Milk yield	900-4 000 kg
Milk fat	8.0 percent
Milk protein	4.2 - 4.6 percent

Products: Mozzarella, treccia, scamorza and other cheeses, ricotta (Italy, figure 5), Vladaesa cheese, Braila cheese (Romania); White brine cheese (Bulgaria, Romania); yoghurt, meat and meat industry products: bresaola, salami, sausages, cacciatorini (little salami), etc., (Moioli and Borghese, 2005).

In Italy the Buffalo Genealogical Book was instituted by Italian Ministerial Decree on June, 23, 1980 and was held by A.I.A. (Italian Association of Breeders).

The A.N.A.S.B. (National Association of Buffalo Species Breeders) had been instituted on 1979 and recognized on the 1994 by Agricultural Ministry.

The Ministry, with Ministerial Decree n° 20154 has entrusted the management of the Book to A.N.A.S.B. on year 2000. In the same year other decree (D.M. 201992 on July,5, 2000) recognized buffalo enrolled in Genealogical Book pertaining to the only own race: **"Mediterranean Italian"**.

The animals rose in Campania and in Lazio Regions of Italy give the milk used for the production of the famous "Mozzarella di Bufala Campana D.O.P." (figure 5).

Figure 5. Italian mozzarella and ricotta.

The D.O.P. (Denomination Origin Protected) Mozzarella di Bufala Campana was recognized with the Ministerial Decree on May 10, 1993, published on the G.U. n.219 on 17/9/1993, and after from European Union; that means that this cheese mozzarella has to be produced in defined areas of the Provinces of Caserta, Salerno, Benevento, Napoli, Frosinone, Latina, Rome, (Foggia was added after), coming only from fresh milk of buffalo cows of Mediterranean Italian breed, registered in the Buffalo Genealogical Book. The Decree establishes the milk characteristics (fresh within 16 hours from milking, raw, minimum fat 7%,), processing techniques (acidification, coagulation, stretching, moulding) and mozzarella characteristics. The control and guardianship is effected by "Consorzio per la tutela del formaggio Mozzarella di Bufala Campana", so the European consumer is guarantee that the logo means a quality product of the made in Italy, according the best standard of animal management, welfare and health, according also the best characteristics of mozzarella, as sanity, freshness, flavour and juiciness.

The main factors that have contributed to the development of buffalo in Italy in the past few years have been the following: no regimen of milk quotas; increase of the consumption of mozzarella in Italy and export in many countries in the world; the high price of buffalo milk (about 1.20 euro/kg) in comparison with cattle milk (about 0.40 euro/kg), the high technology of farmers, high level of management and breeding, high genetic value of the herd, obtained by performance and progeny testing, animal recording and selection, artificial insemination applying, starting with an organization born more than 50 years ago.

Several cycles of progeny tests, with the publication on 1997 in the first time, of the genetic indexes of breeders of buffalo species, both males and females, are effected by ANASB.

The execution of the milk recording in buffalo is applied according ICAR (International Committee for Animal Recording, Moioli,2005), according to the Regulations of the Buffalo Species and to the norms emanated in the Central Technical Committee of the milk recording of the bovines and the buffaloes. For being able to be subordinate to the control, as a result of completely voluntary adhesion, the farms must fulfil to some prescriptions: they must be subordinate to the inspection from an expert of race of A.N.A.S.B.; they must possess the sanitary certificate from National Sanitary System that attests its indemnity and must have the bulls with genealogical certificate in order to admit they to service.

For Mediterranean Italian Buffalo, the productive controls regard: the quantity of milk in kg, the determination of the percentage of fat and of proteins (kg and %) and the somatic cells.

The beginning of the official lactation starts at calving, the first control cannot be carried before the five days from calving and not beyond 75 days. The duration of the reference lactation is 270 days, in any case the duration of the effective lactation must be indicated.

Every milk control must be made on all the milking ordinarily practiced by the breeder in the 24 hours, annotating also the hour in which the same control is carried out, the quantity of milk found must be indicated in kilograms, the milk must be weighed with the balance or be determined with lactometers.

For every subject are reported the following data: number of current lactation, daily production expressed in kg milk, % fat, % proteins and number of somatic cells, the effective production from the calving for: kg milk, kg fat and proteins and the daily medium production, the milk production in comparison to the reference lactation of 270 days, "equivalente bufala matura" (E.B.M.) expressed in kg of milk, fat and proteins (Coletta and Caso, 2008).

E.B.M is a hypothetical production for a buffalo

that started his lactation in January at five years old; the productive ability is the ratio between E.B.M. of the single buffalo and the mean I.B.M. of the farm.

All data are collected by ANASB, which decides on the selection goals which are presently to increase not only the milk quantities but specifically the mozzarella cheese production according to the mozzarella index:

Mozzarella (kg) = Milk (kg) x (3.5 x % proteins + 1.23 x % fat – 0.88) / 100

In Italy there are 370,000 buffaloes and the mean milk production is over 2,200 kg for lactation, in confront of other Mediterranean countries where the maximum production is less than 1900 kg. In Italy the milk production in 46,799 recorded buffaloes (ANASB, 2009) was 2,221 kg (8.24 % fat and 4.66 % protein) in 270 days of lactation (Table 1). Recorded buffaloes are raised in 290 herds with an average of 161.3 head per farm.

N° Head	370 000
N° Dairy buffaloes	180 000
N° Recorded buffaloes	46 799
% Recorded Buffaloes	26.0
N° Recorded farms	290
N° Head/farm	161.3
kg milk production (in 270 d)	2 221
% Fat	8.24
% Protein	4.66

Table 1. Italian Buffaloes (ANASB 2009)

In the year 2010 the milk production in 270 days of lactation was 2,180 kg with 8.47% fat, 4.59% protein. The recorded buffaloes were 50,240 with an increasing of 7.35% (ANASB, 2011). In the year 2011 the milk production was 2134 kg with 8.4% fat and 4.7% protein on 54,548 recorded buffaloes, with a further increasing of 8.57% on recording extension.

In other countries the buffalo productivity is lower, due to the fact that only Italy has undertaken a great deal of work on recording, on selection, on reproductive and genetic improvement, on health, on feeding and livestock systems, as is shown in the following analysis.

The recorded buffalos on year 2006 were 40,425, with an increase of 1,2% regarding 2005.

On the basis of 26,462 considered lactations, we found on 2006 an average production of kg 2,178 with fat average of 8,09% and a proteins average of 4.67% (Coletta and Caso, 2008).

In the reported period, the average production expressed in kg, has been increased slowly but constantly from 1990 with 1893 kg for lactation until 2004 with 2,184 kg for lactation, until 2009 with 2,221 kg for lactation.

In the last few years, in Italy, milk composition has been improved: the average protein content has raised from 4.4% in 2002 to 4.6% in 2010 while the average fat content raised from 7.3% in 2002, to 8.5% in 2010, without operating any selection for the character of protein and fat content. Moreover the possibilities for genetic improvement for milk quantity and quality will be higher, if the selection pressure will be increased reducing the number of bred females, discarding the low productive females. At the present time there are many females in Italy producing more than 5,000 kg milk/270 days of lactation) until the maximum production of 5,600 kg with 8.32% fat and 4.63% protein.

There are in Italy two Bull Buffalo Centres for semen production: the COFA (Cooperativa Fecondazione Artificiale) in Cremona Province, Lombardia Region, in North of Italy, where there are many bulls with genetic potential to produce more than 4,000 kg milk/ lactation as Malandrino Bull and O-B-One Bull lines. The Chiacchierini Bull Centre in Perugia Province, Umbria Region, in Middle Italy: this one started a genetic selection programme with CIPAB consortium and actually produces semen from 16 tested bulls from different bloodlines, coming from mothers over 3,100 kg milk yield per lactation with more than 4.5% protein: there are Ciripicchio Bull with 4494 kg milk/lactation and Jesce Sole Bull with 4,157 kg milk/lactation, as recorded in the best daughters, and Brillante, the best bull for pedigree index of 2010-2011 progeny test. This stud is one of the few European A.I. studs authorized as insect-proof quarantine barn, located away from the semen production zone. It is authorized for worldwide export for the excellent sanitary level. Chiacchierini Bull Centre produces sexed semen too, available from a lot of bulls.

Hereafter the selection will be directed at the improvement of the yield of mozzarella cheese, not simply for milk production, since the farm income is based firstly on mozzarella cheese, secondly on the sale of pregnant heifers, lastly on beef sales and finally on the sale of semen and embryos of high genetic value.

2.2. Murrah

Murrah is the most important and well-known buffalo breed in the world, selected in the North West of India for milk purposes and typical for curled horns.

Description: Black in colour. Massive and stocky animals, heavy bones, horns are short and tightly curled. Placid.

Height at withers of adult male is 142 cm, body

weight is 750 kg.

Height at withers of adult female is 133 cm, body weight is 650 kg.

Distribution: From its origins in the centre of Haryana, it has spread to the Punjab, Ravi and Sutley valleys, north Sind and Uttar Pradesh. It has been exported to Brazil, Bulgaria and many countries of eastern Asia (Moioli e Borghese, 2005).

Husbandry: Buffaloes in India are many million and traditionally managed in domestic conditions together with the calf. They are hand-milked twice a day. Some big farms adopted mechanical milking. They are fed different kinds of roughages (barley and wheat straw, cornstalks, sugarcane residuals). In addition, they are given concentrate mixtures. If grazing is available, they graze all day long. The big farms are managed according intensive system where unified model is adopted. They are naturally mated in the villages, while big farms normally provide artificial insemination.

Dairy performance:

Lactation duration	305 days
Milk yield	1 800 kg
Milk fat	7.2 percent

Products: Milk, ghee, cream, meat.

Sethi (2003) reported the performance characteristics at the Buffalo Research Institute, Hisar, Hariana (figure 6 and 7), India.

Figure 6. Murrah buffalo bull, Buffalo Research Institute, Hisar, India. (Borghese, 2010)

Average body weight (kg) 495
Age at first calving (months) 50.6±2.0
First lactation 305 days or less yield (kg) 1,894±44.
All lactation 305 days or less yield (kg) 2,183±136.

Figure 7. Murrah buffalo cow, Buffalo Research Institute, Hisar, India. (Borghese photo, 2010)

All lactation total yield (kg) 2,226±152.
All lactation length (days) 305±16.
Average fat (percent) 6.70.
Average dry period (days) 144±26.
Service period (days) 146±27.
Calving interval (days) 479±33.

It is possible to find Murrah breed in many countries. In Bulgaria the only breed is Bulgarian Murrah, coming from crossbreeding of Indian Murrah on local Mediterranean breed. From Bulgaria many animals were exported in close countries as Romania and Germany and in far countries as Brazil and Venezuela.

Murrah buffaloes were exported in Sumatra (figure 8) to increase the availability of milk, as the local breeds are Swamp with low production; the same for many Asian countries where the original population is Swamp type.

Murrah buffaloes were exported from India in Brazil too, even if they are managed exclusively on pasture and used to produce calves, according the

Figure 8. Murrah buffalo, Sumatra, Indonesia (Borghese photo, 2008)

model "cow-calf line", for meat purposes, that it is not logic considering that Murrah was selected as a dairy breed. In figure 9 there is a farm on Amazonas, Parà, with a Murrah herd, not used for milk production but only for meat.

Figure 9. Murrah buffalo herd, Amazonia, Brasil. (Borghese photo, 2011)

2.3. Nili-Ravi

Nili and Ravi are the names of two famous rivers in Punjab Region and were also two different breeds until 1950, but after this period it was difficult to distinguish between the two breeds, probably due to an overlapping selection criteria of breeders even if some farmers are following to maintain pure Ravi breed. Thus, the common name Nili-Ravi became popular. It is the most important livestock in Pakistan. It is also present in India and in the Punjab.

This breed is similar to the Murrah in almost all characteristics except for the white markings on extremities and walled eyes; horns are less curled than in the Murrah; the udder is well shaped and extends well forward up to the naval flaps. Height at withers of adult male is 135 cm, body weight is 700 kg, height at withers of adult female is 125 cm, body weight is 600 kg. The skin colour is generally black but there are albino animals, brown, spotted and with clear eyes (figure 12). The major proportion is in Punjab (65%) with more than 10 million head.

The genetic improvement is promoted by the Semen Production Unit in Qadirabad (figure 10), where progeny test and semen collection are carried out, for artificial insemination in the country, while the Buffalo Research Institute in Pattoki (figure 11) promotes applied researches in many fields, particularly on milk production, as Nili-Ravi is the best dairy buffalo breed in Asia, selected for this purpose.

The milk yield is however depending from the buffalo farming system, with 1,130 kg per lactation in rural farms, 2880 kg per lactation in peri-urban and commercial farms until 3,050 kg in rural marked oriented farms (Younas et al., 2009).

Figure 10. Nili-Ravi Bull, Semen Production Unit, Qadirabad District, Sahiwal (Borghese photo 2010)

Figure 11. Nili-Ravi Buffalo Cow in Buffalo Research Institute, Pattoki (Borghese photo 2010)

Figure 12. Nili-Ravi Buffalo Cow, low pigmented in Punjab, (Borghese photo 2010)

The milk is used for direct consumption after the skimming to produce butter, ghee and cream, used too in sweet industry.

3. Buffalo food and market

3.1. Milk products and market

The largest proportion of the buffalo population in Italy is localized in Provinces of Caserta and Salerno (Campania Region), and the next localities for size of population are the Provinces of Frosinone and Latina (Lazio region), which are in the Denomination of Protected Origin (D.O.P.) area.

The hygienic control of the milk and milk products in the industry is of a particularly high standard.

The market is mainly based on mozzarella cheese, very famous one, not only for the local consumption according the traditional Italian cooking style, but also in many foreign countries.

There are different types of mozzarella, the best one is produced in D.O.P. area (figure 14) according the regulations: it is hand made by raw buffalo milk, soft, juicy and tasty, rich of live ferments, natural yeasts and microbes, it is coming from a difficult processing schedule, particularly for stretching phase (figure 13), it changes taste during time, not preserving in fridge but in mozzarella water and the shelf life is about 5 days. The industrial mozzarella, even if produced in D.O.P. area according the regulations, is made by machines and microbes die during pasteurization, with the advantage of a longer shelf life, preserving in fridge (until more than 2 weeks) but the material is too compact and the taste is hard and anonymous; this product is distributed in supermarket and for export.

Figure 13. Milk processing and mozzarella production

Figure 14. Typical Italian Mozzarella di Bufala Campana DOP "Aversana type"

After that there is a lot of false mozzarella, produced by mixing buffalo and cow milk or out of D.O.P. regulations. The basic price of mozzarella at cheese industry is 10 euro/kg, with a good profit, utilizing 4 litres of milk/kg mozzarella and starting from the milk price as 1.20 €/litre that is more than 3 times the price of cattle milk. The price in the shop increases as more as the quality of mozzarella and the distance from the site of production until 20-30 €/kg. The market is richer in Campania and Lazio Regions, where is easy to find shop with a lot of products coming from milk and meat industry. The mozzarella D.O.P. consumption is about 82% for the Italian market, 18% for the export, particularly for Germany (20% of the export), France (20%), USA (18%), U.K. (12%) (Borghese, 2005, 2010).

In the year 2010, 36000 tons of mozzarella were produced, with an increase of 12.5% respect to the 2009, with a sales volume of € 300 million at the production, € 500 million at the consumption (Borghese, 2011). In the year 2011, 37000 tons of mozzarella were produced (320 million €), in the first 6 months of 2012, 18203 tons were produced.

Another very appreciated product is the ricotta (figure 15), that is not really cheese because it is produced boiling the serum proteins remaining after the produced curd.

Very appreciated and common products are: mozzarella, treccia, scamorza, crescenza, robiola, caciocavallo and other cheeses, ricotta, yogurt.

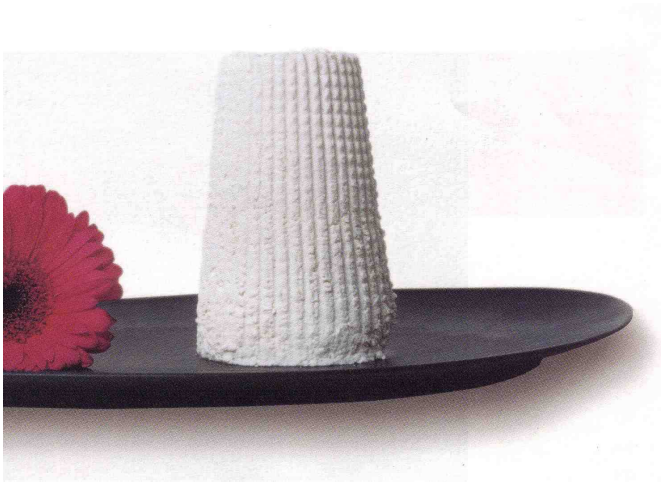

Figure 15. Typical Italian ricotta

Finally Italy is a reference point as buffalo importance in human food sustainability for high quality products.

In Germany there are now 2,111 buffaloes, in 14 different Regions, but particularly in Sachsen (434), in Baden-Wurttemberg (389) and in Brandenburg (287) (Borghese, 2010). The Germany is an example of adaptation capacity of buffaloes to cold climates; they can stay on the snow without problem. The population had a quick increasing linked to a rich market of high quality products, coming from milk and meat processing as mozzarella and other cheeses, cream, yogurt, sausages, meat boxes, and also beauty products (figure 16).

Figure 16. Typical buffalo products from Germany

Germany is another example of a new and rich market, invented by the buffalo farmers.

In Bulgaria high quality yogurt is produced as typical product.

In other European countries the milk is used for direct consumption after de-fattening or low quality products are produced, as in Macedonia, where only simple cheese are found (figure 17).

Buffalo livestock in India plays a crucial role to supply the requirement of animal protein for millions of people: buffalo supplies milk, meat, leather, bones, pharmaceuticals, dung and manure besides draft

Figure 17. Simple cheese in Mojanci village, Kocani, Macedonia. (Borghese photo, 2008)

energy power. Buffalo population is almost 66% of the cattle population in India: 97 million compare to 146 respectively, but the milk produced by buffalo is 58 million tons, as only 47 million tons by cattle. These figures show the great superiority of buffalo in production ability (Madan, 2010) as buffaloes contribute 55% of total milk produced in the country, though their number is only 40% of the total bovine bubaline population. India buffalo population with 97 million animals represents 53.3 percent of the world buffalo population. India is the first country in the world for number of buffaloes and milk production (about 105 million tons, buffalo plus bovine, that is about the 15% of the world's milk production).

India is also the first country in Asia for scientific and technological development in buffalo nutrition, production, reproduction, biotechnologies and genetic improvement. Moreover India has implemented national programs such as the "green revolution" (to increase crop production for animals), the "white revolution" (to increase milk productivity and satisfy human needs for proteins) and finally the "red revolution" (to increase meat production and strengthen the meat industry), particularly with regard to buffalo.

India posse the best River milk breeds of Asia as Nili-Ravi, Surti, Jaffarabadi and particularly Murrah (figures 6, 7 , 8, 9) that is the most diffuse breed in the world, from South America to Asia, all are originated from the north-western states and have high potential for milk and fat production, besides being used for work and surplus stock used for meat production (Sethi, 2003).

The most quantity of milk is used for direct consumption after skimming, fat is used to produce butter, ghee and the cream. Dry milk, condensed milk, milk replacers are very used in national market and for export, as different industrial utilizations (figure 18).

The National Dairy Research Institute formulated different foods, as whey-based lassi and flavoured drink, weaning foods based on whey/skin milk, soy butter milk softy, malted milk food, whey based soups and low fat spreads. New functional dairy products such as probiotic cheese and dahi, sport drinks, low cholesterol ghee, ice cream, burfi for diabetics, health food for cardio vascular people have also been developed (NDRI, 2009).

Figure 18. Milk processed food (National Dairy Research Institute, 2010).

Industry equipment and bio-preservative formulation for enhancing the shelf life of paneer have also been developed. Paneer is a cottage cheese, used in several vegetarian curry dishes in India and in other countries.

Therefore India is a great potential producer of animal protein and food availability for human needs, involving many East Asian countries importing milk and meat, according to the Buffalo improvement program in India as reported by Sethi (2010).

Buffalo population in Pakistan is about 30 million head, the second in the world, after India. The major proportion of buffalo (65%) is inhabited in Punjab, followed by (27%) in Sindh, (7%) in NWFP, (1%) in Balochistan. Buffalo breeds are River types Kundi and Nili-Ravi (figures 10,11,12) and among the best milk producers of the world. The population increase was very fast, comparing with 22 million head reported by Borghese (2005) and comparing too with many Asian countries where the population has decreasing pictures because of low milk production due to Swamp breeds predominance.

Total milk production is 43.6 million tons of which 62% derives from buffalo (Anonimous, 2009) with 27 million tons, therefore buffalo role in milk production system and in food availability in Pakistan is very important. The demand for milk and milk products are constantly rising, mainly because of increasing urbanization.

The milk is used priority for direct consumption after skimmed. The fat is a richness as it is used to produce butter, ghee for cooking, cream, sweet (figure 19).

The skin is used in leather industry (figure 20) and the manure is the primary source of fuel in the villages (figure 21) and it is used too as bio-fertilizer.

Figure 19. Food products from milk (UVAS, Lahore, 2009)

Indonesia has a buffalo population of about 2 million head in 2010. There was a declining trend as in 1985 the total population of buffalo was 3,285 thousand (Borghese, 2005). There are varieties of Swamp breeds in the different isles of Indonesia with divergence in size, weight, color, marking and horn dimensions.

Most of rural buffaloes maintained by families in the villages produce less than 1000 kg of milk per lactation; sometimes the milk is suckled by calves and the buffalo cows are not milked absolutely.

The Swamp buffalo is generally considered to be a working animal, but it also has a considerable capacity for milk production. Swamp buffalo are used for draught power in most areas and for beef in the Java lowland areas and the Sumatra uplands.

Figure 20. Leather products from skin (UVAS, Lahore, 2009)

Figure 21. Fuel from manure in the villages (UVAS, Lahore, 2009)

Spotted buffaloes are highly prized (and therefore they command high prices) to be sacrificed and consumed on special occasions such as marriage or obsequies ceremonies (figure 22).

Figure. 22. Indonesian Spotted Buffalo.

Generally milk production not yet been marketed widely but is only processed in the form of sagon puan, buffalo oil, sugar puan curdle and penjem.

1. Sagon Puan

It is a product obtained mixing 4 litres of fresh milk, 16 egg yolk item (duck, rate chicken, chicken buras) and added by 1 sugar Singk, the mixture swirled flatten is later; then heated until 4-5 hours is at the same time swirled tilt run dry to form the smooth item, if its items have flattened hence the process of sagon puan have, the endurance sagon is about 6 month (figure 23).

Figure 23. Sagon Puan;

2. Sugar Puan

Five milk litro mixed with by 1 sugar singk swirled flatten, is later; then filtered and is afterwards cooked/beat until the dough jell with the colour turn into yellowish.

3. Buffalo Oil

Fresh Milk precipitated by during 5-6 hours, its tabletop in taking and in precipitated during 2-3 day. Water then its tabletop is again cooked/beat until brass colour filtered and filtered for the dissociation of colour yellow with chocolate as its dregs

4. Curdle

One mixed with by fresh milk litre one matured water tablespoon is later then swirled flatten the homogen precipitated during 24 hours until the curd formed and for the making of next curd hence in the place of matured water can be used by a itself whey.

5. Penjem

Semi litre irrigate the mixed with by fresh milk of tape water (soft rice, cassava) as much 3-5 tablespoon and pack into the mug is at the same time swirled to by flatten is later then precipitated by during 2-3 hours, penjem of ready for consumed (Borghese and Sodikin, 2008).

In West Sumatra (Padang is the Capital City) the calves suckle milk from the mothers that, after calve suckling, are hand milked (figure 24); afterwards the milk is put in bamboo-cane (figure 25), where it is naturally

Figure 24. Buffalo hand-milking

acidified and fermented for 2 days. It is a particular product, named dadiah (figure 26), rich of probiotics, similar as taste to kefir or to yogurt but it is really a fresh cheese cream, rich of fat and protein. It is possible to conserve dadiah for 8 days and to distribute and sell it in many lands of Sumatra at the price of 7,000 rupias/piece. When people like to eat dadiah, they cut the bamboo-can (figure 27) and take it with a spoon to eat directly or with cereals, wheat, dried gluten rice or rice (figure 28, Borghese and Sodikin, 2008).

Figure 25. Milk putting in bamboo-cane

Figure 26. Dadiah

Figure 27. Dadiah cutting

very long history in Azerbaijan. Is has always been a traditional industrial sector. Prof A. Agabeyli (1939-

Figure 28. Dadiah with dried gluten rice

1980) founded a buffalo breeding research centre that was in instrumental in creating a new Caucasian breed of buffalo (Farajev and Bashirov, 2002).

The Ital Fromage industry was found and produces very appreciated cheese particularly mozzarella with advanced techniques and modern machines (figure 29).

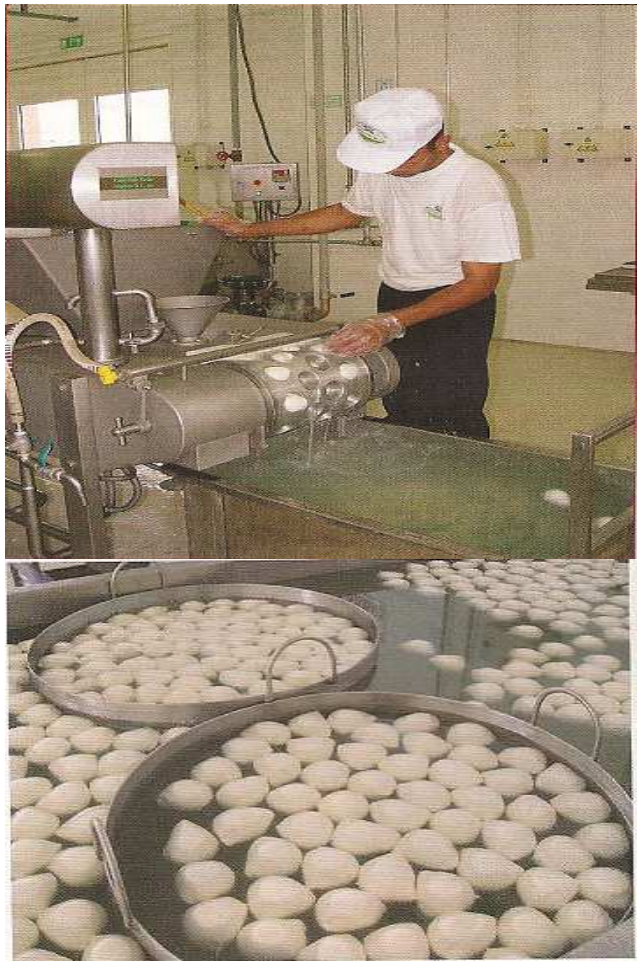

Figure 29. Mozzarella production in Ital Fromage industry (Borghese photo, 2003).

Now mozzarella cheese is produced in the

capital Baku and it is possible to find it in the five stars Hotels, together with the red sturgeon caviar as a luxurious food. This is an example of a local rich market. Other products are butter, sour cream, kaymak (which is an ethnic product similar to sour cream), yogurt, cottage cheese and ayran (a drink with yogurt), used in Turkey too.

In American countries the buffalo livestock was imported to produce work in sugar cane plantations and after to produce meat in large pasture fields, particularly flood areas where cattle cannot survive; now, according consumer demand, selected buffalo dairy cows have been created to produce milk for processing as in Italy; mozzarella and other cheese are very appreciated.

Brazil imported Murrah and Mediterranean Italian semen for this purpose and many farms created cheese industry and a vivacious market.

In Argentina the Salamandra farm, 70 km from Buenos Aires, developed a semi-intensive system with feeding-stuff integration for milk purpose; the milk is processed to produce mozzarella with the same name of the farm, milk sweet and ice cream (Zava, 2011).

Since the late 1970s the use of Trinidad water buffaloes for meat as well as for milk production has been encouraged, not only in Trinidad but also throughout the Caribbean. In order to achieve this objective, the Ministry of Agriculture established a small milking herd at the Aripo Livestock Station during the early 1990s.

Today Buffalypso is considered as a dual purpose breed (milk and meat) and the population is 5,700 head (Rastogi, 2011) with a milk production of 611 kg in 191 days of lactation.

Different milk products are available in the market: yogurt, butter, ghee, mozzarella, queso blanco, soft cheese (figure 30), dahi (figure 30) and paneer (cottage cheese), very used in Indian vegetarian dishes.

Figure 30. soft cheese and dahi. (Rastogi photo, 2004)

3.2. Meat products and market

The buffalo meat market is developing in Italy and in some countries of Europe, as Germany, where the breeding of the male buffaloes for meat production is increasing. So, buffaloes are actually reared under favourable environmental and food conditions and its aptitude to meat producing is more and more accepted, recognized and appreciated, as the carcass and meat quality are going according to market requirements. The Italian production occupies more than 90% of the total production in European Organization. The buffalo meat is quite popular in some South American countries as Argentina, Brazil, Venezuela, Colombia and in some Mediterranean areas, including Egypt, Bulgaria, Turkey and Iran. Anyway statistical data on its consumption are not very reliable, because in some countries, such as in Argentina, is sold as beef. In the Arab areas this meat is usually sold in the markets, accounting for 4-5% of total meat sold, while in Eastern Europe the incidence is around 2%.

So, buffalo meat could represent a considerable economic and nutritional source in all those countries where it is used only for the milk production, which is why it is necessary to study methods for buffalo meat production and buffalo meat quality improvement.

Many studies are being conducted on methods of breeding, to achieve maximum body development and the best ratio between meat and fat content. Some trials compared cattle and buffalo (Borghese et al., 1982, Romita et al., 1982, Abdallah et al., 1982, Failla et al 1997), on the base of their production and highlighted a good aptitude of buffalo to produce meat that was similar to Friesian bulls (Gigli et al., 1993). The first quality parameter which is taken into account for estimating the aptitude to the production of meat is the evaluation of the conformation and fatness of the carcass according to the SEUROP system. The characteristics of the carcass are influenced obviously by the level of nutrition as well as by the age, even if the fat is deposited primarily as visceral fat and subcutaneous fat, that are easily separable. Now in Italy the meat market is rapidly increasing: there are some fattening centres for the production of excellent buffalo carcasses.

Calve carcasses are appreciated for clear and tender meat but normally the live weight at slaughter is 400-440 kg obtained at 15-16 months of age with 800-1000 g/d of daily gain, managed on slatted floor to avoid bad smell of urine and faeces: young bulls without defect or pathologies, beautiful carcasses with conformation R (good), medium fattening (figures 31, 32) according Italian market requirements are obtained, 52% dressing percentage, 57% net dressing percentage, 62% meat on carcass, meat with low fat (less than 3%), very clear, tender and juicy, with good dietetic qualities: <50mg cholesterol /100 g, unsaturated fatty acid/saturated fatty acid >1, iron >1.5mg/100g.

The first quality cuts are well represented with good muscular growth and are sold at 14-25 €/kg for

Figure 31. Carcass of young bull with conformation R and fatness 2+ .

Figure 32. Rump of young bull with conformation R and fatness 2+ .

typical restaurants and many products, as bresaola, salami, cacciatorini are sold in typical shop together with buffalo cheese (figure 33), as meat also obtained I.G.P. (Indication Geographic Protected) "Carne di Bufalo Campana".

Very appreciated and common products are:

"Naples" salami.

We prepared three different salami types. Two of them being composed of buffalo meat only, and the other containing about 5 % of pork meat. Salami were made according to "Naples" handcrafted methods. Salami were regular and attractive shaped and had a normal and smooth covering of mold. The texture of salami resulted quite soft although slightly higher in the mixed pork one. When cut, the lean was rich red colored, but a bit darker in those containing only buffalo meat. Anyway all three types appeared slightly darker than the regular salami of pork. The mixed meat salami presented a white and shiny fat while the fat of full buffalo salami was ivory and opaque. Slices were dry and enough homogeneous

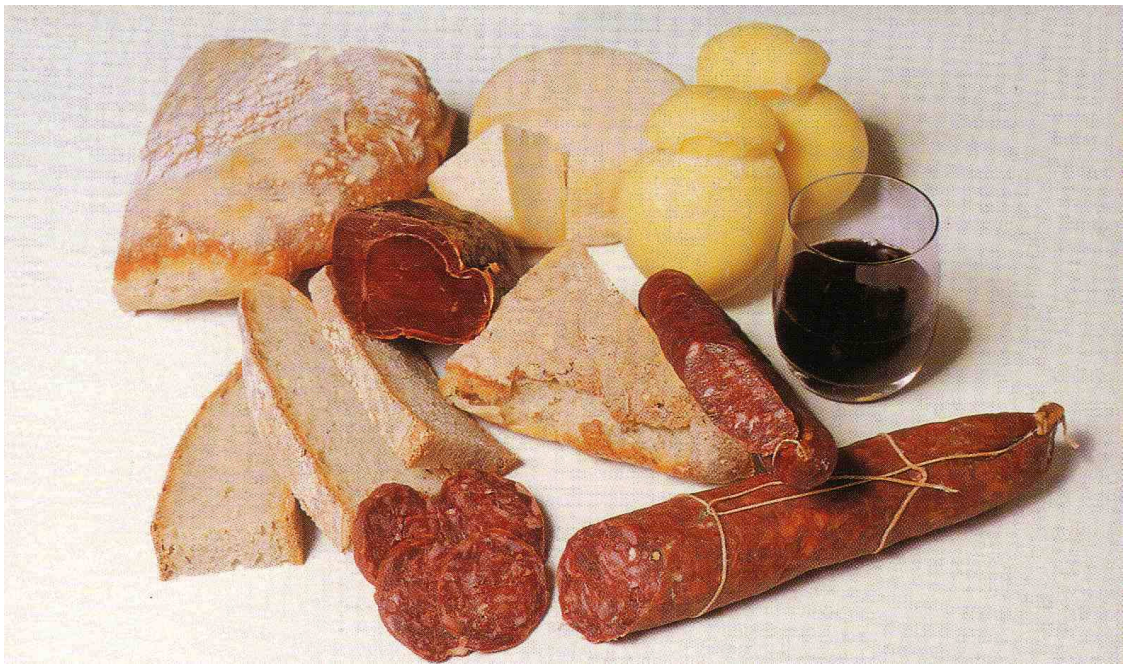

Figure 33. Scamorze, bresaola and salami from buffalo.

both for manual and mechanical cutting, for all three salami types.

Buffalo Bresaola

Delicate dry salt meat obtained from first quality thigh cuts with a soft flavour resulting from the special salting and the long ripening, obtained by 100 % buffalo meat, salt, pepper and natural flavoring.

Spicy buffalo sausage

Hooked spicy sausage wrapped in natural gut. Ripening lasts at least 30 days, obtained by 85 % buffalo meat, 15 % pig lardon, salt, pepper, spices and natural flavouring

Salame schiacciata di bufalo

Flat buffalo sausage (schiacciata di Paestum)

Middle grain flat sausage with lardon core wrapped in natural gut. Light and pleasant taste. In this salame the pig lardon is only about 10%.

Buffalo meat production is comparatively new area of buffalo production in Asia too, as social taboos are not attached to the buffalo slaughter unlike bovine and swine. India produces 1.5 million tons of buffalo meat (FAO, 2008) which is the 36% of the total meat produced in the country, India mainly being a dairy country, a tremendous export potential lies with buffalo meat. Annual per capita consumption of both beef and broiler meat is 1.5 kg, compared with 745 grams for lamb meat: the current retail price of beef averages USD 1.4 per kg, compared with 1.8 for poultry meat and 2.9 for lamb (Kumar and Singh, 2010).

Dressing percentage in such animals is low and varies between 40 to 45 % with average carcass weight as low as 138 kg (Sethi, 2009). However, dressing percentage can be substantially increased by proper feeding (55-60%), as growth rate can achieve 1000 g/day, as reported under feed lot systems (Ranjhan, 2007). In experimental trials, daily body weight gain up to 541 g has been achieved under conventional concentrate feeding system.

Today there is great enthusiasm about buffalo in America, particularly among buffalo breeders and livestock associations as buffalo is considered very important for the economy as beef producer. Buffalo numbers have significantly increased and it is felt that breeding policies have led to an all-round improvement in quality, as can be seen from Table 2.

One of the characteristics that makes buffalo so widely used in these countries is their extraordinary ability to convert fiber into energy. Research trials indicate the superiority of the buffalo in food conversion and in the use of tropical forage and agricultural by-products. Therefore, it is emphasized that the buffalo does not compete with humans, for it does not necessarily use the main production from the crops. It is also an efficient tool in the recycling of nutrients in integrated production (Borghese, 2005).

Other important characteristics of the buffalo are their rusticity, their ability to adapt to different climates and their high fertility rates, always superior to those of bovines. Buffalo breeding is a synonym for low production costs and high levels of

Table 2. The buffalo population in America (Borghese, 2012)

COUNTRY	POPULATION
Argentina	100 000
Bolivia	10 000
Brazil	3 500 000
Colombia	150 000
Cuba	67 300
Ecuador	1 300
Paraguay	10 000
Peru	1 000
Venezuela	350 000
Trinidad and Tobago	5 700
Costa Rica	4 500
Mexico	10 000
USA	6 000
Canada	1 000
Guatemala, Panama, Belize	10 000
TOTALE	**4 227 000**

productivity (Rocha Loures, 2001).

In Argentina, as in the other South America countries with hot and humid climates (Zava, 2010) buffaloes are reared on an extensive system, on natural grasses, on poor pasture on low fertile land, together with bovine herds, on farms with an area of between 750 and 2 000 hectares with about one head/two hectares. Under these conditions the weight gain of buffalo is better than cattle: 700 g/day from birth to weaning, 500g after. The live weight is 500-550 kg at 27-30 months (cattle requires 48 months), the dressing percentage is 50-55%, the meat is of excellent color and tenderness (Zava, 2005). The production per hectare is 60 kg live weight for buffalo, while is only 40 kg live weight for cattle. Buffalo beef is sold at the same price than cattle beef, but recently buffalo beef has started to be sold differentiated as it is appreciated in high quality restaurants in the city of Buenos Aires.

The problems in Argentina are: use of low-level technologies, inadequate sanitary conditions, low quality products and insufficient productivity (Vargas, 2004). Now developed technologies have been introduced also in extensive systems, applying sanitary plans with vaccination against mouth and foot disease, brucellosis, carbonchio, gangrene and with treatments against parassithosis.

The meat export is very important for Argentina economy to introduce money from many countries of Europe, particularly Germany, USA and Canada.

The policy actually in Cuba is to substitute the Swamp buffalo (bufalo de Pantano) with the Buffalypso (bufalo de Rio) by crossing. The buffalo population in Cuba is represented by 67 246 head (Mitat, 2011), the breed is named Cuban Buffalypso, as the more evident characteristics are of this breed, even if the variability is very high, with albino animals too (figure 34). This breed was used before only as draught animal for drawing carriages and for working in the sugar cane fields. The meat production is about 3000 tons/year, slaughtering the males at 364 kg live weight, the weight is 148 kg at 8 months, 192 kg at 12 months.

Figure 34. Buffalypso herd with albino animal. Livestock Company "El Cangre", Cuba (Borghese photo, 2011)

In the 6th Symposium of Americas and Europe, held in Havana, Cuba, on November 21-30 2011, the Ministry of Agriculture declared the Government proposal to develop Cuban Buffalypso to increase the milk and meat production, as people need food rich of protein, as Buffalypso is able to utilize the pasture of internal land of the isle and the byproducts coming from sugar cane cultivations. For this purpose, artificial insemination has been applied with Mediterranean Italian semen, using too the semen of champion Millennium (figure 35) on Buffalypso herd.

Figure 35. Crossbred Millenium (Mediterranean Italian breed) x Buffalypso. Livestock Company "El Cangre" (Borghese photo, 2011).

4. Productive, reproductive and sanitary requirements for the buffalo esport

During the last decade, in Italy buffalo breeding has shown steady growth trend. The quality performance of the Italian Mediterranean buffalo is also significantly improved thanks to a careful selection plan aimed to obtain a highly specialized morphotype for milk prouction to meet the demand for exporting to both EU and non-EU countries.

The greatest demand comes from countries with specialization in buffalo milk production. The farmers of these countries have realized that the breeds of water buffalo (swamp) grown in their territories, the current state of genetic selection, fail to produce a significant quantity of milk. They agreed, therefore, that the current genetic levels achieved by these breeds need to be overcome by introducing new genetic lines of higher milk production capacity.

And all this must be done quickly to create milk markets corresponding to the human requirements. Obviously, the best results can be obtained introducing in these countries the Mediterranean Italian Buffalo Breed that is the most advanced and productive: therefore the Mediterranean Italian Breed is used in many countries to apply cross breeding to enhance and improve the milk production of indigenous breeds and lastly, in Philippines, 2,200 Mediterranean Italian Buffaloes were introduced to start an experience of dairy purpose buffalo breed.

To export live animals for breeding, it is necessary to select them to ensure high morphological and functional parameters, excellent milk production, high genetic and health standards. Furthermore, they should be selected mainly from farms enrolled in the Herd Book of the Mediterranean Italian Buffalo Breed.

The criteria to select the proper animals necessarily take into account parameters that:

a) ensure productive and reproductive performance;
b) guarantee sanitary status regarding specific infectious diseases from which the buffaloes are susceptible.

a)

In order to accomplish the first point, genetic lines of animals belonging to the progeny of good size, height and weight, robust constitution, with proper morphology, early in the growth and productivity, prolific and long-lived, with ability to produce milk with appropriate percentace of protein and fat, who have achieved at least 2,500 liters of milk per lactation are selected. However, the animals must have obtained at least a good judgment, which is equivalent to a minimum score of 75 established according to the parameters of linear score and morphological evaluation under Regulation genetic selection of the Herd Book of the Breed.

Moreover, young animals are favorite, especially aged between 12 and 20 months, maximum 24 months, not pregnant to prevent transport's stressors which can have negative affects to the state of pregnancy.

b) As for the second point, to ensure a good health status of the animals, we have defined a protocol check for some specific infections that can cause infectious diseases for which the buffaloes are susceptible.

The animals to be exported must have a sanitary status that meets the stringent health criteria demanded by European regulations to allow the moviments within the EU. But in addition to the General Agreement on Tariffs and Trade (WTO) provides also that the governments of the importing countries may adopt, through an international protocol known as the SPS Agreement, broader control's measures to import in order to protect humans, animals and plants health, according to the specificity of their countries. However, in these extraordinary measures, a form of trade protectionism mast not been configured.

First, the animals must come from herds officially free from all infectious diseases for which eradicazion and control plans are required (according to the current rules/laws), like brucellosis, tuberculosis and enzootic bovine leukosis.

In addition, animals intended to been exported are also checked for other diseases to ensure health status free, in particular from :

- Blue Tongue by BT-Virus
- Mucosal disease/bovine viral diarrhea by BVD-Virus
- Q fever by *Coxiella burnetii*
- Paratuberculosis by *Mycobacterium avium* sbp *paratuberculosis*
- Schmallemberg by Schmallemberg-Virus

All animals will be checked by serological tests to demonstrate the absence of specific antibodies against these infections immediately after their choice from origins farms.

After serological testing, animals are moved to quarantine stable where they are isolated at least 60 days (quarantine period) from other animals, even of different species, susceptible to diseases for which they have been checked.

Immediately before leaving, all animals are checked a second time with serological and

diagnostic tests to guarantee absence of specific infection BTV, BVDV and Schmallemberg-Virus releted.

The diagnostic panel tests adopted is:

Disease	Test
Brucellosis	RBPT(1) FdC(2)
Leukosis	ELISA(3)
Tuberculosis	IDT(4)
Blue Tongue	ELISA(3) PCR(5)
MD-BVD	ELISA (3) PCR(5)
Schmallemberg	SN(6) PCR(5)
Paratuberculosis	ELISA(3)
Q Fever	ELISA(3)

(1) Rose Bengale Plate Test of agglutination antibody indirect
(2) Fixation/Deviation of complement indirect antibody test
(3) Enzyme linked immuno-sorbent assay antibody test
(4) Intradermo tubercolinic allergic test
(5) Polymerase chair reaction antigenic test
(6) Serum neutralization antibody test

A protocol of choice of the animals to export, which takes into account productive, reproductive and sanitary requirements, is useful to ensure quality levels that have not to limit the free movement of animals between Member States and non-EU countries.

Furthermore, the sanitary guarantees about the animals to be exported reduce the risk of introducing infectious diseases in the countries to which they are destinated.

We are reporting a recent experience of export from Italy to Philippines of 2,200 buffaloes of Mediteranean Italian Breed.

The animals were selected in different farms registered in the National Herd Book.

After that, the animals followed all the protocol of serologic tests in the Laboratories of Serology of the Prophylactic Institute. We obtained negative results in all the tests.

After that the animals were moved to the Centre of quarantine, where, after 60 days, a new complete serologic test, was effected.

Finally the animals were exported to Philippines travelling on boat (figure 36) by the exporter society of Nello Giorgi in Latina, Italy.

Figure 36. Boarding of buffaloes on the boat. (Giorgi photo, 2013)

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