Buffalo Newsletter

Number 19 - June 2003

EUROPE - NEAR EAST

BULLETIN OF THE FAO INTER-REGIONAL COOPERATIVE RESEARCH NETWORK ON BUFFALO

INCLUDES SHORT COMMUNICATIONS, RESEARCH PAPERS, TECHNICAL NOTES, ONGOING RESEARCHES

First research project implemented by the Buffalo Network

AFTER SEVERAL YEARS OF activity, consisting mainly in favouring the increasing of scientific and technical expertise among the scientists of different countries through workshops and exchange of papers, the co-ordination centre of the Buffalo Network is proud to announce that the **first co-operative project** has started and is being successully carried out. Title of the project is *"Improvement of productive and reproductive efficiency of Anatolian buffaloes through the use of artificial insemination with Italian bulls"*.

The Buffalo Network started to discuss the opportunity of implementing a project of this kind during the 1996 meeting of the Coordination Board of the Network, because several member countries asked to be provided with excellent genetic material to improve the productivity of the native buffaloes. During that meeting it was emphasised that: 1. while dairy cows have tremendously improved thanks to the genetics, buffalo is still at the beginning; 2. artificial insemination is fundamental for the genetic improvement system, but the physiology of buffalo makes it difficult and expensive much more than in cattle.
It was decided to ask INTERBULL how to approach the problem. INTERBULL is an international, non-profit organization aiming to globally use animal genetic resources to obtain the largest sustainable genetic progress. INTERBULL promotes the standardization of genetic evaluation systems among countries and, in 1994, it has implemented a truly international routine evaluation of bulls.
The requested INTERBULL expert panel gave an answer during another meeting of the Coordination Board of the Network (1997) making evident that it was too early for thinking of a programme for international exchange of semen and comparison of buffalo genetic merit.
However, each country should prepare itself through implementing the accurate identification of each animal and its own ascendants and accurate performance recording as well.
During a further meeting of the Coordination Board of the Network (1998), it was made evident that only Italy had some semen available to be circulated to other countries, collected from bulls of known genetic merit. At the same time, the representative of Turkey, prof. Ozel Sekerden of the University of Antakya, declared that her country offered a good opportunity for starting a co-operative programme for the following reasons:

• the Turkish government is member of the International Committee for Animal Recording (ICAR) the non-profit organization promoting the standardization of animal recording world-wide;
• prof. Ozel Sekerden has created an experimental buffalo herd near Antakya, belonging to the University, where milk performance recording of buffaloes is applied by her staff with her supervision;
• in the nearby villages (Hatay province) there are several buffalo herds where prof. Sekerden with her group of researchers succeeded in applying animal registration and milk recording;
• artificial insemination had never been performed on buffalo in Turkey; at the

follows page 2 ☞

INSIDE THIS ISSUE

same time, in the province of Hatay there is a group of ready-to-learn veterinarians, and the milk recorded farms were ready to participate to the trial as well.

This first co-operative programme embodies the main items for which the Buffalo Network was established by FAO: training (AI to veterinarian); **research** (progeny test trial); **development** (improvement of buffalo production and reproductive efficiency); **co-operation** (Italian and Turkish scientists work together).

The co-ordinator of the Buffalo Network, A. Borghese, went to Antakya to put the project in force in April 2002, after that the semen of two Italian proven bulls had been purchased, had reached Turkey and had fulfilled the necessary custom procedures. A. Borghese is himself a veterinarian; together with his research group he formulated and adjusted a protocol for the correct timing of estrus induction and insemination in buffaloes *(Livestock Production Science, 68(2001) 283-287. Effect of PRID treatment on conception rate in Mediterranean buffalo heifers).* In fact, estrus induction is necessary in buffalo for the lack of estrus symptoms. The products and drugs to perform estrus synchronisation (the PRID: Progesteron Releasing Intravaginal Device, the prostaglandin and the gonadotropin) were purchased in Italy, with funds that had been provided partly by FAO and partly by the Animal Production Research Institute of Rome. During Borghese's stage in Turkey, 44 buffaloes were submitted to the synchronisation protocol and 3 veterinarians were trained in: a. synchronisation technique, b. pregnancy diagnosis and 3. artificial insemination.
Inseminations were therefore performed by the veterinarians 72 hours and 96 hours after the removal of the intravaginal device. In November 2002, twenty-nine more buffaloes were submitted to the same synchronisation procedure: this time everything was performed without attendance of any Italian technicians.
The details of the trial, as well as the preliminary results, will be presented during the Symposium on *"Recent progress in buffalo reproduction"*, a satellite event of the 54th Meeting of the European Association for Animal Production, that will be held in Rome on August 30th , 2003.
On this occasion, we wanted simply to make the readers aware of the opportunity offered by the the Buffalo Network to become involved in international co-operation projects. We are therefore proud of the obtained result, and thank FAO responsibles who have trusted our activity.

The Editor
Antonio Borghese

The activities of the International Buffalo Federation (IBF)

On August 28th and 29th, the Second Italian Congress on Buffalo Farming will be held at Monterotondo (Rome). The relevant scientific programme was published in the Buffalo newsletter n. 18.

On August 28th, at 6:30 p.m., the European American Scientific Buffalo Association (EASBA) will be established.

On August 30th, after the EAAP Satellite Symposium "Recent Progress in Buffalo Reproduction" (see Buffalo newsletter n. 18 for the scientific programme), in the Congress Palace, Rome, at 4:30 p.m., the IBF Council meeting will take place, with the purpose to define the organization of the 7th World Buffalo Congress, that will be held in Manila, The Philippines, in October 2004.

The IBF General Secretary
Antonio Borghese

DEVELOPMENT OF RUMEN ACTIVITY IN BUFFALO CALVES FED ON MATERNAL MILK OR RECOSTITUTED MILK

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ABSTRACT

Two groups of 6 male buffalo calves were fed on maternal milk (MM) and reconstituted milk (RM); three animals of each group were slaughtered at 60 days; the remaining at 90d.
Rumen anatomical measures were higher in RM than in MM group; moreover total viable and cellulolytic bacteria showed higher values in RM ($RM=5.35*10^{10}$**a** *vs* $MM=1.01*10^{10}$**b** and $RM=162.82*10^{7}$**a** *vs* $MM=0.84*10^{7}$**b** respectively; $P\leq0.05$) in accord with cellulolytic and amylasic activities (RM=67.71**a** *vs* MM=38.29**b**, $P\leq0.05$, and RM=32.76**A** *vs* MM=17.60**B**, $P\leq0.01$, respectively). The rumen of RM group was more developed and fluid activities resulted closer to that of adult animals than MM group.

INTRODUCTION

Buffalo calf breeding in the early days of life and raising up to weaning are of great importance for a correct management of dairy farm at least as they have a noticeable weight in the farm budget. In Italy whole buffalo milk production is practically destined to cheese making: milk prices are quite high and so milk is not destined to calves at all. New-born calves are separated from their mothers at birth or after few hours and usually are fed on reconstituted milks. In this context right breeding and weaning modalities become essential to avoid serious sanitary and "economic" consequences. Following some authors buffalo calf weaning age is about 2.5- 3 months and the only suckling period lasts 40-45 days *(Arora, 1988; Esposito & Di Palo, 1997; Tripaldi & al., 2001)*; moreover weaning must occur when the calves reach about 75 kg of live weight independently from the age *(Esposito & Di Palo, 1997)* while other experimental data suggested higher average weaning weights *(Tripaldi & al., 2001)*. It is also well-known that weaning age of bovine calves is lower. At present the reasons about this different behaviour between the two species and the performances of the buffalo calves fed on maternal milk are scarcely known.
This trial was part of a wider experimental design which had the aim to contribute to the knowledge of behaviour, growth, physiology and sanitary problems of buffalo calves fed on different milks during the suckling and weaning periods. In this paper we tried to compare rumen anatomical measures, fluid microflora content and enzyme activity of buffalo calves fed on maternal and on reconstituted milks and to link the possible differences to performance results *(Roncoroni & al., 2001; Tripaldi & al., 2001)*.

MATERIAL AND METHODS

The trial was performed on two groups of 6 male buffalo calves (average birth weight = 44.13 kg ± 5.8) fed respectively, after colostrum administration, on maternal milk (MM) and reconstituted milk (RM) at 18% (milk powder + wheat flour formulated for buffalo calves); milk chemical composition is reported in **Table 1**. Milks were offered at

follows page 4 ☞

Table 1. Chemical composition of maternal milk (MM) and reconstituted milk (RM), % on dry matter.

	CRUDE PROTEIN	CRUDE FAT	ASH	CELLULOSE	kcal/kg
MM	4.6	7.9	1.0	--	1188.8
RM	4.5	4.2	1.3	0.09	962.0

30°C twice a day; milk ingestion grew up to 10 litres at the 7th to diminish at 2 litres at the 12th week *(Roncoroni & al., 2001)*. The animals were kept in single boxes for one month and then transferred into collective pens where water, lucerne hay (CP = 13.8%) and concentrate (CP = 17.0%) were offered *ad libitum (Roncoroni & al., 2001; Tripaldi & al., 2001)*.
Three animals of each group were weighted, after 12 hours of fasting, and slaughtered at 60 days of age; the remaining six at 90 days. Weights of whole rumen-reticulum, stomach (abomasum + omasum) and enteric fat were recorded; rumen volumes were measured by recording the water displacement after the total immersion of the organ. Whole rumen content was then recovered and subdivided into samples for the different determinations.
Total viable, cellulolytic and xylanolytic bacteria, fungi and protozoa were determined on samples of whole rumen content. The total bacteria and xylanolytic bacteria were grown on Petri dishes on Leedle and Hespell solid media *(1982)* and counted after incubation at 39°C for 5 days. The cellulolytic bacteria were grown on Hungate liquid medium *(Ogimoto & Imai, 1981)*, fungi on Joblin medium (1981) and counted after incubation at 39°C for 15 days by the MPN procedure. The protozoa number was determined by a light microscope *(Warner, 1962)*. The microbiological tests were all performed in an anaerobic glove box (CO_2 95% + H_2 5%).
Immediately after recovering, part of rumen content was filtered on a cheese cloth, in order to remove rough food residues. Cellulase activity was determined by incubating anaerobically at 39°C 0.5 g of cellulose (purified Watman paper) in rumen liquor plus Mc Dougall buffer (pH =6.9, ratio10:40-ml) for 6,12, 24, 30, 48 and 72 h according to Tilley and Terry (1963). Cellulolytic activity was calculated as percentage of digested substrate for each incubation time.
The amylase activity was determined, on filtered and centrifuged (25000 x g) rumen fluid by incubating 0.8ml of fluid + 0.1ml of phosphate buffer (pH 6.9) for 10' at 38°C with a substrate of soluble starch (0.1ml of 1% solution). The amylase activity was calculated by determining, spectrophotometrically at 620nm, the disappearance of substrate after the reaction with iodine/iodide solution *(Pace & et al., 1989)* and was expressed in Enzymatic Units/ml of rumen fluid (1 EU = amount of enzyme which digests 50% of the substrate in 10').
Data were treated with variance analysis and means were compared with the **t** Student test.

RESULTS AND DISCUSSION

Average slaughtering weights (MM 60= 89,5 ±. 8,84; MM 90= 115,0 ±. 18,3 *vs* RM 60= 74,5 ± 0,50; RM 90= 115,0 ± 13,75) resulted similar without significant differences between the two feeding groups; the slight difference in favour of MM group was explained by its higher average daily gain all over the trial period *(MM= 0.945 kg ± 0.238 vs RM= 0.678 kg ± 0.145; $P \leq 0.05$; Roncoroni & al., 2001)*.
Buffalo rumen anatomical development, from 60 to 90 days of age, was of about 26 to 31% **(Table 2)**, internal rumen volume increased even of over the 56%. Generally, for the anatomical measures **(Table 2)**, RM group values resulted higher than those of MM group, moreover, for the rumen volume and for the weights of the stomachs (omasum + abomasum) the differences were statistically significant ($P \leq 0.05$) with the exception of the fat deposition around the stomachs which was significant higher in MM animals (MM= 0.54 kg ± 0.07 *vs* RM= 0.45 kg ± 0.15; $P \leq 0.05$); in an other trial the authors observed that fat deposition resulted quite similar (≅ 0.6 kg) when buffaloes, fed on the two milk types, were slaughtered at six months of age *(Failla et al., 2001)*. It could be noticed, between MM and RM group at 90d, a significant interaction in the ventral sac measures (MM 90 = 34.00 kg ± 1.41 *vs* RM 90 = 36.33 kg ± 0.75; $P < 0.05$).
Reticular groove diameters had similar average dimensions (1.72 cm) in all the rumens examined, therefore in MM group the grooves were slightly larger (MM = 1.84 cm vs RM = 1.61 cm); it was also observed that intestinal *villi* seemed more developed in RM animals at 90 days of age.

follows page 5 ☞

Table 2. Rumen anatomical measures (cm) and external volume (litres), weights of stomachs and fat (kg) in the two groups MM and RM slaughtered at 60 and 90 days of age.

	R Dorsal Sac Lengths	R Ventral Sac Lengths	R Maximum Height	External R. Volume	Weights of Stomach	Fat of Stomachs
MM 60	28.33 ± 3.10 **b**	25.33 ± 2.28 **c**	21.83 ± 2.33 **b**	6.75 ± 0.18 **b**	2.75 ± 1.34 **bc**	0.48 ± 0.17 **b**
MM 90	39.50 ± 3.12 **a**	34.00 ± 1.41 **b**	31.00 ± 6.07 **a**	15.45 ± 4.31 **a**	4.00 ± 0.99 **b**	0.60 ± 0.14 **a**
RM 60	29.66 ± 1.58 **b**	25.66 ± 1.57 **c**	23.33 ± 0.38 **b**	7.87 ± 1.00 **b**	1.98 ± 0.41 **c**	0.29 ± 0.01 **c**
RM 90	38.83 ± 2.54 **a**	36.33 ± 0.75 **a**	34.66 ± 1.39 **a**	18.20 ± 0.84 **a**	7.02 ± 0.95 **a**	0.62 ± 0.16 **a**
MM	33.91 ± 6.76	29.66 ± 5.11	26.41 ± 6.48	11.10 ± 1.03 **b**	3.37 ± 0.25 **b**	0.54 ± 0.07 **a**
RM	34.25 ± 7.45	30.99 ± 6.72	28.99 ± 5.45	13.04 ± 0.57 **a**	4.50 ± 0.51 **a**	0.46 ± 0.15 **b**

Significant differences: **a**, **b** and **c** for $P \leq 0.05$.

Table 3. Dry matter content of rumen fluid (DM, % on weight), total viable bacteria (T B), cellulolytic and xylanolytic bacteria (C B and X B) counts (=n/g dry rumen content) in the two groups MM and RM slaughtered at 60 and 90 days of age (means ± s. d.)

	DM	T B ($*10^{10}$)	C B ($*10^{7}$)	X B ($*10^{6}$)
MM 60	1.81 ± 0.42 **(ab)**	1.53 ± 1.28 **b**	0.27 ± 0.04 **c**	1.41 ± 0.47 **(b)**
MM 90	1.56 ± 0.27 **(b)**	1.01 ± 0.16 **b**	0.84 ± 0.40 **c**	2.16 ± 0.49 **(b)**
RM 60	2.33 ± 0.32 **(a)**	4.63 ± 2.15 **a**	11.67 ± 1.86 **b**	8.68 ± 3.92 **(a)**
RM 90	1.64 ± 0.08 **(b)**	5.35 ± 2.22 **a**	162.82 ± 27.31 **a**	2.05 ± 0.43 **(b)**

Significant differences: **a**, **b** and **c** for $P \leq 0.05$; **(a)**, **(b)** and **(c)** for $P \leq 0.10$.

Total viable and cellulolytic bacteria had higher values in RM rather than in MM group **(Table 3)**. This result was probably due to the composition of the reconstituted milk which contained wheat flour, vitamins and minerals that positively affected the growth of rumen microflora.
Xylanolytic bacteria showed the higher counts in the 2 month RM group in comparison to the 3 month RM group: it seems likely that, because of this period ration was mainly constituted by enriched milk added with small quantity of roughage, there was a favourable environment for the growth of this kind of bacteria in association with amylolytic flora which contemporary produced a noticeable amount of reducing sugars. At 3 months of age the percentage of roughage in the ration increased *(Roncoroni & al., 2001)* and allowed a sharp growth of cellulolytic bacteria **(Table 3** and **4)**.
Buffalo calf rumen samples did not show fungi presence: the counts were completely negative while few and randomly distributed protozoa were present since the age of two months but their number was too low to be considered.

follows page 6 ☞

Table 4. Cellulase activity after 48 and 72 hours of incubation (CA, % digested cellulose) and amylase activity of filtered and centrifuged rumen fluid (Enzyme Units, FEU, CEU) of the two groups, MM and RM, slaughtered at 60 and 90 days of age (means + s. t.).

	CA 48 h	CA 72 h	FEU	CEU
MM 60	29.56 ± 7.79 **a**	31.65 ± 6.97 **b**	18.82 ± 0.06 **c(a)**	2.44 ± 1.82
MM 90	25.78 ± 7.38 **b**	44.93 ± 7.33 **a**	16.40 ± 0.56 **c(b)**	2.08 ± 0.46
RM 60	50.81 ± 28.01 **a**	71.66 ± 24.29 **a**	36.31 ± 2.84 **a**	5.84 ± 3.89
RM 90	50.27 + 18.43 **a**	63.77 ± 25.14 **a**	29.20 ± 1.49 **b**	1.47 ± 0.35
MM	27.67 ± 6.57 **b**	38.29 ± 9.64 **b**	17.60 ± 1.43 **B**	2.26 ± 1.11
RM	50.54 ± 21.21 **a**	67.71 ± 22.53 **a**	32.76 ± 4.39 **A**	3.66 ± 3.44

Significant differences: **A** and **B** for $P \leq 0.01$; **a**, **b** and **c** for $P \leq 0.05$; **(a)**, **(b)** and **(c)** for $P \leq 0.10$.

In the **Table 4** are reported only the percentages of the digested cellulose at 48 and 72 hours, therefore cellulase activity resulted higher in RM than in MM groups from the first times of incubation; the cellulose began really to be attacked after 24 h of incubation *(Settineri & Puppo, 1998)* but values were still very low (RM = 21.05 + 19.38 *vs* MM= 11.12 + 3.83; $P \leq 0.05$), the excessive variability of RM group was essentially due to the rumen fluid of an animal, slaughtered at 60 days, which had a rumen enzyme activity much more developed, since the first hours of incubation, in respect to all the others subjects. After 48 h RM group digested half of the cellulose while MM reached only about the 30%, however, in spite of the high variability, RM administration seemed to enhance microflora proliferation while MM cellulase activity raised with the age of the animals but resulted quite modest. Two subjects of RM group, slaughtered one at two months and one at three, reached respectively, after 72 h, the 94.16% and the 91.90% of degradation, values which are normally found with the rumen fluid of mature animals *(Settineri & al., 1995)*.
Like cellulase activity the rumen fluid amylase activity **(table 4)** was higher in the group which received reconstituted milk (RM) as consequence of the presence of wheat flour in its formulation *(Pace & al., 1994)* but probably, also because of an earlier intake of concentrate and hay by this group *(Roncoroni & al., 2001)*. Values of amylase activity were about 8 to 10 fold greater in filtered rumen fluids than in centrifuged samples, in fact, in the surnatant only small amounts of eso-enzymes are active (mainly amylases) while cellulase activity was not at all detectable *(Pace & al., 1994)*. Amylase activity decreased on three month animals fed on both M and R milks, veritably because of the increase of forage amount in the diet which depressed progressively amylolytic bacteria growth.
At the same age and similar weights, rumen fluid activity of RM animals resulted closer to that of adult animals than maternal milk group.

ACKNOWLEDGEMENTS

This paper has been presented as poster at *"The 1st Buffalo Symposium of Americas"*, Belem (Brazil), 1-8 September, 2002 (407-410).

follows page 7 ☞

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Buffalo paddock at Tor Mancina farm (Rome).

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PATTERN OF REGULATION FOR SANITARY AND FEEDING MANAGEMENT OF BUFFALO HERDS

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Istituto Sperimentale per la Zootecnia, via Salaria, 31 - 00016 - Monterotondo (Roma)

The Consortium of producers for the protection of the cheese *"Mozzarella di Bufala Campana"*, on 10 October 2002, has presented the Pattern of regulation for sanitary and feeding management of buffalo herds for the production of "Mozzarella di Bufala Campana" (cheese of Protected Origin Denomination). The presentation took place during a Meeting at Caserta, in Southern Italy, not far from Naples.

The technical-scientific Committee that has prepared the text of the regulation was chaired by the director of the Consortium, Dr. Vincenzo Oliviero, and was composed of Prof. Vincenzo Proto, Prof. Luigi Zicarelli, Prof. Giuseppe Campanile and Dr. Antonio Di Francia (University of Naples), Dr. Franco Consalvo (veterinarian), Dr. Ernesto Correale (Central Inspectorate of Fraud Repression) as well as of the Authors of the present paper.

We will here describe the regulation, which aims to provide sanitary and feeding rules for the correct management of buffalo herds, so that the qualification of milk used for the production of "Mozzarella di Bufala Campana" is fulfilled.

In the first chapter, the major problems of buffalo breeding are approached and discussed. Buffalo is a species the estrus cycles of which are affected by the period of the year, i.e. their cyclic activity is more intense as the daylight gets shorter. Therefore, spontaneous calvings take place in autumn and winter. When the season of calving is forcedly modified to meet the market demand for milk, the calvings take place in spring and summer; in any case, calvings are concentrated in definite times of the year. Milk quality (fat content, casein content, titrable acidity, numbers of somatic cells) is extremely variable during the year, which creates great problems to mozzarella quality. Such problems get even worse if sanitary standards of milk are poor and/or if the diet is not correct, either for lack of protein or energy, or for lack of hygienic quality.

The second chapter of the pattern of regulation is relevant to the hygienic conditions of the farm. Generally, buffaloes are managed in paddocks where floors are made of concrete. The removal of dung must be performed regularly (every day in rainy weather). If buffaloes are managed on litter, straw should be added every day, to maintain a dry surface and therefore reduce udder infection (mastitis). Litter should not only be dry but also with no moulds; it often occurs that dirty and wet litters produce udder infections. The hygienic quality of milk gets worse (i.e. the bacterial count increases) when the maximum number of heifers calve, usually because of the sudden removal of the milking machine cluster due to kicking and/or during the very rainy days. It is suggested to provide shower or washing tubs in the waiting room of the milking parlour, so that the low part of the body can be washed, which is very important particularly on rainy days. The administration of some concentrates during milking should be avoided because the dust and small particles will favour the development of moulds and yeasts in milk. Yeasts make damages to mozzarella (the so-called swelling or bulge) so that the shelf-life is reduced; on the other hand, moulds, through the production of aflatoxins, are dangerous to humans. The milking area should be composed of four functional zones: waiting room, milking parlour, refrigerated milk room, accessory rooms. It is important to design buildings and materials so that the washing of floors and walls are made easy. The milking parlour should allow to carefully and easily observe the animals, the udder in particularly, and to easily and comfortably perform the milking operations. It is also suggested to build a small pool at the entrance of the milking parlour, to allow the washing of feet with cleaning and disinfectant liquids. The milking parlour should be regularly washed and disinfected. In order to reduce the risk of udder infections and related increase in bacterial count of milk, accurate cleaning of the teats and continuous and complete milking should be performed. The milk-man must wear clean clothes; his hands and arms must also be clean and he should be able to immediately detect any anomalies in the ejected milk from the first sprinkles: in this case, he must separate the bad milk. It is extremely important to wash and disinfect the udder immediately before milking operations.

follows page 9 ☞

The washing must be done with a water gush followed by drying with disposable tissues. The disinfection must be performed by plunging the teats in anti-bacterial liquids or with a disinfectant spray. To reduce bacterial contamination from one animal to the other, it is suggested to plunge the milking machine cluster in disinfectant liquid, then to wash it.
The milking machine must fulfil ISO regulations and must be submitted to a test once a year.
The size of the rubber liners should reflect the size of the teats, they must be intact and their substitution, every four months or according to the suggestions of the producer, must be performed. A constant and correct vacuum level can be obtained by operating 60 cycles every minute. After each milking, the whole milking machine, as well as the containers in which milk has been collected, must be washed and disinfected, first with warm water (35-36° C) in order to remove residual milk, then with a warm (60-65° C) cleaning and disinfectant solution, and finally by rinsing with two washing with clean water for five minutes. All tools and containers that are being used for milking, collecting and transporting milk should be made of smooth materials, easy to wash and to disinfect, resistant to corrosion and they must not give any particle or substances that could damage human health. Immediately after milking, milk has to be filtered and directed into the collection room. This room must be clean and equipped with refrigerating tanks (according to ISO regulation), protected against parasites and kept separate from the livestock.
After milking, if milk is not collected by the dairy plant within two hours, it must be quickly refrigerated at 6-8 °C, in order to maintain quality and avoid bacterial production. Refrigeration must be performed quickly, the temperature of 16° C should be reached in 10 minutes from ejection.
Milk should not be shaken because fat globules can be damaged or broken, causing milk to quickly get rancid. As regards to the bacterial count, it might increase for the following reasons: pollution in the stages between milk ejection and refrigerator, contact with open air, bad-working refrigerators, wet and dirty litters.
To avoid them, be sure that litter is dry and when using loose housing, maintain the optimal number of buffaloes according to the surface.
Somatic cell count (white blood cells and exfoliated skin particles from udder) helps to know if udder is suffering. Recent researches made evident that buffalo milk, in normal conditions, has no more than 300,000 somatic cells/ml.
Somatic cell count might increase for the following reasons: no correct working of the milking machine; mistakes in handling the milking machine in the various stages; bad udder shape for some buffaloes and therefore problems when milking these buffaloes; poor hygienic conditions, too many animals in the paddock cause diffusion of bacteria and infections; non correct feeding system, bad preserved forages (micotoxins, non correct fermentation of silages, etc.). When milk contains antibiotics it cannot be used for human consumption, therefore it cannot be processed into Mozzarella di Bufala Campana.
Whenever either antibiotics or any drug is administered to a lactating animal, residuals in milk are found, whatever way of administration is employed.
The third chapter of the regulation refers to foodstuffs. Feeding system should be correct, therefore appropriate feedstuff of good quality must be available, so that animal health is not endangered, that nutrition requirements are satisfied and that neither bad smells or tastes are transferred to milk. Buffalo diets are based on local forages, in order to preserve the link between the product and the land of origin.
Therefore, in the diet for the lactating buffaloes, the following rule must be followed: 70% at least of the dry matter of forages or 40% at least of total dry matter of the ration, should be provided by local fodder. Forages, either cut and fresh fed, or directly grazed, are highly digestibile and are well appreciated by livestock, provided that they are correctly administered. Fresh cut forages should be eaten before any dangerous fermentation is started (in summer, within 24 hrs. after cutting). Forages should be cut at the optimal time according to the botanic variety: if cut earlier, digestive problems might arise; if cut too late, they are not appreciated by the animals and they are difficult to digest, so that the animals ingest an insufficient amount.
Because not all the amount of produced forages can be fresh consumed, part of them should be correctly preserved in various ways. Making hay is the most traditional and common way to preserve those plants that have a thin stalk; the cut forage is left on the ground until the

follows page 10 ☞

wanted dry matter amount is achieved. Colour depends on the botanic type of the forage as well as on the weather conditions when hay is made; hay should have a nice smell, should be leafy and soft, with neither dust or dirt on it. To preserve forages it is also possible to fastly dry them. Silage, moreover, offers the opportunity to preserve, during the whole year, plants that cannot be made into hay; silage is very appreciated by livestock, and highly digestible, and the losses during preserving are reduces compared to hay. Good silage should: show more or less the same colour as the fresh plant; have a pleasant, slightly sour and not too strong smell; plants should look intact; pH lower than 4.3 for grasses and lower than 4.5 for legumes; ammonia nitrogen lower than 10% of total nitrogen; soluble nitrogen lower than 50% of crude protein; no propionic or butirric acids or traces of them; ethanol lower than 2% of dry matter.
Another system to preserve grass is hay-silage: cut forage is left to dry up in the field until the dry matter content of 35-40% is reached and preserved in silo or wrapped bales: in the second system, dry matter content should reach 50-60% to be sure that the bales are solid during storing.
Production and trade of concentrates is ruled by the national laws. In practice, according to the laws in force, concentrates are divided in two groups: simple grains and mixtures of different materials. All feedstuffs should be healthy, hygienically guaranteed, with no contamination or toxic residuals.
In the fourth chapter the allowed foodstuffs, as well as the forbidden ones, are listed. Feeding is extremely important for influencing milk yield, quality (chemical and physical characteristics) as well as cheese yield. In order to assure that the milk to be processed into Mozzarella di Bufala Campana fulfils the necessary requirements, it is forbidden to feed the buffaloes with foodstuffs that might have a bad effect on milk quality and/or on the processing system. Fresh forages should be administered only in small amount so that they do not negatively affect digestive organs. All hays made from the non forbidden grasses and legumes are allowed, provided that they are well preserved. All silages made from the non forbidden forages are allowed, provided that they are of good quality. Raw materials allowed in farm-made and industrial concentrates can be grouped as follows: grain meals; processed grains (flakes, steamed, etc.); byproducts from industrial grain processing (gluten, gluten bran, gluten meal); oil seeds (soybean, sunflower, flax) that can be used in many ways: straight, ground, in flakes, cooked; byproducts of oil seed industry: soybean, cornflower or sunflower meal; dried alfalfa meal and various hays; dried sugar beet pulp (stripes or pellets); fats and fat byproducts (they increase diet total energy but should not interfere with rumen fermentation); salts of fatty acids, vegetable fats, non-protein nitrogen in concentrates and in high starch diets; free amino-acids; minerals and vitamins (according to the laws in force).
Those buffaloes, the milk of which will be processed into Mozzarella di Bufala Campana, cannot be fed any foodstuffs containing genetic modified organism.
The feedstuffs, the peculiar characteristics of which can alter milk quality, are forbidden because they contain non-wanted matters that can be found in milk giving bad smell or flavour and/or dangerous residuals. Among those we remind the following: rapes, colza, white mustard, fenugreek, wild garlic, grape residuals, fennel, cabbages and kales, turnips, tomato peels and seeds, industrial byproducts from: olive oil processing, citrus processing, bean and peas processing, rice processing, peanut cakes, coconuts, tobacco, sesame, poppy, nuts; branched aminoacids, peptides, protein lysates, isoacids; seed oils, high protein meals from animal products, bone meals, bone fat, any fat or oil of animal origin; all liquid byproducts from slaughter; non-saturated oils; antibiotics as well as any additive forbidden by EU regulations.
In chapter 5, the rules to correctly feeding lactating and dry buffalo are referred. Optimal feeding, as for any livestock, includes, on one side, the correct evaluation of both chemical and nutritional characteristics of foodstuffs, on the other side the correct evaluation of the nutritional requirements in the different physiological times. Chemical analyses of foodstuffs includes the parameters of the Weende and Van Soest schemes. After chemical composition, the parameter that best characterises the nutritional value of any foodstuff is the net energy as Milk FU. When preparing the ration for buffalo, the following requirements should be taken into account:

follows page 11 ☞

Table 1. Dry matter intake (kg/d), net energy (MilkFU/kg DM) and chemical characteristics (%DM) suggested for herd feeding (average live weight 650 kg) estimated on the basis of standard milk yield (8.30% fat and 4.73% protein).

	STANDARD MILK YIELD (kg/d)							
	<6	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Dry matter intake	13.3	14.2	14.7	15.1	15.6	16.1	16.5	17.0
Net energy	0.75	0.79	0.82	0.84	0.86	0.88	0.90	0.92
CP	13.0	13.9	14.3	14.6	15.0	15.3	15.6	15.9
PDI	7.3	7.8	8.1	8.3	8.5	8.7	8.8	9.0
EE	2.8	4.1	4.5	4.9	4.9	5.4	5.7	5.6
Starch + sugars	17.0	18.0	19.0	20.0	20.0	20.0	21.0	22.0
NSC	25.0	27.0	28.0	29.0	30.0	30.0	31.0	32.0
CF	26.3	26.0	24.6	23.3	22.6	21.7	20.9	19.9
NDF	52.0	47.0	46.0	44.0	43.0	42.0	40.0	39.0
Ca	0.73	0.78	0.80	0.82	0.83	0.85	0.86	0.88
P	0.38	0.39	0.40	0.40	0.42	0.42	0.43	0.44
Mg	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19

maintenance, production, growth, pregnancy. These requirements are given in tables in the Pattern of regulation for sanitary and feeding management of buffalo herds. Finally, conversion factors were calculated to transform any milk into "standard" milk (8.30% fat and 4.73% protein content).
During the dry period, animal supplies necessary after calving are built up. Optimal condition, in this stage, is to balancing again the nutritional status while losing the eventual body fat accumulated during the last stage of lactation. Buffalo ends up lactation after 270 days and is dried off during 95 days averagely, if calving interval is one year. When buffaloes are dried off, the Committee suggests to divide them into groups according to fattening, so that energy content of the diet can be fixed in order to make the buffaloes to achieve the ideal weight before the nineth month of pregnancy (6-7 Milk FU/d). When dried off, dry matter should be higher than 8.5 kg/d; it is also suggested not to overtake 800 g/d of crude protein and to maintain the ratio Ca/P around 1. For the buffaloes that are going to calve within 3 weeks, it is suggested: not to give them more that 5-7 kg/d maize silage; not to use fresh forage; give only one-grass hays and concentrates (no more than 2-3 kg/d), i.e. give optimal amount of crude protein while avoiding high fermentable matters.
A feeding technique called "unifeed" has become very popular for buffalo, both during lactation and when dried off. Unifeed means that only one mixture containing all matters is given to the animals. To make unifeed, short cut silage (0.5-1 cm) must be available, because the high water content (67-70%) allows a uniform mixture of all components. Hay to be included in unifeed should be cut into 4-6 cm pieces. To use unifeed, moreover, a mixer wagon be available, and because this machine is expensive, unifeed technique is not applied in all farms. If using unifeed, the farmer should divide the buffaloes into at least two groups: the dried off and the lactating ones. Moreover, the lactating ones should better be divided in two more groups based on milk yield.
Dry matter intakes for the lactating buffalo depends on the following factors: liveweight, milk yield, lactation stage (the highest consumption is registered between the 50th and the 150th day from calving), forage:concentrate ratio, and forage quality.

In table 1, chemical and nutritional characteristics of optimal diets are reported, for buffaloes yielding 6-12 kg/d standard milk, not considering lactation stage. Values were estimated considering 20% of primiparous in the herd as well as the recovering of liveweight that takes place generally between 100 and 170 days after calving. Energy density was calculated by evaluating the required dry matter amount and the necessary energy to assure milk yield. As regards to protein, the reported data is the fruit of the experience of the working group and it is different from the theoretical one, because it takes into account not only the use of the ingested proteins for producing milk, for growth and for liveweight recovering, but also the endocrine and metabolic effects of protein on productive activity.

PHYSICAL AND MICROSATELLITE BASED CHARACTERIZATION OF TARAI BUFFALO OF INDIA

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KEYWORDS

Tarai buffalo, characterization, microsatellites.

INTRODUCTION

India possesses the worlds largest buffalo population but has only nine well recognized breeds while the majority of the buffalo population is regarded as nondescript or *desi*. The large genetic diversity represented by these local or *desi* buffaloes is rapidly declining due to indiscriminate substitution policies with more productive breeds. Such *desi* buffaloes are largely maintained by small and marginal farmers and have proven to be productive even under minimal inputs of nutrition and management. The Tarai buffalo is one such *desi* buffalo population that has adapted and is thriving under stressful climatic conditions of the Tarai region. The word Tarai in Hindi literally means foothills. The Tarai region lying at the foothills of the Himalayas in Uttaranchal is a very fertile land with hot and humid climate. The buffalo population native to this region is known as the Tarai buffalo. The Van Gujar community dwelling in the forest pockets or "khattas" and marginal farmers of this area has been rearing the Tarai buffalo. The study was undertaken to generate information on population status, breed utility and management practices in the native tract of this buffalo population and to estimate the within population genetic diversity using microsatellite markers.

MATERIALS AND METHODS

The details of physical characteristics were recorded by survey and random sampling of the Tarai buffaloes in their native breeding tract. For molecular genetic characterization, blood samples from 40 unrelated animals were collected into EDTA coated vacutainers. The genomic DNA was isolated by standard phenol-chloroform protocol *(Sambrook et al 1989)*. A set of 22 bovine microsatellite markers were used for studying the genetic polymorphism within the population These microsatellite loci were amplified by PCR (95°C for 2 min, 30 cycles of denaturation at 95°C for 45 sec, annealing at optimal temperature for 45 sec and extension at 72°C for 45 sec). The amplified products were resolved on 6% denaturing PAGE and visualized by silver staining *(Bassam et al 1991)*. Allele number was calculated by direct counting, observed and expected heterozygosity were estimated using the software progamme POPOGENE *(Yeh et al 1999)* and the polymorphism information content (PIC) values were calculated according to Botstein et al (1980).

RESULTS AND DISCUSSION

Physical characterization.

The natural breeding tract of Tarai buffaloes comprises the Nainital and Udham Singh Nagar districts of Uttaranchal and adjoining districts of Pilibhit and Bareilly of Uttar Pradesh. These buffaloes are medium sized animals, grayish brown to black in colour with compact body and strong built. The horns are black, swept backwards, slightly curved, with the tip pointed upwards. The head is somewhat convex with prominent and long nasal bones. The ears are small and oriented backwards and the tail reaches upto the hock. Heart girth of adult animals is 201cm while paunch girth is 227cm. Average height of the adult animal is 156cm. Naval is tight and sheath is non-pendulous. Udder size is small and rounded with non-prominent milk vein. The estimated population size is about 4 lakhs. Since marginal farmers rear majority of these buffaloes their management system is low input based. These farmers are dependant on buffalo milk and male calves while female calves are kept as replacer. The animals are housed in well-ventilated sheds that are mostly of closed type and form part of the residence. Sanitary conditions are poor. In the villages only one to three breeding females are kept by the

follows page 13 ☞

Table 1. Characteristics of bovine microsatellite markers tested on Tarai buffaloes.

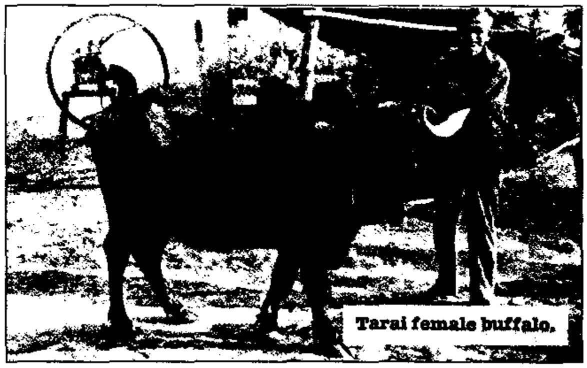
Locus	Annealing Temp. (°C)	Number of Alleles	Observed Heterozygosity	Expected Heterozygosity	PIC
BM1818	58	4	0.3448	0.4332	0.40
CSSM6	55	5	0.8919	0.7216	0.66
CSSM8	55	6	0.6842	0.6653	0.59
CSSM19	55	6	0.5455	0.5166	0.48
CSSM33	58	5	0.9143	0.7164	0.67
CSSM45	58	6	0.9744	0.7905	0.75
CSSM57	60	5	0.8571	0.7586	0.71
CSSM66	58	3	0.9231	0.5861	0.49
ETH3	65	3	0.7353	0.4921	0.39
HAUT24	58	2	0.1842	0.4474	0.34
HAUT27	58	4	0.6316	0.6032	0.52
ILSTS005	55	3	0.5750	0.5288	0.42
ILSTS011	58	4	0.5750	0.5364	0.48
ILSTS019	50	2	0.1316	0.1246	0.12
ILSTS029	55	5	0.9000	0.6168	0.56
ILSTS030	55	4	0.5500	0.5497	0.46
ILSTS034	58	3	0.5588	0.5123	0.45
ILSTS038	55	3	0.4595	0.4187	0.35
ILSTS049	55	3	0.4412	0.4350	0.37
ILSTS052	55	4	0.5833	0.6209	0.57
ILSTS058	55	6	0.7222	0.8106	0.77
ILSTS059	55	7	0.9167	0.8149	0.78
Mean		**4.2**	0.6409	0.5772	0.51

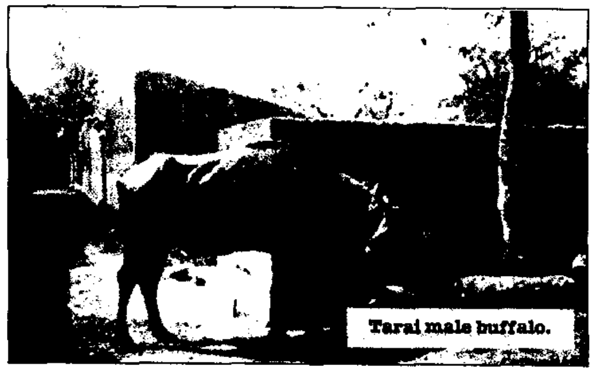
farmers whereas in the 'khattas' the herd size may be as large as hundred. Wheat and paddy straw are the main sources of dry fodder, while berseem, oats, sugarcane tops, jowar and maize are included as green fodder in the villages. In 'khattas' grazing and tree lopping sustain the animals. These buffaloes thrive well on grazing on bunds, riverbanks and roadsides in Tarai where green grasses are aplenty.

The milk yield of the Tarai buffalo averages from two to four kg per day with an average lactation yield of 1054 kg, inspite of the stressful climatic conditions and poor management systems. Fat content in milk is 6.6% and SNF 8.6%. The overall lactation length has been recorded to be 291 days. Service period in Tarai buffaloes is 197 days with an average calving interval of 470 days.

The animals are used both for milk and draught purposes. As these animals exhibit high heat tolerance capacity the average duration of work are six to seven hours daily during peak season. The males are utilized for ploughing, carting and puddling. Haemorrhagic septicaemia (HS), foot and mouth disease (FMD) and black quarter are the major diseases affecting these animals whereas parasitic infestations of liverfluke

follows page 14


Tarai female buffalo.


Tarai male buffalo.

and round worms pose the major health problems for the Tarai buffalo. Vaccination against HS and FMD and deworming against liverfluke are practiced by some farmers.

Molecular genetic characterization.

The Tarai buffalo is riverine with 50 chromosomes as revealed by karyotyping *(Chauhan et al 2003)*. Heterologous (cattle) microsatellite loci were used for molecular genetic characterization of Tarai genome. A set of 22 cattle microsatellite loci was found to be polymorphic in the Tarai genome. Genotyping of these polymorphic microsatellite loci revealed alleles ranging from two to seven and observed heterozygosity of 0.60 in the Tarai buffalo population **(Table 1)**.

As the Tarai buffalo is known to have high heat tolerance capacity and is able to thrive even at a subsistent level of management, it represents a valuable gene pool adapted to the hot and humid climatic conditions. Therefore, improved and effective breeding policies, management and feeding practices are required to upgrade the Tarai buffalo germplasm without the encroachment from elite buffalo germplasm to augment its productivity.

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HARMONISING TRADITIONAL BUFFALO PRODUCTION SYSTEMS TO THE CONSUMERS DEMANDS FOR CERTIFIED QUALITY PRODUCTS

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ABSTRACT

The objective of this article is to present the possibilities of the economic exploitation of the buffalo population in Greece through the production of certified quality products. The buffalo population in Greece has decreased dramatically during the last decades, due to the rapidly changing socio-economic conditions, mainly the mechanisation of the agricultural sector. The current study has been undertaken in the region of Kerkini Lake, where the majority of buffalo population of Greece is concentrated. The main characteristics of the production system, feeding based on the natural vegetation, the unique way of product processing and the gastronomy are investigated by filling up questionnaires. The next step includes the detailed description of the production system and the definition of the critical points where the intervention will take place. The proper application of the production protocols will be undertaken by the official organisation for certification. The farmers association will be responsible for the management of the transition of the production system. As the driving force of the new development of buffalo breeding is the production of quality products, further investigation on the special characteristics of milk and meat buffalo products, is required.

INTRODUCTION

In Greece, due to the rapidly changing socio-economic conditions, including the mechanisation of the agricultural sector and the substitution of buffalo milk by milk produced by imported dairy cattle, the number of buffaloes has declined dramatically over the last decades. As a result, from the 75,000 animals counted at the end of the 50s, today only 900 heads remain in some wetlands in Northern Greece, particularly in the regions of Macedonia and Thrace. These animals are mainly used for meat and milk production *(Boyazoglu, 1997; Georgoudis, 1993; Georgoudis et al., 1994; 1998)*. According to the last survey of the National Focal Point for the Preservation and Conservation of Farm Animals Genetic Resources, the buffalo population is distributed in 11 herds in wetlands of Macedonia and Thrace: a) one in the region of Vistonis Lake and Porto-Lagos, b) seven in the region of Kerkini Lake, c) one in the region of Volvi Lake, d) one in the region of estuaries of Gallikos River and Delta of Axios River in Thessaloniki and e) one in the region of Prespa Lake *(National Focal Point, Ministry of Agriculture, 1999)*.

The new trends that have been recently observed in Europe among livestock farmers seeking new specialised markets, based on the local resources can be the driving force for the development of the buffalo farming in Greece. The quality of these traditional products is specified by the uniqueness of the resources, the natural vegetation, the cultural influence on farming and product processing and gastronomy.

THE PRODUCTION SYSTEM

Taking into consideration the trends mentioned above, a study has been carried out, in collaboration with the farmers in the region of Kerkini, where the majority of buffalo population is concentrated. A detailed questionnaire, based on the relevant questionnaires of EAAP databank, was developed and completed by trained technical personnel in collaboration with the farmers. In general this indigenous population is well adapted to the local conditions and is based on grazing and suckling of young animals. Some of the main characteristics of the production system and the production traits are presented below.

MANAGEMENT -BREEDING

The buffalo-breeders prefer cows with good maternal attributes and longevity. Artificial

follows page 16 ☞

insemination is not applied. The bulls of natural mating are kept in the herds and are used in proportion 1 to 8-15 cows. The distribution of calvings is regular during the year, but higher frequency is observed mainly at the end of spring, summer and autumn. The calves are weaned at the age of 7-8 months, with a live weight of 75-90 kg. Buffaloes are usually stabled at night and graze during the day.
The population is characterised by the absence of any selection activity, but retains a high amount of genetic variability that can be exploited in planning future breeding strategies appropriate for small populations *(Moioli et al., 2001)*.

FEEDING

The riparian zones of Strimonas River and Kerkini Lake are used for grazing the whole year. However, during the period from November to April, grazing is not sufficient and complementary feeding is given to the animals. The farmers do not apply a particular grazing system. In general, no sumplementary feeding is provided to the animals before slaughtering.

PRODUCTION

In the region of Kerkini, the buffalos are raised exclusively for the production of meat. Milking of animals is applied occasionally and only for family consumption. Milk is used for the production of cheese, yoghurt and liquid yoghurt. Calves are slaughtered in various ages according to the farmer's needs. At the age of 15-17 months, it is calculated that they have living weight of 350-450 kg. The average age at slaughter is 24 months. There is regularly supply of the market the whole year, locally, but also there is a supply to big urban centers.

THE STEPS IMPLEMENTED

The special characteristics of the production system, namely the exploitation of the natural resources with minimum management, the availability of areas for grazing in the wetlands of Northern Greece, the resistance of buffaloes to diseases are elements that meet the necessary standards demanded by high quality, environment friendly products.
The transition of the production system includes the following steps:

- Creation of a breeders' organization, which will be responsible for the management of the system and the marketing of the products
- Adaptation of the production system to the certification standards. The quality certification standards, which describe the requirements of the management system and the administrating procedures, together with the general rules to follow in creating the desired quality and services to the consumers will be published with the collaboration of the official organization for certification.
- Establishment of a beef marketing policy. The local slaughterhouse can cover all the demands and the carcasses will be promoted to the butcher, through direct sales or to large chain stores. Measures for the continuous supply of the market will be taken.
- Gathering feedback data to improve the system.

The project is expected to have multiple benefits, not only increasing directly the income of the farmers by producing high quality animal products, but also in other activities that are being carried out in the region.
Future research will focus on the characteristics of the buffalo milk and meat products, in order to identify the special elements and the factors that influence their quality.

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DEVELOPMENT OF SWAMP BUFFALO BREEDING IMPROVEMENT FOR SUSTAINABLE USE IN THAILAND

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INTRODUCTION

The Kingdom of Thailand covers an area of 514,000 square kilometers in Southeast Asia, roughly equidistant between India and China. It shares borders with Myanmar to the west and north, Lao P.D.R. to the north and northeast, Cambodia to the east and Malaysia to the south. Thailand is divided into four distinct areas: the mountainous North, the fertile Central Plains, the semi-arid plateau of the Northeast, and the peninsula South. The country is situated within the humid tropics and remains hot throughout the year. There are three seasons: the cool season (November to February), the hot season (April to May), and the rainy season (June to October). The geographic and climatic conditions make the country suitable for the cultivation of the wide range of tropical and semi-tropical crops that provide the residues being used as animal feed.

Population of the country is about 60 million of which 75% are farmers who live in the rural area where agriculture provides the major income for living. Livestock production is an integral part of crop production system mainly under the small farmer condition. The system of production is for multipurpose usage of animals with small population size. The indigenous ruminants are cattle *(Bos indicus)* and swamp buffalo *(Bubalus bubalis)* both of which are traditionally raised under poor condition of small farmer level where they are selected by natural selection on survival and adaptation in combination with a stressful environment.

POPULATION AND DISTRIBUTIONS

Swamp buffalo has been raised as part of Thai agriculture at small farmer level for draft power and meat production. The 83% of the buffalo population in Thailand is predominantly distributed in the northeast of the country (**Table 1**; Department of Livestock Development, 2001). There are approximately 518,000 families who raise buffalo and 88% among those live in the northeast part of the country. They still provide 20% to 30% of the farm power for small farmer. However, the population has lost a considerable number with the negative annual growth rate regarding many factors that affected buffalo production.

BUFFALO PRODUCTION SYSTEM AND THE DEVELOPMENT LIMITATION

The production system of swamp buffalo under the village householders is generally to keep animals in their own-built housing in the backyard as part of their family regarding social traditional pattern. Numbers of buffalo per household is approximately 3.25 females. Regarding the capability of utilizing agricultural waste products or low quality feed, buffalo is fed by the availability of native grasses, crop residues, rice straw and rice stubble or any substantial sources of roughage available. When the cropping season begins during rainy season, buffalo is normally tied up and is fed only rice straw and even so growth is still obtained.

follows page 18 ☞

Table 1. Buffalo population in Thailand (1995-2000).

Year	Central	North-east	North	South	Total	Growth
1995	228,023	3,009,063	398,562	74,413	3,710,061	
1996	153,892	2,258,494	236,686	70,602	2,719,674	- 26.69
1997	135,618	1,911,639	187,095	59,586	2,293,938	- 15.65
1998	109,806	1,614,867	171,371	55,024	1,951,068	- 14.95
1999	97,879	1,503,176	151,134	47,417	1,799,606	- 7.76
2000	98,968	1,406,442	151,829	44,984	1,702,223	- 5.40

Source: Department of Livestock Development, 2001

Buffalo marketing is quite extensive. There is no standard price for quality meat. It depends on the buyers who offer the price on individual animal which in fact is not the reasonable price to gain profit. Compared with cattle at the same size, the price of live buffalo in Thailand is about 10% less therefore the merchants prefer to buy buffalo for meat.
Most of the farmers do not maintain buffalo bulls but rather share with the neighbor's. There are only 8% of the farmers who raise their own bulls in their herds. Buffalo breeding in the village is generally random mating. 80% of the mating occurs naturally by buffalo bulls while grazing together after the harvesting season. Artificial insemination is very limited due to lack of accurate heat detection and the distances from AI Center. The average annual calf crop of the village buffalo is 35-40%. On the contrary, numbers of buffalo are slaughtered at higher rate than production according to the rapid increase demand for meat consumption.
The major constraints that are taken into account are the reduction of the land use for buffalo production as well as less labor regarding the change of social economic pattern. Young people leave villages for industrial job. Consequently, farm machinery has been used to cope with the limitation of plantation time. Recently, however, the thought of using buffalo for its power has been re-considered, due to the economic crisis, because the cost of machine maintenance has increased very much.
Another limitation that affected buffalo production in the village is the health care. Buffalo calf loss from internal parasites is still the problem in the villages. Villagers are unlikely to spend money on the sick buffalo but rather use herbs and medicine plants to treat their animal. This probably is part of their cultures, traditions or their religious beliefs.

THE UTILIZATION OF SWAMP BUFFALO

Roles of buffalo under small farmer level in Thailand are summarized *(Chantalakhna, 2001)* as follows:
Buffalo is a component of the integrated farming system. They primarily provide draft power and manure with the secondary products of meat, milk.
Buffalo production by smallholders has low cost of production. Buffalo can utilize the crop residues or low nutritive value plants efficiently due to their unique micro bacteria in the rumen. Therefore, it can be classified as 'family saving bank' for financial security for the family.
While the need for beef consumption highly increases, buffalo supply meat with low cost by transforming the agricultural waste products into high protein food for human. Thus increase buffalo production can assure human food security.
As buffalo has been part in the social life of Thai farmers for very long time, it comes to be part of cultures and traditions in the rural areas. Family considers buffalo as part of the members, friends and companions.

THE PRESENT BUFFALO GENETIC IMPROVEMENT PROGRAM IN THAILAND

The first buffalo development program was approached in Thailand since 1975 when the researchers from Department of Livestock Development (DLD), Kasetsart University, Khon Kaen University and the Rockfeller Foundation set up the joint research program on buffalo development named 'National Buffalo Research and Development Center Project' *(Chantalakhna, 1994)*. Performance Testing Program as well as researches on buffalo development have been conducted in various fields ever since. Animals are weighed at birth, 240 days old and at further ages every six months. Selection is based on growth performing during the test and the animal appearances were the basic tool to define the superior animals to establish elite herd. A close nucleus herd has been set up at Surin Livestock Breeding Station.
New technology of genetic evaluation has been approached since 1996 when Australian Centre for International Agricultural Research (ACIAR) funded project in Thailand has

follows page 19 ☞

Table 2. General data of buffalo at the government research stations.

Research Station	Weigth (kg) At birth	Weigth (kg) 240days	Pre weaning AGD (gm)	Age at first calving (years)	Calving interval (days)
Surin	31.9	185.4	640	3.68	610.4
Lamphyaklang	28.9	164.9	540	4.91	700.0
Buriram	29.4	167.4	570	3.87	644.6
Srisaket	25.8	162.0	570	-	509.4
Payao	29.6	158.0	530	4.64	489.7
Surattani	32.7	184.0	630	3.86	610.3
Nakorn sri thummarat	31.0	166.7	430	4.26	549.0
Average	29.9	169.8	558.6	4.19	573.3

enabled the developed genetic evaluation procedure called BREEDPLAN to be adapted and implemented under the support of the Agricultural Business Research Institute, University of New England, Australia. The historic data from the previous records from the performance test program and from various DLD breeding stations were loaded into a customized database and analyzed in a full animal multi-trait model using Best Linear Unbiased Prediction methodology (BLUP) The estimated breeding values (EBV) of each animal are being used as part of the selection criteria for the DLD's elite breeding program for swamp buffalo. The database is also used to maintain genetic diversity within the population of Thai swamp buffalo and encourage in-situ genetic conservation of this species *(Allen, 2001)*. BREEDPLAN is now used as the tool for selection of the breeding animals. Breeding buffaloes to produce superior offspring are raised in seven research stations around the country. The general data of buffalo raised at DLD research farms is showed in **Table 2.**
Result from BREEDPLAN analysis showed that the genetic trend over years on growth and days to calving, the average EBV of birth weight (BWt), weaning weight at 200 days (WWt), yearling weight (YWt), final weight (FWt) in **Figure 1**, and 200 day milk and days to calving (DC) in **Figure 2**, are slightly improved.

Figure 1 Surin Buffalo Genetic Trends

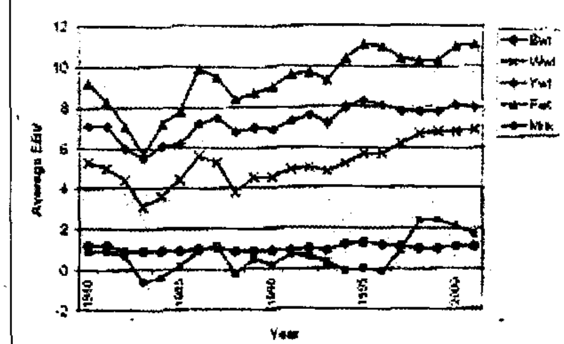
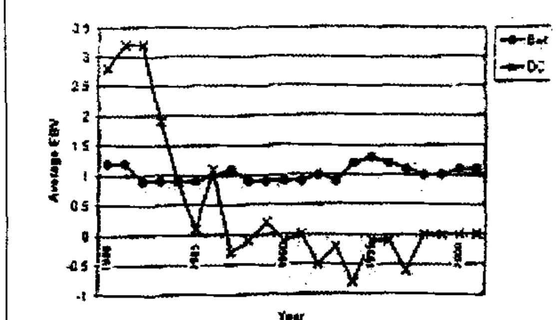


Figure 2 Surin Buffalo Genetic Trends



THE BUFFALO CROSSBREEDING PROJECT IN THAILAND

Research on crossbred buffalo was conducted in Thailand when the government imported a herd of Murrah buffaloes, 10 males and 90 females, from India in 1978 for crossbreeding to increase size, meat and milk production. The program was aimed to increase the income of rural small-scale farmers and increasing animal protein in the village. The breeding plan was designed to use Murrah buffalo crossed with swamp buffalo to produce first cross (F1) and then do either back-cross to Murrah or inter se mating to produce F2 offspring. Both F1 and F2 were studied to obtain information in various fields.

follows page 20 ☞

Table 3. Growth and carcass quality of crossbred buffalo (F1) fattened by palm kernel cake and coconut cake.

Parameters	Palm kernel cake		Coconut cake	
	Swamp	F1	Swamp	F1
Initial wt (kg)	264.75	327.00	431.62	457.50
Final wt (kg)	429.37	453.00	431.62	457.50
Daily gain (gm)	764	901	756	1078
FCR	8.140	7.625	8.840	5.937
% Dressing	43.64	44.15	43.85	44.65
% Lean	68.07	68.18	71.08	71.50

Na-Chiangmai et al., (1990-1988)

Table 4. Milk yield and milk composition of different buffalo breeds.

Parameters	Murrah	F1 Crossbred	Swamp
Number of buffalo	10	10	10
Lactation periods (days)	212.85	268.10	249.00
Milk yield (kg)	1105.11	1112.88	477.14
% Fat	7.57	8.59	8.78
% Protein	4.21	5.23	4.90
% Lactose	4.93	4.72	4.77

Na-Chiangmai et al., (1990-1988)

Table 5. Growth of different genotype buffaloes.

Traits/ Genotypes	F1 50%M 2n=49	F2 75%M25%S 2n=49	F2 75%M25%S 2n=50	F3 87.5%M12.5%S 2n=49	F3 87.5%M12.5%S 2n=50
No animals	35	34	44	3	11
Birth wt	33.2	31.1	32.6	25.2	30.6
Weaning wt	181.9	196.4	206.0	164.6	192.5
Yearling wt	213.1	228.6	236.1	187.6	221.4

Na-Chiangmai and Allen, (2000)

1. Karyotyping

Chavananikul (1994) reported the results of karyotyping of the crossbred buffalo (F1) produced from Murrah and swamp buffalo indicate only one karyotype of 2n=49 with the 4th non-homologous pair and a single acrocentric chromosome of the 9th pairs. The offspring produced by the backcross of F1 to Murrah has the karyotypes of 2n=49, or 2n=50 in the proportion of 1:1. The other backcross of F1 to swamp buffalo produced offspring carrying 2n=48 or 2n=49 karyotypes with the ratio of 1:1. Interestingly, the F2 crossbreds produced by inter se mating possess three karyotypes of 2n=48, 2n=49 and 2n=50.

2. Growth performances

There were many studies on growth of crossbreds buffalo in Thailand. Na-Chiangmai et al., (1990) studied the use palm kernel cake and coconut cake fattened F1 crossbreds. Result revealed that crossbred buffalo had potential on growth to be introduced for beef production **(Table 3).** Similar result are supported by *Sanghuayprai et al.*, (1994).

3. Milk production

Milk yield and composition of the F1 crossbred were observed and result revealed that fat and protein of milk from the crossbred buffalo are significantly higher than in swamp buffalo **(Table 4).**

The author with the Grand Champion Buffalo (two years old buffalo bull) of the 2002 National Buffalo Day held at Surin Buffalo Research and Breeding Center on 3 March 2002.

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BREEDING OF BUFFALOES IN EGYPT. I. MILK PRODUCTION TRAITS

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INTRODUCTION

The dairy sector contributes about 1/3 of the national agricultural production of Egypt. The total number of Egyptian buffaloes in Egypt in the year 2000 **(Table 1)** is about 3,329,700 heads and represents 49.35% of the total population of dairy animals (MALR, 2000). Because buffaloes produce about 56% of the total milk production in Egypt **(Table 1)** and buffalo milk is characterized by high fat (about 7%) and solid non-fat (about 16%) contents, white colour and good flavor compared with cow's milk, therefore, buffalo is considered the main dairy animal in Egypt. On the other hand, buffalo males aged between 2 – 24 months are considered an important source of red meat. About 42.6% of the total red meat produced in Egypt comes from buffaloes *(Economy of Agricultural Production Research Division, 1989)*. The present article describes the current situation of buffalo production in Egypt, focusing on the results of some researches and articles published on milk production traits of the Egyptian buffaloes.

The importance of buffaloes in Egyptian animal agriculture:

There are more than 166 million domesticated buffaloes raised in the world *(FAO, 2003)*. According to FAO *(2003)*, the total number of Egyptian buffalo population is 3,550,000 head in the year 2002 representing about 2.13% of the global buffalo population. Data given in **Table 2** indicate that the contribution of the Egyptian buffaloes to milk and meat production of the world is relatively considerable. The Egyptian buffaloes produce 2,050,610 metric ton of milk. This amount represents 2.67% of the total world milk production from buffaloes. The Egyptian buffaloes also produce 306,000 metric ton of meat, which represents about 9.9% of the total world meat production from buffaloes **(Table 2)**. The figures given in **Table 2** indicate also that while total numbers, milk and meat production of the Egyptian buffaloes increased from 1990 to 2002, there was decreasing rate in the production of milk and meat in the world buffalo production. No genetic improvement programs for buffaloes are practiced in Egypt due mainly to the lack of links between recording, genetic evaluation and AI institutions *(Nigm, 2000)*.
Regarding the age structure, about 50% of the total buffaloes population in Egypt are mature females (> 2 years). This percentage confirms the recognition of the buffalo by the Egyptian farmer as the major dairy animal *(Sadek, 2002)*. The farmers use to sell buffalo male calves at 40 – 60 days of age to save milk of suckling and to avoid the high mortality rates in early ages. The Egyptian buffaloes are mostly kept under low input production system where more than 87% of the buffalo population are maintained in small herds (less than 10 breedable females) and less than 2% of the total buffalo population are

follows page 22 ☞

Table 1. The average numbers and milk production from cattle and buffaloes in Egypt in the year 2000 as reported by MALR.

Species	Number (head)	% of the total number	Milk Production (ton)	% of total milk production
Cattle	3,417,577	50.56	1,596,000	44.16
Buffaloes	3,329,700	49.35	2,018,000	55.84
Total	6,747,277	100.00	3,614,000	100.00

maintained in large farms (more than 50 heads) **(Table 3)**. The small herds suffers from inadequate nutrition, unhealthy housing systems and lack of veterinary services. The supporting services of artificial insemination, milk recording and genetic evaluation and improvement of the breeding stock are not available. On the other hand, the large commercial farms (representing less than 2% of the total buffalo population) apply computerized daily management programs for controlling farm activities and decision-making. The large commercial farms (few of these farms maintain > 500 heads/farm) keep a good standard of management and they are members of "Egyptian Buffalo Producers' Association *(www.ebpa.com.eg)*" which was established at the end of the year 1992.

Table 2. Average numbers and milk and meat production (MT) of the Egyptian buffaloes as percentages of the global buffalo population during the period from 1990 to 2002 as reported by FAO (2003).

Year	Number (head)	Milk production	Meat production
		Egyptian buffaloes	
1990	2,897,467	1,250,000	161,000
1995	3,017,726	1,358,000	179,354
1998	3,149,429	2,022,380	266,235
1999	3,329,700	2,018,200	276,951
2000	3,379,410	2,030,305	302,000
2001	3,532,244	2,050,610	306,000
2002	3,550,000	2,050,610	306,000
		World buffaloes	
1990	148,183,910	44,077,622	2,266,191
1995	159,321,289	54,425,143	2,825,281
1998	160,723,317	66,895,291	2,891,383
1999	162,206,113	69,577,695	2,990,888
2000	164,541,404	71,901,726	3,018,998
2001	165,958,682	73,821,544	3,063,598
2002	166,418,998	76,734,759	3,089,875
		Egyptian/world (%)	
1990	1.96	2.84	7.10
1995	1.89	2.50	6.35
1998	1.96	3.02	9.21
1999	2.05	2.90	9.26
2000	2.05	2.82	10.0
2001	2.13	2.78	9.99
2002	2.13	2.67	9.90

Table 3. Distribution of buffaloes population in Egypt by herd size (MALP, 2000).

Item	Herd size (head)				
	Less than 10	10 - 24	25 - 49	50 and more	Total
No. of buffaloes	2,899,809	279,339	84,486	66,066	3,329,700
% of the total	87.09	8.39	2.54	1.98	100.0

Milk production traits:

Averages of total and 305-day milk yield, lactation period and fat percentage of Egyptian buffaloes as reviewed in the literature are given in Table 4. These averages show that there are wide ranges in all traits from herd to another. For example, the average total milk yield (TMY) across all lactations ranged between 773 kg *(Abdel-Aziz and Abdel-Ghani, 1978)* to 2097 kg *(Ashmawy, 1981)*. The average of 305-day milk yield ranged between 694 kg (Abdel-Aziz and Abdel-Ghani, 1978) to 1552 kg *(El-Tawil, et al.,1976)*. Average of lactation period (LP) ranged between 205 days (Sadek, 1984) to 354 days *(Alim and Ahmed, 1954)*. Milk fat percentage of the Egyptian buffaloes is the most important component in milk constituents where it determines the price received for milk. In spite of this, it is rarely recorded in most farms. The very low available data on fat percent of Egyptian buffalo milk indicate that the average of fat percentage range between 6.4 to 7% **(Table 4)**.

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follows page 23 ☞

Table 4. Averages of some milk production traits of Egyptian buffaloes as reviewed in the literature.

Reference	Number of obs.	TMY (kg)	305-DM (kg)	LP (day)	Fat (%)
Sidky (1951)	702	1720		305	7.0
Ragab et al. (1953)	929			323	
Alim and Ahmed (1954)	1027	1680		354	6.5
Bedeir (1965)	2281			307	6.4
El-Kimary (1966)	521	1954		325	
Shaheen et al.(1966)		1098	971	245	
Ali (1972)	2832	1800			
El-Tawil et al. (1976) (1st lactation)	254		1004		6.59
El-Tawil et al. (1976) (2nd lactation)	150		1552		6.63
Soliman (1976)	2874	2151		325	
Abdel-Aziz and Abdel-Ghani (1978)	185	773	694	241	
Alim (1978)	698	2025		311	6.6
Mourad (1978)	4324	1869		286	
Ashmawy (1981)	2763	2097	1999	324	
Mourad (1984)	888		1461	302	
Sadek (1984)	935	1044	1020	205	
Eid (1988)	473	1292	1251	280	
Khattab and Mourad (1992)	1180	1309		322	
Mansour et al. (1992)	2664	1363		288	
Osman (1997)	4206	1525		244	
Aziz et al. (2001)	1589			209	
Khattab et al. (2002)	1226	1253		313	
Sadek (2002 b)	2336	1940		320	

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Buffalo Newsletter - Number 19
june 2003

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Printed by: ANIS EDITRICE - Roma, June, 2003

"Buffalo Newsletter"
Istituto Sperimentale per la Zootecnia
via Salaria, 31
00016 Monterotondo, Italy