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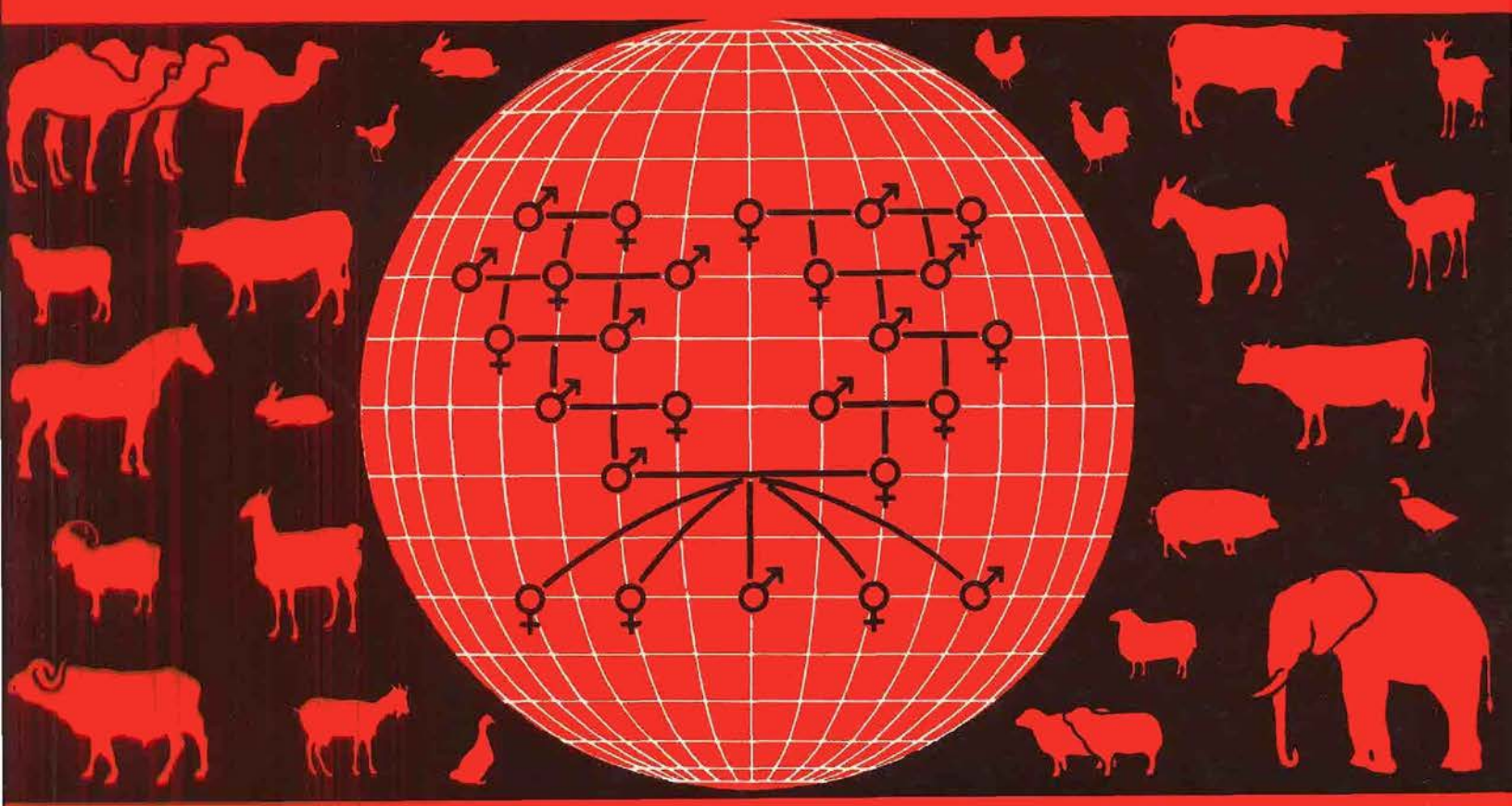
ANIMAL GENETIC RESOURCES INFORMATION

BULLETIN D'INFORMATION SUR LES RESSOURCES GÉNÉTIQUES ANIMALES

BOLETIN DE INFORMACION SOBRE RECURSOS GENETICOS ANIMALES

1996



Food and Agriculture Organization of the United Nations

Organisation des Nations Unies pour l'alimentation et l'agriculture

Organización de las Naciones Unidas para la Agricultura y la Alimentación

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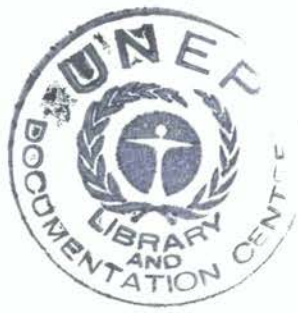

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CONTENTS

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ANIMAL GENETIC RESOURCES INFORMATION will be sent free of charge to those concerned with the conservation, management or utilization of domestic livestock. Anyone wishing to receive it regularly should send their name and address to the Editor, at the address on page iii.

LE BULLETIN D'INFORMATION SUR LES RESSOURCES GÉNÉTIQUES ANIMALES sera envoyé gratuitement aux personnes intéressées par la conservation, l'élevage ou l'exploitation du bétail domestique. Les personnes souhaitant recevoir cette publication régulièrement voudront bien faire parvenir leurs nom et adresse à l'éditeur, à l'adresse indiquée en page iii.

El BOLETIN DE INFORMACION SOBRE RECURSOS GENETICOS ANIMALES será enviado gratuitamente a quienes estén interesados en la conservación, gestión o utilización del ganado doméstico. Si se desea recibirlo regularmente, se ruega comunicar nombre, apellido y dirección al editor a la dirección indicada en la página iii.

GUIDE TO CONTRIBUTORS

Animal Genetic Resources Information will be pleased to receive contributions up to 3000 words long in English, French or Spanish. If accepted, they will be published in the original language. Reports, news and notes about meetings, conservation and evaluation activities, and techniques would be appreciated. Manuscripts should be typed in double space and accompanied by a summary of not more than 5 percent of the original length. Photographs are acceptable but only high quality black and white prints. AGRI will also review new books on animal genetic resources. Correspondence is invited.

All contributions should be addressed to:

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Le Bulletin d'information sur les ressources génétiques animales souhaite recevoir des articles en anglais, en français ou en espagnol, de 3000 mots au maximum. Les communications publiées paraîtront dans la langue originale. Les rapports, informations et notes concernant les réunions et les activités de conservation et d'évaluation et les techniques seraient particulièrement appréciés. Les manuscrits devront être dactylographiés en double interligne et accompagnés d'un résumé ne dépassant pas cinq pour cent de la longueur de l'original. Le Bulletin accepte les photographies à condition qu'il s'agisse de bonnes épreuves en noir et blanc. Le Bulletin rend également compte des ouvrages nouvellement parus sur les ressources génétiques animales. Un échange de correspondance est le bienvenu.

Adresser toutes les contributions à l'adresse suivante:

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El Boletín de Información sobre Recursos Genéticos Animales recibirá con mucho gusto colaboraciones de hasta 3000 palabras de extensión en español, francés o inglés. Si son aceptadas, las contribuciones se publicarán en el idioma original. Interesa recibir informes, noticias y notas sobre reuniones, actividades de conservación y evaluación, y cuestiones técnicas. Los originales deberán presentarse mecanografiados a doble espacio y acompañados de un resumen que no supere el 5 por ciento de la extensión original. Se aceptan fotografías, pero únicamente en blanco y negro y de buena calidad. AGRI también publicará reseñas de libros sobre recursos genéticos animales. Cualquier intercambio de correspondencia será bienvenido.

Todas las contribuciones deberán dirigirse a:

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EDITORIAL

What a big issue: 178 pages! The flow of manuscripts submitted for publication in AGRI is increasing, and although not all future issues will be this big, we receive now enough material to produce regularly three issues per year. We want to thank all those involved with the bulletin: finances permitting it is now in good shape to continue.

There are discussions about the type of publication AGRI should be. These address both content and physical support. You the reader have not reacted enough to our request for comments. What do you think of the content of the last eight issues? Is AGRI covering important elements of animal genetic resources management? Are there topics being neglected? Are there topics included which are not relevant to the scope of AGRI?

Then comes the all important question: how to produce AGRI? Hard copies are expensives to produce and mail. But they are accessible to all. New possibilities are now available. We have in mind two new approaches, obviously not mutually exclusive. The first is to make AGRI available on diskette. This would lower mailing costs, but it would be difficult to include as many photos as we do now (if one issue = one diskette), and we feel that quality photos of animals and their environment are an essential part of breed description. The second possibility is to use electronic networks. The Animal Genetic Resources Group is now designing and developing, with the necessary consulting expertise, a global system which will be launched on the World Wide Web in early 1996 to form the information axis for FAO's Global Programme for the Management of Farm Animal Genetic Resources. The system is known as DAD-IS. DAD-IS will comprise a set of Information Resources, such as those contributing to the Global Databank for Animal Genetic Resources, guidelines for the range of management elements, the World Watch List for Domestic Animal Diversity, a work planner, lists of functionaries, and so on. In addition, the second phase will incorporate a number of activity resources, training, research and conferencing modules. DAD-IS will also be in English, French and Spanish.

As not everyone has access yet to the more sophisticated equipment, it may be necessary, at least during a transitory phase of a few years, to maintain all three systems. We would like some feedback from you to help define the relative importance that should be given to the three forms of AGRI release, hard copy, on disc and via electronic mail, the Internet and World Wide Web. A relevant questionnaire will be included in one of the next issues.

Meanwhile we have succeeded in producing the second edition of the World Watch List for Domestic Animal Diversity (in English) in time to be distributed during the FAO 50th Anniversary ceremonies. This second edition, greatly expanded, since it now includes also yaks, all camels and 14 poultry species, together with a section on wild relatives of the common livestock species. The list will be published in English, French and Spanish, within one year.

BIBLIOGRAPHY NOTES

Hariana Cattle. B.K. Joshi, M.S. Tantia, P. Kumar, Neealan Gupta, P.K. Vij, A.E. Nivsarkar and R. Sahai (1995). National Bureau of Animal Genetic Resources, P.B. 129, Karnal, 132001, India. Research Bulletin No. 3, 95 pp. text and XVI pp. bibliography.

The Hariana is one of the most prominent dual purpose (draught and milk) humped cattle breeds of North Western India. This breed was developed by a judicious selection approach carried out by the livestock farmers of mainly three districts (Rohtale, Hissar and Gurgaon) of the Haryana State since time immemorial.

The breed has been extensively used in the past to up-grade the nondescript cattle population in the plains bordering the rivers Indus and Ganges. Today many of the country's grey and white cattle strains have marked phenotypical similarities with the Hariana.

Once a predominant and popular breed the Hariana is now facing extinction because of rapidly declining population numbers and lower productivity and performance qualities. The authors ascribe this decline to a number of factors: intensification and mechanization of agricultural practices; emphasis on rearing dairy animals of exotic origin, mainly crossbreeding with highly specialized dairy breeds and introduction of Murrah buffaloes; growth in cash crop production and commercial livestock units, including poultry; reduction in grazing availability; absence of clear and consistent global selection and improvement policies for the indigenous cattle populations and non-existence of breeding society/herdbook structures. This decline of the purebred Hariana population is quite impressive, even in the State where the breed originated (Haryana): 52.4% of the total cattle population in 1966 went down to 15.76% in 1993/94.

An urgent need to reverse this trend of genetic degeneration and declining population numbers and the necessity to protect and preserve this most adaptable of Indian breeds were the reasons behind the publishing of this special bulletin by the Indian Bureau for Animal Genetic Resources. It was attempted with success to identity, collect and evaluate all the available information and develop norms and standards for the clear and comprehensive characterization of the breed and its potentialities. The authors go further and formulate clear strategies for the conservation, improvement and use of this most valuable animal genetic resource.

Jean Boyazoglu

Races d'hier pour l'élevage de demain. Annick Audiot. 1995. INRA, Editions, 147 rue de l'Universitè 75007 Paris, France; Col. Espace ruraux, 229p.

L'auteur retrace d'abord l'histoire des populations animales en France, de leur différenciation en races, de leur amélioration, puis l'émergence plus récente du concept de conservation. Ce dernier résulte à la fois d'un mouvement de l'opinion et d'un courant de recherche, dont la convergence a amené sa reconnaissance progressive puis conduit à son institutionnalisation. Dans ce cadre - et il faut le dire à contre-courant des idées qui dominaient alors dans le monde de la recherche comme dans celui du développement agricole - l'auteur a activement participé aux initiatives locales qui se sont développées à travers tout le territoire national pour conserver des races domestiques menacées, découvrant à cette occasion (et s'appuyant sur) une diversité culturelle elle-même menacée par les excès rationalistes et jacobins de l'application de la loi sur l'élevage.

L'ouvrage analyse les dynamiques de conservation qui se sont mises en place pour les différentes espèces de bétail, et leur accompagnement scientifique. Chaque exemple est appuyé sur une présentation détaillée du contexte local et du rôle joué par les différents partenaires de l'action, ce qui met en évidence les spécificités de chaque cas et la diversité des approches, en relation avec la diversité des succès qu'elles ont connus. Cette présentation souligne aussi les profondes convergences intellectuelles qui réunissent toutes ces initiatives. L'iconographie abondante, la cartographie, l'usage judicieux des hors-textes aident le lecteur à se construire une image précise et cohérente de ce mouvement à l'échelle nationale.

De cette analyse émergent trois principaux types de modèles de conservation associant l'homme, éleveur ou technicien, l'animal, pris comme individu ou intégré dans un troupeau, la technique et ses outils. Pour chacun d'eux, la question de l'organisation humaine sous-jacente à la conservation biologique apparaît centrale:

- dans le cas des bovins et des porcs, la maîtrise technique de la congélation de la semence, l'affranchissement vis-à-vis de l'inscription régionale, la médiation du technicien qui relaie l'éleveur confèrent un rôle dominant à l'infrastructure;
- dans le cas des petits ruminants, ovins et caprins, c'est au contraire l'organisation collective des éleveurs et son inscription dans des systèmes agraires locaux qui prédomine;
- le changement rapide d'usage des chevaux et l'existence d'une administration d'Etat (le Service des haras) a conduit à privilégier des actions techniques de reconversion de l'usage du cheptel, aboutissant ainsi indirectement à sa conservation.

Approfondissant son analyse, Annick Audiot s'attache à préciser ce que les protagonistes s'efforcent de conserver derrière l'identité sociale du bétail et ses expressions héréditaires. Il peut s'agir du polymorphisme dû à des gènes dont l'effet est visible ou s'exprime par des variations de nature biochimique; il peut aussi s'agir de polygènes dont les effets quantitatifs sur les productions de lait ou de viande sont statistiquement estimés dans les populations contrôlées et introduits dans l'expression savante des index génétiques; il peut s'agir enfin de caractères d'adaptation de telle race à tel milieu d'élevage, défini à la fois par les caractéristiques de l'environnement physique et les pratiques des éleveurs, gestionnaires

des troupeaux. Mais les ressources qu'ils leur attribuent et les objectifs de production qu'ils leur fixent (niveau des performances escomptées, période de mise-bas, de vente, etc.), dans leur diversité, échappent l'expérimentation et sont du seul ressort de l'observation.

D'une manière générale, le propos, à la fois clair, précis et concret, appuyé sur des multiples exemples, est extrêmement pédagogique. Il s'agit pour l'auteur de mettre à la disposition du lecteur les connaissances zootechniques et génétiques qui fondent le concept de race et de lui montrer comment il peut les utiliser à l'appui d'un projet de conservation. Dans le cas des ovins, l'auteur, intégrant les caractères mis en jeu en élevage extensif, où le comportement social, spatial et alimentaire de l'animal joue un rôle central, ébauche ainsi la structure d'une typologie des races rustiques et explique comment évaluer l'adaptation d'une race à un milieu d'élevage donné.

Mais les acquis de la biologie n'y suffisent pas, car la race est à la fois un fait de nature, un fait de société et un fait de culture; il faut "comprendre comment la connaissance des processus biologiques et socio-économiques peuvent concourir à l'élaboration de programmes de conservation et de gestion des races locales". Annick Audiot mobilise à cette fin les représentations systémiques développées par les chercheurs du département Systèmes agraires et développement (SAD) de l'INRA (France), ce qui lui permet d'intégrer les "points de vue" des différents acteurs concernés et la diversité des stratégies de conservation qu'ils mettent en oeuvre. Sont ainsi croisés le point de vue "biologique" (quand race rime avec ressource), le point de vue administratif (quand race rime avec reconnaissance), le point de vue économique (quand race rime avec revenu), le point de vue des pratiques (quand race rime avec système agraire), le point de vue culturel (quand race rime avec identité), pour déboucher sur une conception élargie de la race, vue comme le produit d'un système social. L'auteur ne dissimule pas que son engagement dans la lutte pour la conservation des races en péril a été guidé par la passion qu'elle a découverte et appris à partager auprès de ces éleveurs militants, véritables résistants, à qui nous devons la survie de ces races d'hier dont nous aurons besoin pour l'élevage de demain.

La clarté et la présentation attrayante de cet ouvrage le rendent accessible à un très large nombre de professionnels, d'enseignants, d'élèves de l'enseignement technique agricole ou de l'enseignement général, d'étudiants, comme au grand public. Les définitions de tous les termes spécialisés qui sont utilisés sont parfaitement explicitées.

Bertrand Vissac et Etienne Landais

GENETIC IMPROVEMENT AND GERMPLASM CONSERVATION FOR QUALITY

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SUMMARY

Biological diversity is the main measure of genetic evolution; it links to the state of genetic polymorphism as influenced by environmental changes and modulates the speed of transferring genetic information. The authors concentrate in this note on the importance of the contribution of indigenous animal genetic resources when addressing the complex and economically most important problem of the intrinsic quality of products of animal origin, with special reference to regional/local specificity.

RESUME

La diversité biologique est la mesure principale de l'évolution génétique; elle est associée au degré de polymorphisme génétique qui est à la fois influencé par les changements environnementaux, et, en outre, règle la vitesse du transfert de l'information génétique. Les auteurs soulignent l'importance de la participation des ressources génétiques indigènes, lorsqu'il s'agit de faire face au problème principal, du point de vue économique, c'est à dire, la qualité intrinsèque des produits d'origine animale, en particulier de la spécificité locale et régionale.

1.0 INTRODUCTION

Strategies and procedures of both quantitative and qualitative genetics are universally valid for the genetic improvement of farm animals. The success of any genetic improvement programme depends on the amount of genetic variability existing in the population. Any genetic group - and in particular indigenous populations - is the carrier of ancient civilizations and old biological equilibria playing a role which in many cases has yet to be defined. Genetic resources are essential for the qualitative traits of animal products. Biological diversities (bio-diversity) are likely to be essential in solving the complex problems of nutrients in human nutrition (Matassino, 1991, 1992a and b; Matassino et al. 1991a).

The meaning of the genetic resources, is clearly evidenced in the behaviour of individual genic families: it is the result of a true democratic genic conversion, dynamic in time and space; a process that function is the natural example of the biological strategy called **suitability to adapt or evolutionary fitness**.

Biological diversity can be considered a unique precious good because it expresses a diversity in the genetic information. It is both the link with the past and the basis for **biological evolution**. Only if it is large enough can it guarantee evolution, therefore future existence. The qualitative improvement of any species or group, i.e. their **fitness** or **biological** success to survive environmental modifications is due to the biological diversity: what is therefore important is the level of organization and/or the hierarchical level of the information. The divergency of the genetic information leads to innovation; while the convergent biological processes (cell differentiations and embryo development) all form part of a genetic progress based on already existing information, thus with no innovation (Matassino, 1992c and d; Matassino *et al.*, 1993).

Biological diversity apparently increases disorder, i.e. increases the entropy of the whole system. The animal - Schrondinger says - is an open system, therefore it is filled continuously by negative entropy, which is order: chlorophyll synthesis is an example of this. Since the majority of living organisms (except some groups of bacteria) depends on the sunshine, the response to the negative entropy - expressing the continuously increasing order in life - is a decrease of positive entropy of the sun mass. The animal was, in fact, defined in 1940 by von Bertalanffy as an open biological system. Considering the homeostatic processes and consequent cybernetic links, Bettini (1972) prefers the definition of a biological open, dynamic and bound system.

Therefore an animal can be considered a complex highly integrated cybernetic and biological mechanism: it exchanges energy with information and detects the messages from outside, being sensitive and able to choose. Moreover, being a multidimensional entity it needs feelings and affection.

Homeostasis gives the animal the ability to modify inside traits, as far as outside traits vary, in order to prevent irreversible damages from occurring. This self government is often periodical becoming a true biological biorhythm.

Biological diversity, or **genetic polymorphism** allows nature to adapt to the speed of the environmental modifications thanks to a complex mechanism able to modulate the speed of transferring the genetic information. Therefore the lack of genetic variability brings a

reduction (or even disappearance) of homeostatic ability and self-government; with the risk of losing the information produced with great consumption and that will also never be found again.

Differences between genetic groups, especially indigenous, both within and between species, could be correlated with a different suitability to adapt to different environments.

The genome of such genetic groups is a biological material of high value with as purpose the detection of evolutionary models for intermittent equilibria; in fact, the individuals of a peculiar ecological niche might undergo effects which speed up the dynamics of their "jumping genes" called **trasposones**.

Therefore these individuals might have a more speedy evolutionary process, mutations being more frequent with them because their **trasposones** move faster.

In other words, these genes might be true genetic rules and/or modulators; their activity might lead to new cybernetic links at molecular level and to new developed models at phenotypic level. The mentioned dynamic biological processes assume that each cell contains a continuously changing socio-biological environment, the purpose of which is to improve the suitability of a population to adapt to modified environmental conditions.

The self-government of each system is due to complex active cybernetic processes. The grounding of cybernetics lies in the structure and the function of living beings which have survived and evolved for millions of years although both the inside and outside environment have dramatically changed. The individual must therefore:

- be able to control the events as far as they occur - such ability is individually variable;
- reduce the negative effects of environmental modification by eventually directing them towards positive effects;
- react easily to cope with the many environmental variations affecting its behaviour;
- be able to realize many and various behaviourial patterns;
- be able at any time to achieve an inside equilibrium (homeostasis), and
- be able to fulfil all the above tasks spending the minimum of energy, i.e. be able to use the smallest amount of inside energy for each response.

The micro-environment where the producing animal lives, is today more **cultural** than **natural** being almost totally influenced by man (progress in biotechnology).

The animal becomes the main character of the enterprise, therefore the relationship between farmer and animal must be revised. The technocratic society, fruit of the big industries, does not allow the natural optimum development of farm animals. It is therefore necessary to rely on the knowledge of new sciences, such as ethology, zoo-psychology, zoo-sociology, adaptability and zoo-semiotics.

2.0 PROBLEMS

The socio-economic context in which we live is extremely dynamic and depends more and more on sudden changes and on new discoveries in the biology of living beings.

At the beginning of the third millennium, production, demand, supply and animal product trade are altogether one variable in the international economic system, which is itself dependent on national economies, these last grouped in a subsystem corresponding to a geographical area, the EU being one of these subgroups. The mutual dependence is likely to become increasingly stronger, considering:

- scientific and technical progress;
- that computing science quickened any activity;
- the environment is monitored.

The requirements of the different human groups-social, hectic, economical, political, environmental, will also be different and they need to be foreseen before evaluating the components of one system, the scientific and technical knowledge are only one of them.

The available resources and the events of future development will influence production, supply and trade. Therefore, research and the political and productive strategies will be highly differentiated but highly affected by international strategies, approaches and results.

The future economic decisions must take into account the structural modifications: some events, in fact, cannot be measured, i.e. the weakness of the consumer.

Recently, Matassino (1992a and e) evidenced that the decisional process is the last step of the systemic model. It requires professional and enterprise skill, therefore the farmer needs a strategic mind, also must be sensitive to outside events. The reality that should be known has become too large therefore the farmer or the scientist must strongly pursue research in order to complete his lack of knowledge.

The society which is going to develop is multicultural, multiethnic, therefore involves multiple civilization. This requires various problems to be solved globally.

2.1 Quality

No doubt that the genetic progress, which can be achieved using also indigenous germplasm, will contribute to satisfy the more sophisticated requirements of **total quality** of animal products.

In this context we are challenged from everywhere, therefore the policy - agricultural, food and environmental - must consider first the nutritional requirements: it is a nonsense to increase just quality.

The word quality is difficult to define, due to the many meanings that each human group gives to it. Moreover, very often neither the producer, nor the consumer agrees with the definition of quality. International competition might emphasize the gap, but further studies are possible (Peri, 1990; Matassino, 1991 and 1993; Valfré and Moretti, 1991; Matassino *et al.*, 1991). The idea of quality does not concern only one particular food as we see it, but must involve the whole background, which begins with the individual animal giving that product and for which is reared in a certain environment.

The importance of the genetic information of the individual (genetic typing) is therefore evident. This is the starting point to obtain animal products satisfying nutrients requirements according to the physiological condition of human beings. We hope, therefore, that any strategy of genetic improvement considers nutritional qualities. Such a goal will not be

achieved without a more professional and sensitive farmer. Researchers in animal production play an important role in this context: research needs to be always innovative and new.

Biotechnologies and new techniques will be used to a larger extent and the products will be more and more different both for their dietetic traits and for the processing technologies which raw materials will undergo. Also the conservation techniques and the distribution of products will be modified.

A food revolution is in course: it is based on the promise of freshness, health, well feeling, young-looking which is sponsored by mass media.

Strategic decisions concerning food will be very much influenced by the modified eating habits.

2.2 Systemic approach

According to Cartwright (1970) the evolution of the genetics applied to livestock production can be divided into 6 periods:

- premendelian;
- mendelian;
- population genetics;
- contemporary selection for more than one trait;
- quantitative genetics; and
- systems analysis.

Matassino (1989) defines as "historical" the above classification.

Cartwright (1970) states that the systems analysis allows an evolution from the evaluation of the individual animal to the evaluation of a group of animals identified as productive unit, in the same way as in the past the selection index evolved from single-trait to a multi-trait. The systemic approach allows animals to be considered individually, or from the point of view of their interaction either between each other or between themselves and the environment, with the result of measuring the "net" productivity of the actual productive unit. The productivity might be expressed as number of units leaving the system per unit entering.

More details on the systemic approach can be found in Bettini (1972 and 1988) and Matassino (1984). No doubt animal modelling contributes to detecting the optimum level of the most important traits interesting certain productions; such a level, however, might not be associated with the top level of a certain phenotypic expression which at present the selection tends to achieve. Because the knowledge of the parameters to introduce into the model is an essential requirement, performance recording cannot be substituted; on the contrary it needs to be further implemented in order to obtain results reliable in the different farming conditions.

2.3 The buffaloes example

An interesting example is that of buffalo farming. The importance of maintaining the genetic variability of buffaloes and of using it in animal production was recently evidenced by Steane (1994).

FAO long term strategies, look in fact very much similar to the ones proposed by Italian authors (Matassino, 1979 and 1992d; Matassino and Grasso, 1991; Matassino *et al.*,

1993). From these strategies a proposal emerges: within the Working Group Products' of the FAO Inter-Regional Research Network on Buffalo, a subgroup needs to be created to approach the genetic typing of buffaloes (i.e. milk protein and fat polymorphisms and chromosome polymorphisms) and to detect eventual associations between marker genes and productive performances. In this case, in order to avoid theoretical and operational mistakes, not the single locus but the whole genotype must be taken into account, since interrelations might exist between the genes responsible for certain traits (Bettini, 1972; Matassino *et al.*, 1993; Prandi *et al.*, 1994).

Such approach is required because the ability to adapt or to produce of the single gene instead of the gene in the genome context is not yet known.

Recently, the social significance of buffaloes was evidenced in the development of agriculture in large areas of Asia (Sasaki, 1994; Chantalakhana, 1994; Bunyavejchewin, 1994). The problem evidenced by the above authors is similar to the one approached politically by the European Union (EU). In fact, they both state that the agricultural productive process must be considered globally (systemically). In the systemic approach, agriculture is one basic component of a socioeconomical macro-or micro system. Rural development is, in fact, considered a basic component of the future European social system. This new idea, foreseen by Maastricht agreements, will favour all inside trials aiming to achieve a targeted development of the land, so that the inside productive potential of that land will be allowed to valorize local production, naturalize indigenous resources and implement different activities (Matassino, 1981 and 1987a).

In order to put this strategy into practice, whatever the geographical area might be, it will be necessary to foresee at the same time: operations on the animal genotype, nutrition, irrigation, herd structure, management, extension service, and human health.

3.0 REFERENCES

Bettini T.M. (1988). Elementi di scienza delle produzioni animali. Edagricole, Bologna, Italy.

Bettini T.M. (1972). Concezioni moderne sulla validità dei cosidetti gruppi etnici, anche ai fini dello sviluppo zootecnico. In: Riproduzione animale e fecondazione artificiale. Edagricole, Bologna, Italy. XVIII-331.

Bunyavejchewin P., Sangdid S and Chantalakhana C. (1994). Socioeconomic conditions affecting the use of draught buffalo versus two-wheeled tractor in some villages of Surin province. Proc. First ABA Congr., Bangkok, 28pp.

Chantalakhana C. (1994). Swamp buffalo development in the past three decades and sustainable production beyond 2000. Proc. First ABA Congr., p.14. Bangkok, Thailand.

Mattasino D. (1992a). Per una zootecnia europea c'è ancora bisogno di tecnica. L'Allevatore 48(13), p.7. Terra Pugliese 40(7), p.15.

Mattasino D. (1992b). Genetic improvement for bovine milk production for human nutrition. Proc. Int. Symp. on "Health risks due to the lack of milk consumption in human nutrition". Capri 9-10 October. In press.

Matassino D. (1992c). Il ruolo del germoplasma animale autoctono nell'ecosistema culturale. L'Allevatore 48(17), p.18. Alto Tammaro 4(15), p.39.

Matassino D. (1992d). Salviamoli dall'estinzione. L'Allevatore 48(34), p.12.

Matassino D. (1992e). Il ruolo dell'agrotecnico nello sviluppo delle produzioni animali. Atti Conv. "Il ruolo dell'agrotecnico nella realtà agricola molisana verso l'Europa del 1993". Riccia (CB), 25 April.

Matassino D. (1991). Il miglioramento genetico nei bovini per la produzione di latti finalizzati all'uomo. Atti Conv. "Il ruolo del latte nell'alimentazione dell'uomo". Paestum (SA), 24-26 ottobre. Quaderni ANAFI, p.70. February 1992.

Matassino D. (1988a). Il futuro delle biotecnologie nelle produzioni animali: Alcuni aspetti scientifici e tecnici. Prod. anim. 1, III Serie, p.35.

Matassino D. (1988b). Il bovino: la produzione del latte oggi e domani. Atti Conv. "Il bovino al servizio dell'uomo: quali prospettive per il 2000". Giorni, 74(22), Supl.

Matassino D. (1987a). La zootecnia del mezzogiorno: alcune ipotesi per il miglioramento produttivo. La questione agraria 26, p.45.

Matassino D. (1987b). Lo sviluppo delle biotecnologie: aspetti scientifico-tecnici e prospettive per il futuro. Atti Conv. "Le nuove frontiere della selezione: dalla fecondazione artificale alle biotecnologie". Cremona, 18 septembre. L'Allevatore 44(33), 1988 Supl.

Matassino D. (1985). La carne bufalina merita il banco del macellaio al pari di quella bovina. L'Informatore Agrario 41(44) p.27.

Matassino D. (1984). Problematiche del miglioramento genetico dei bovini. Atti XIX Simp. Int. Zootecnia. Milano, Italy. 15 April. p.11. L'Allevatore, 40(35) p.6. Terra pugliese 33(11-12), p.5. L'Informatore zootecnico 32(7), p.20.

Matassino D. (1981). Aree interne della Basilicata. Ecco cosa bisogna fare per lo sviluppo zootecnico. L'Allevatore 37(22), p.1. Sviluppo zootecnico delle aree interne della Basilicata (5)58.

Matassino D. (1979). Intervento alla tavola rotonda su "Prospettive e misure per la difesa genetica delle popolazioni animali. Atti conv. CNR "Salvaguardia genetica e recupero zootecnico delle popolazioni autoctone italiane". Foligno, Italy, 14-15 November 1979, p.495.

Matassino D. and Grasso F. (1991). Preservation of animal ecotypes bred in the Mediterranean area. Proc. Int. Symp. "Animal husbandry in warm climates". Viterbo 25-27 October 1990. EAAP publ. no. 55, p.137.

Matassino D., Pilla A.M. and Alendri R. (1993). Recording and selection of buffaloes. Proc. Int. Symp. "Prospects of buffalo production in the Mediterranean and the Middle East". Cairo 9-12 November 1993. EAAP publ. n. 62, p.87.

Matassino D., Zucchi G. and Di Berardino D. (1991). Management of consumption demand supply and exchange. Proc. Symp. "On the eve of the 3rd millennium, the European challenge for animal production". Toulouse, 11 July 1990. EAAP publ. n. 48, p.105.

Peri C. (1990). Qualità e certificazione dei prodotti agro-alimentari in vista del mercato unico europeo. Atti Soc. Agr. di Lombardia. III Serie, 128(3), p.27.

Prandi A., Falaki M., Corradini C., Sneyer M., Formigoni A., Massart S., Fazzini R., Dal Bo A., Burny A., Prtelle D. and Renaville R. (1994). Marcatori genetici e produzione del latte nelle bovine di razza Frisona e Pezzata Rossa Italiana correlate. Atti Conv. Biotecnologie e produzione del latte. Torino 3-4 November, p.156.

Sasaki M. (1994). Progress in Asian buffalo production: its implication to small farmer development. Proc. First ABA Congr. Bangkok, p.5.

Steane D.E. (1994). Overview of world animal genetic resources. Proc. First ABA Congr. Bangkok, p.46.

Valfrè F. and Moretti V.M. (1991). Characteristics, quality and control of animal products for human consumption. In: "The livestock production in Eastern Europe as affected by current changes". EAAP publ. n. 57, p.144.

LE POINT SUR LES RESSOURCES GENETIQUES EN MATIERE D'ELEVAGE AU BURKINA FASO

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RESUME

Le Burkina Faso, avec plus de 11 millions de petits ruminants et près de 4 millions de bovins (MAE, 1990) pour un territoire essentiellement sahélien de 274 00 km^2, est un pays exportateur de bétail. On estime la contribution des produits du bétail à 27% de la valeur de l'ensemble des produits agricoles. L'élevage occupe donc une place de choix dans les activités de la population. Avec le dernier recensement de 1989 (MAE, 1990), on connaît à peu près les effectifs du cheptel; cependant, on peut estimer que peu de travaux ont porté sur la description des races locales. Ces travaux sont surtout ceux de Doutressoulle (1947), Dumas et Raymond (1975), et Bourzat (1979). Les données présentées ici proviennent donc essentiellement des sources suscitées; pour certains aspects (taux de croissance) les chiffres proviennent de la cellule statistique du Ministère Délégué aux Ressources Animales (MDCRA, 1991) et de l'Etude prospective du sous-secteur élevage (MAE, 1991).

SUMMARY

Burkina Faso, with more than 11 million of small ruminants and about 4 million of cattle (MAE, 1990), with 274 000 km^2, mainly Sahelian land, is a cattle exporting country. It is estimated that the contribution of cattle products represents 27% of the total of agricultural products. So, livestock represents an important activity for the population. From the last census of 1989 (MAE, 1990) we more or less know the livestock number; however, few informations are available about the description of local breeds. Relevant works were carried out by Doutressoulle (1947), Dumas et Raymond (1975) and Bourzat (1979). The data presented in this paper come mainly from these papers. For some aspects (growth rate), data come from the Statistic Unit of the *Ministère Délégué aux Ressources Animales* (MDCRA, 1991) and from a prospective study of the livestock sub-sector (MAE, 1991).

1.0 DESCRIPTION DES POPULATIONS DE BETAIL

1.1 Effectifs et utilisation des populations de bétail

Les espèces les plus nombreuses sont les herbivores domestiques (4 170 400 UBT), dont 69% pour les bovins, 12% pour les ovins, 12% pour les caprins, et 7% pour les autres herbivores (ânes, chevaux, dromadaires). Le taux d'accroissement est supérieur ou égal à 2% pour ies bovins, les ovins, les caprins, les porcins, les asins et les volailles. Le taux d'accroissement des équidés et des camélidés est inférieur à 2% (tableaux 1 et 2).

Le tableau 1 donne les effectifs et les taux d'accroissement des différentes races de ruminants au Burkina Faso.

Parmi les monogastriques, les plus nombreux sont les volailles (plus de 17 millions en tout), et les porcs (493 000). Le tableau 2 donne des précisions sur les effectifs des monogastriques domestiques représentés au Burkina Faso.

Les principales utilisations de ces espèces et races sont les suivantes: viande, lait (zébus, chèvre du sahel, dromadaire), travail (bovins, asins, équins, dromadaires), et le fumier.

2.0 CARACTERISTIQUES DES PRINCIPALES ESPECES ET RACES DU BURKINA FASO

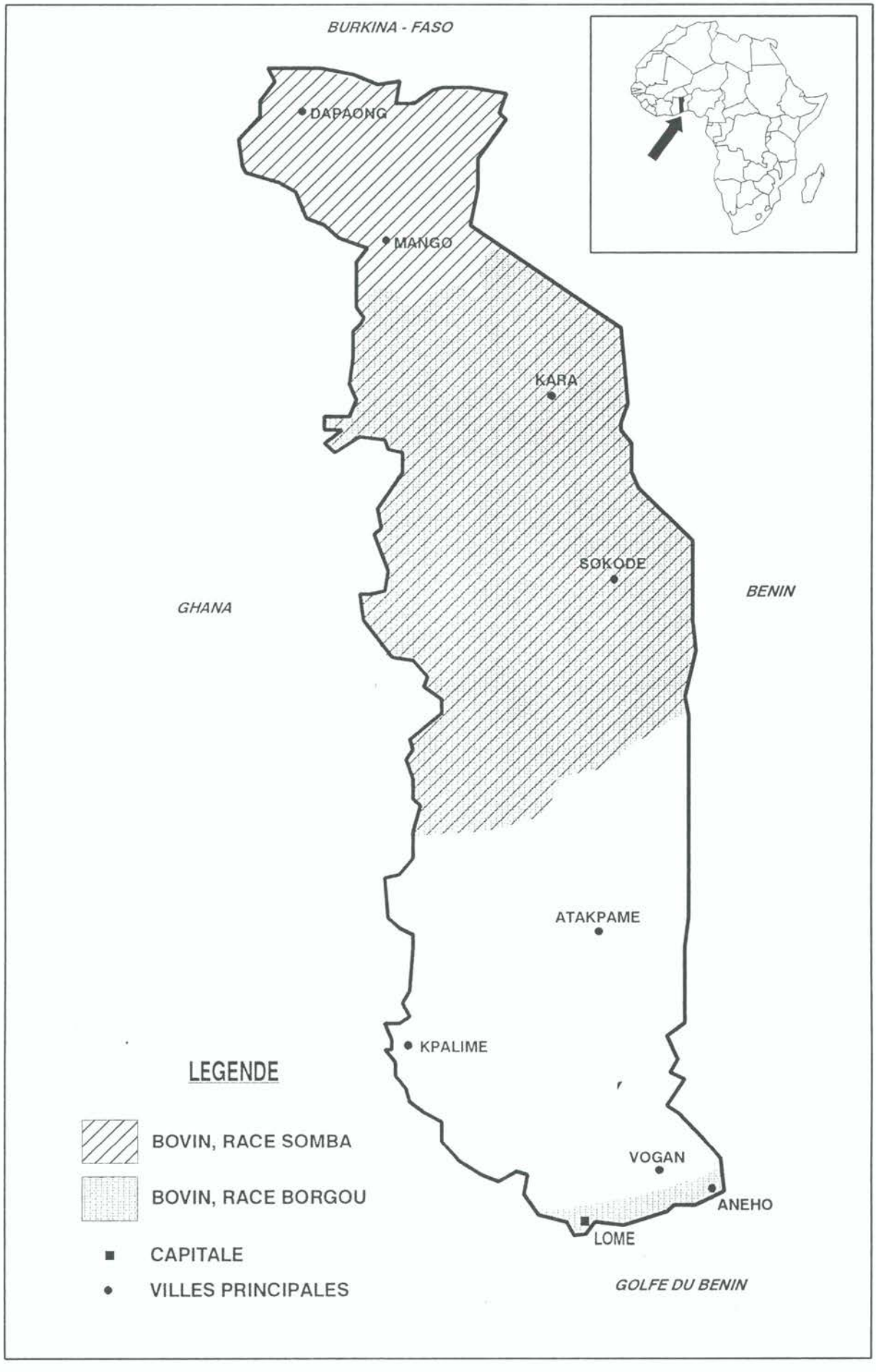
2.1 Bovins

Les bovins sont surtout localisés dans les zones nord soudanienne (45,39%) et sud soudanienne (25,08%) (MAE, 1991). La bibliographie (CIPEA, 1979) insiste plus sur la présence de zébus Peuhl Soudanien, qui serait localisés dans les zones soudaniennes du pays (centre et sud); cependant, les zébus rencontrés dans les provinces sahéliennes (extrême nord du pays) présentent des caractéristiques assez différentes du zébu rencontré plus au sud; on note en particulier une taille et un poids plus élevés; bien que la bibliographie disponible n'en fasse pas cas, on peut donc estimer qu'une partie (à déterminer) des bovins du nord du pays sont des zébus Peuhl sahéliens. On rencontre également dans le pays des zébus Azawack (ou Azaouak) dans des fermes d'Etat non loin de Ouagadougou (dans le cadre de la politique laitière péri-urbaine) et aux mains de très rares producteurs.

Les zébus sont souvent utilisés pour le labour et le transport dans les zones centre et surtout sud du pays. Dans ce cas ils sont castrés entre 18 et 24 mois puis introduits au travail à l'âge de 2 à 3 ans.

Quant aux taurins Baoulé ils sont surtout localisés dans les zones humides, en particulier vers les frontières ghanéennes et ivoiriennes, où la pression trypanosomienne est plutôt forte. En raison de leur petit format ils ne sont pas particulièrement recherchés pour les labours. Une centaine de taurins N'Dama est élevée dans une ferme d'Etat à une cinquantaine de kilomètres au nord de Bobo-Dioulasso.

On rencontre un grand nombre de métis Peuhl x Baoulé dans les zones relativement humides et plutôt agricoles. Ceci peut être interprété comme une recherche d'animaux plus performants pour la traction animale, mais conservant un minimum de tolérance vis-à-vis de la trypanosomiase.


BURKINA - FASO
DAPAONG
MANGO
KARA
SOKODE
GHANA
BENIN
ATAKPAME
KPALIME
VOGAN
ANEHO
LOME
GOLFE DU BENIN
LEGENDE
BOVIN, RACE SOMBA
BOVIN, RACE BORGOU
CAPITALE
VILLES PRINCIPALES

Les zébus présentent des poids et une taille plus élevés que les taurins; ils fournissent également plus de lait. Le rendement carcasse est supérieur à 48% pour les deux groupes; les métis présentent des performances intermédiaires entre les deux (tableau 3).

2.2 Ovins et caprins

Les petits ruminants sont surtout localisés dans les zones nord-soudanienne (47,35% pour les ovins et 39,83% pour les caprins) et sub-sahélienne (26,57% pour les ovins et 27,27% pour les caprins). Les petits ruminants de race sahélienne (mouton Peuhl burkinabé ou voltaïque[1] et chèvre du Sahel burkinabé ou voltaïque[2]) sont essentiellement localisés dans les trois provinces les plus au nord; les races plus petites se rencontrent dans le centre et le sud du pays. Cependant on rencontre un nombre important mais non inventorié d'ovins croisés Peuhl x Mossi, et de caprins croisés Sahéliennes x Mossi dans la zone sub-sahélienne; il y a même une tendance générale à l'absorption des petites races par les grandes, compte tenu de l'attrait des populations pour les grands formats. C'est à ce titre que les sujets Bali-Bali qui sont encore de plus grande taille sont importés du Niger et croisés avec les brebis locales surtout par les producteurs du nord.

Comme chez les bovins, les races sahéliennes présentent des tailles et des poids plus élevés que les races Mossi. Pour les deux groupes, les rendements tournent autour de 45 à 48% (tableau 4).

2.3 Les monograstriques

2.3.1 *Le cheval*

La race équine locale du Burkina Faso serait un métis entre le cheval "Barbe" et le cheval "Arabe". C'est un sujet rustique qui fournit une viande de bonne qualité consommée tant à l'intérieur qu'à l'extérieur (558 tonnes de viande produite en 1993 et 1 500 têtes exportées).

2.3.2 *L'âne*

L'âne du Burkina Faso revêt trois caractéristiques fondamentales qui sont la rusticité, la sobriété et l'endurance. Il est capable de porter 1,5 à 2 fois son poids en charge, et avec 150 kg de poids vif fournir un effort de traction égal à celui que fournirait un bovin de 260 kg.

2.3.3 *Le dromadaire*

Le dromadaire a d'énormes potentialités de production de lait (9 litres en moyenne par jour) et de viande (208 kg de poids de carcasse) (CIPCA, 1985). Son cuir est utilisé dans la maroquinerie.

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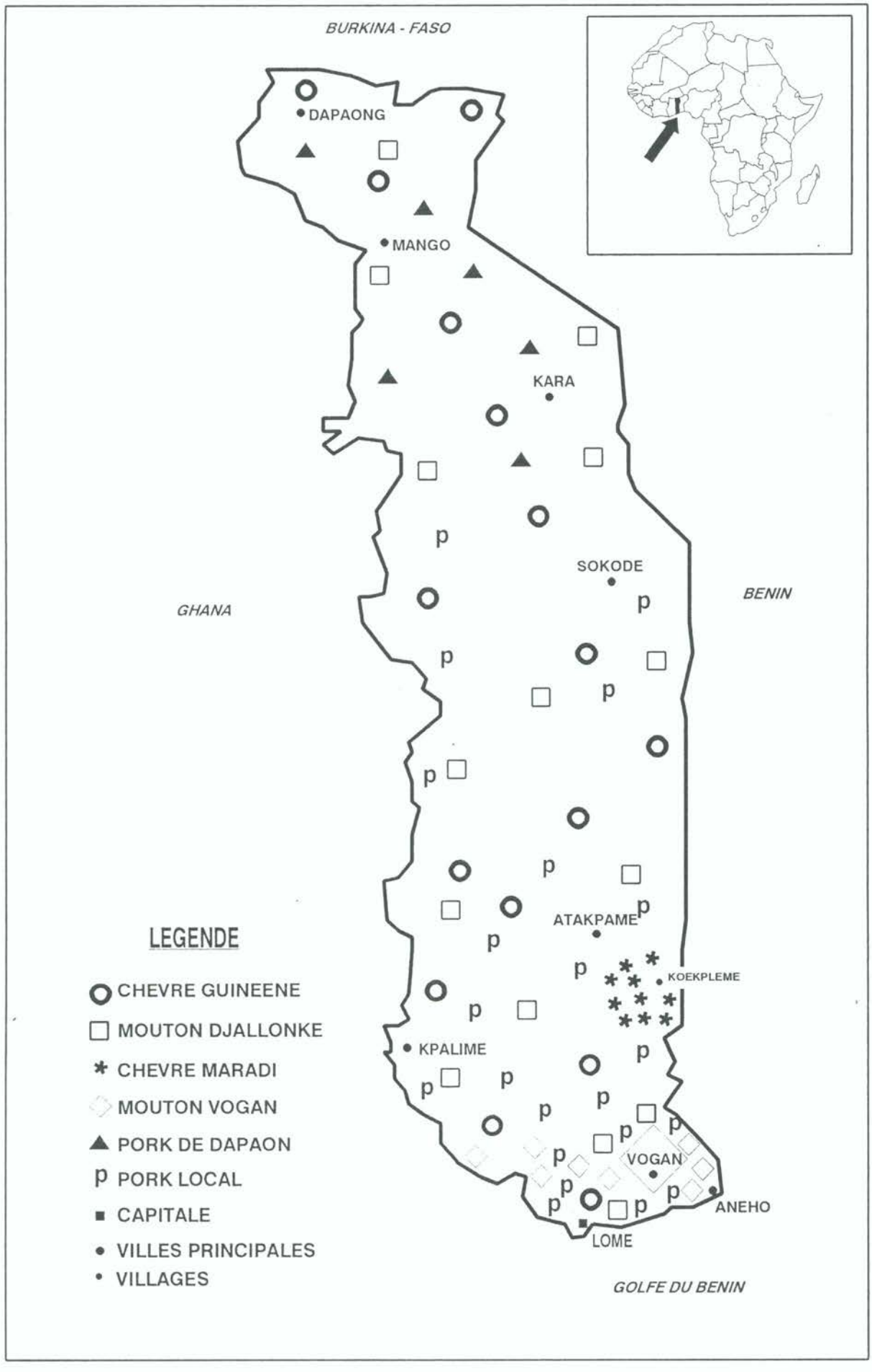
[1] Il s'agit bien ici du mouton Peuhl voltaïque décrit par Dumas et Raymond (1975) qui a été rebaptisé mouton Peuhl burkinabé après que l'appellation du pays soit passée de Haute Volta au Burkina Faso.

[2] Il s'agit bien ici de la chèvre du Sahel voltaïque décrite par Dumas et Raymond (1975) qui a été rebaptisée chèvre du sahel burkinabé.


BURKINA - FASO
DAPAONG
MANGO
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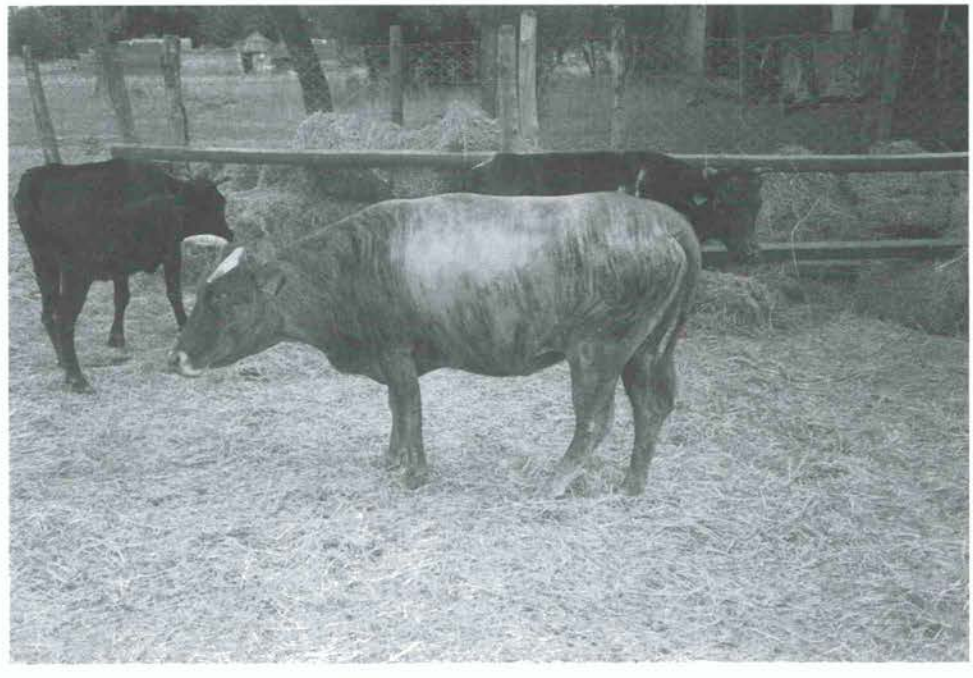
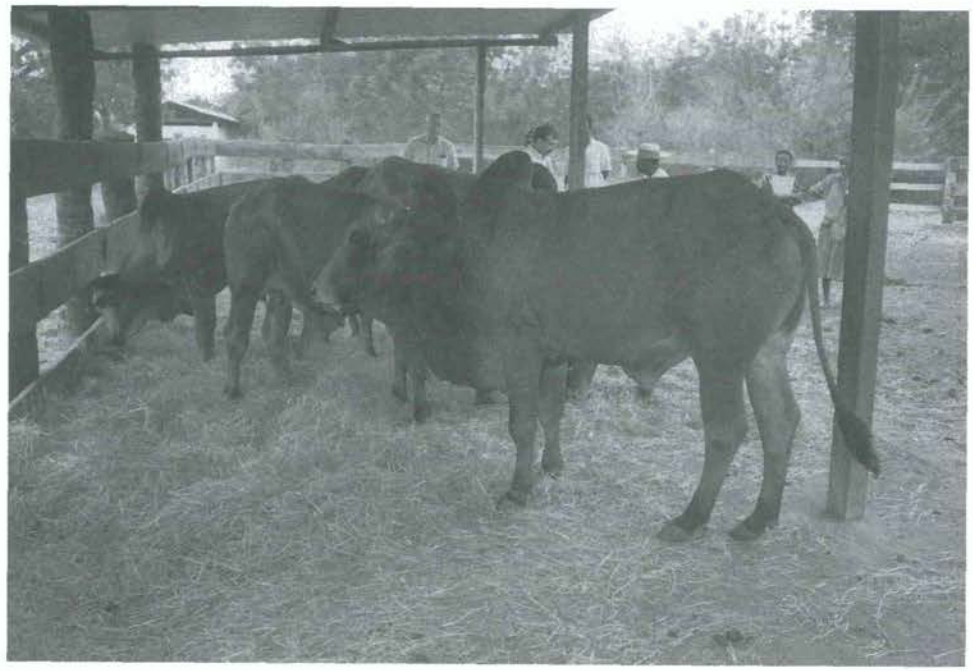
ANEHO
LOME
GOLFE DU BENIN
LEGENDE
CHEVRE GUINEENE
MOUTON DJALLONKE
CHEVRE MARADI
MOUTON VOGAN
PORK DE DAPAON
PORK LOCAL
CAPITALE
VILLES PRINCIPALES
VILLAGES

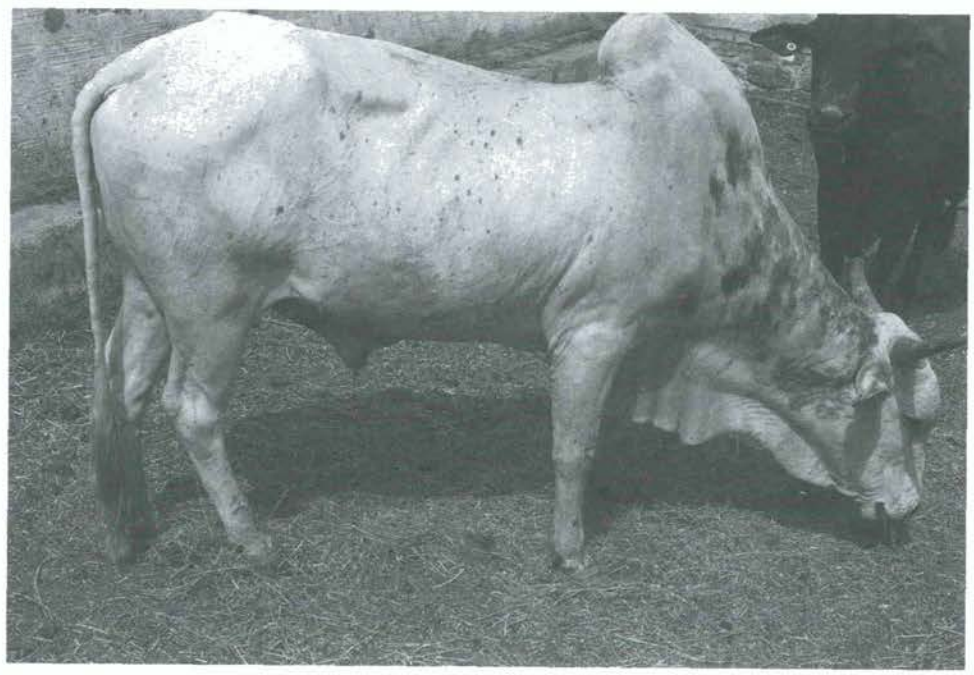
Taurins N'Dama



Taurins Baoulé



Taureaux Azawak



Taureau zébu Peuhl soudanais

2.3.4 *Le porc*

Le porc local du Burkina Faso est rustique avec une bonne prolificité mais il a une faible productivité en viande (87,8 g de GMQ en milieu traditionnel et 304 en exploitation moderne). Il y aurait deux souches d'animaux; une de petite taille avec 5 à 6 porcelets par portée et une de grande taille avec 10 à 15 porcelets par portée. Des races étrangères ont été introduites en nombre très limité en vue d'améliorer la race locale; ce sont la race de Korogho (métis Large White x Locale Ivoirienne) et la Landrace d'origine danoise.

2.3.5 *La volaille*

a) Le poids du coq local fait 1,5 kg, celui de la poule 1 kg. La poule pond 40 à 50 oeufs par an d'un poids moyen de 25 à 30 g.

b) Le dindon pèse de 7 à 15 kg et la dinde de 3 à 8. L'entrée en ponte se situe entre 7 et 8 mois avec un poids moyen de 54,82 g par oeuf. La dinde est une très bonne couveuse et est utilisée par les producteurs pour les oeufs de pintades à raison de 60 à 100 oeufs de manière répétée 2 à 3 fois par an.

c) La pintade locale se compose de 2 souches; la petite pintade du sud et la grosse pintade de Dori. La dernière pond 100 oeufs par an avec un poids moyen par oeuf de 45 g et un taux d'éclosion de 80%. La pintade de Dori a un poids moyen de 2 à 2,5 kg.

3.0 MODES DE CONDUITE

Les ruminants domestiques dépendent essentiellement du pâturage naturel pour leur alimentation; cette alimentation est complétée en saison sèche par des résidus de récolte et quelques fois des concentrés (sous-produits agro-industriels). L'utilisation de ces ressources alimentaires varie d'une zone à l'autre, d'une saison à l'autre, d'une espèce à l'autre, et selon le mode d'élevage.

3.1 Mode d'élevage des ruminants

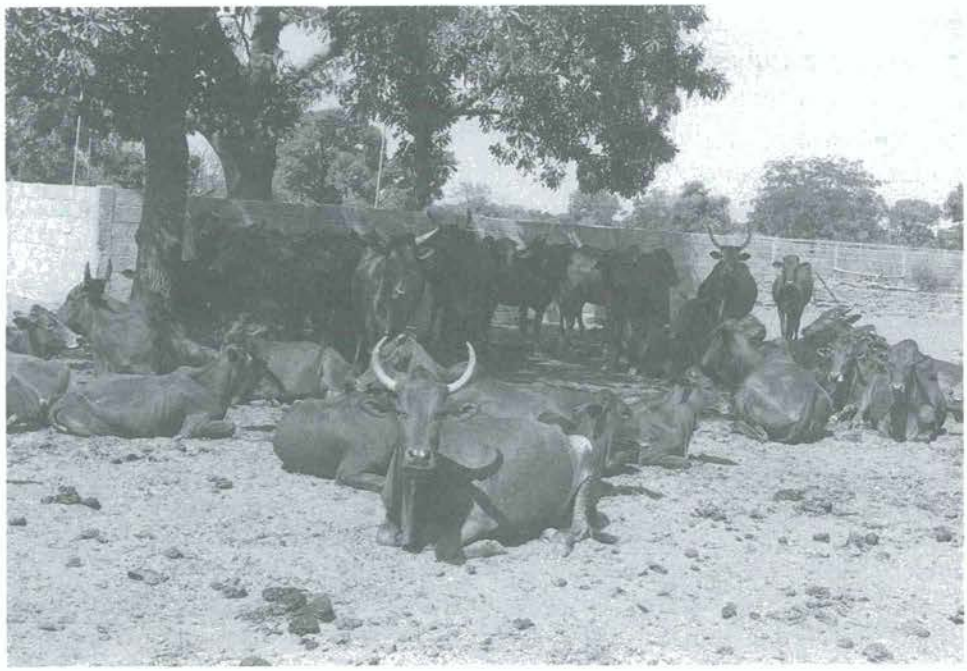
Au Burkina Faso on distingue essentiellement deux types d'élevage: l'élevage transhumant, pratiqué par les pasteurs (surtout dans les zones sahéliennes et sub-sahéliennes), et l'élevage sédentaire, pratiqué surtout par les agro-pasteurs dans les zones plus humides.

La transhumance porte sur les ruminants au sahel et s'effectue du nord au sud en saison sèche et du sud au nord en hivernage. L'élevage sédentaire porte par contre sur les ruminants au sud.

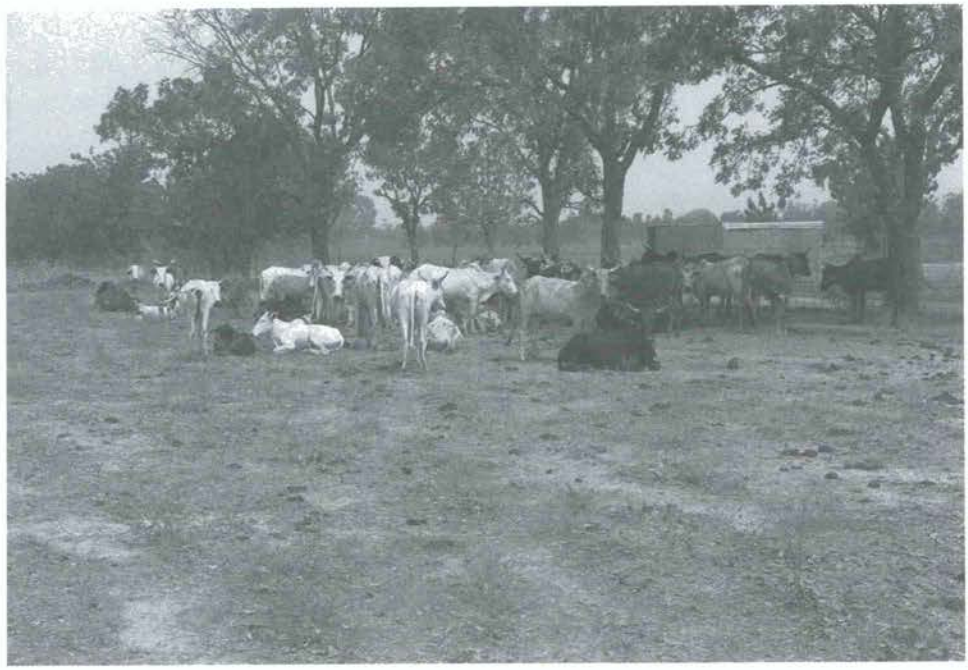
Les bovins et les gros troupeaux de petits ruminants sont conduits par des bergers au pâturage en hivernage. Les petits troupeaux d'ovins et caprins sont à l'attache aux piquets aux bords des champs. Les mouvements du bétail sont moins contrôlés en saison sèche, surtout pour les petits ruminants.

Pendant les périodes de soudure, des baisses de poids sont enregistrées au niveau des bovins et des ovins.

Les bovins sont utilisés pour la viande (embouche intensive par les producteurs ou les associations de producteurs), la traction/le lait (essentiellement autour des centres périurbains). La spéculation sur les petits ruminants est axée sur l'embouche intensive ou traditionnelle. Les cuirs et peaux de même que le fumier sont également exploités.



Troupeau Azawak



Troupeau zébu Peuhl soudanais

De même que pour les ruminants, des dispositions sont prises en hivernage pour la conduite des monogastriques (porcs, ânes, chevaux, dromadaires) pour éviter les dégâts champêtres, causes très fréquentes de conflits sociaux profonds. Ces monogastriques (excepté le porc) sont soumis à un problème commun qui est leur marginalisation à la fois par les producteurs, les développeurs et les chercheurs alors qu'ils prennent de plus en plus d'importance sur le plan socio-économique (force de travail, viande pour tous et en plus du lait pour les dromadaires).

4.0 PROGRAMMES SUR LES RESSOURCES GENETIQUES DU BURKINA FASO

Très peu de travaux ont été effectués sur la génétique animale au Burkina Faso. Cependant, plusieurs projets ont inclus l'amélioration génétique ou la multiplication de races dans leurs objectifs (tableau 6). Mais on peut considérer qu'en dehors du Centre d'Elevage et de Formation de l'Oudalan (CEFO) de Markoye (qui est d'ailleurs fermé), l'impact réel de tous ces projets est négligeable sur le plan national, soit en raison de la durée généralement courte de ces projets, soit en raison d'une absence de suivi des animaux diffusés.

Il existe plusieurs structures ou institutions compétentes en matière d'élevage (voir tableau 7), mais à l'heure actuelle les seules qui mènent des activités d'envergure sur les ressources génétiques au niveau du bétail sont l'INERA le CRTA/CIRDES, et l'ONAVET.

4.1 Au niveau de l'Office national vétérinaire (ONAVET)

Il s'agit d'une multiplication de la race Azawak, que le Ministère chargé de l'élevage essaie de diffuser, pour son grand gabarit, sa bonne production laitière et sa vitesse de croissance supérieure à celles des races locales. Les Azawak du ranch de Loumbila sont importés du Niger mais ils ont d'abord séjourné au ranch de Markoye, avant le changement d'orientation de celui-ci. Le déplacement de ces animaux de Markoye (360 km au nord de Ouagadougou) vers Loumbila (25 km au nord de Ouagadougou) avait pour but de les rapprocher des éleveurs périurbains, qui en sont de grands demandeurs.

4.2 Au niveau du Centre de recherches sur les trypanosomiases animales. Centre international de recherches-développement sur l'élevage en zone subhumide CRTA/CIRDES)

Le CRTA a contribué pendant plus d'une décennie à la caractérisation des races bovines trypanotolérantes d'Afrique de l'ouest. Cette caractérisation a concerné les taurins trypanotolérants (N'dama, Baoulé, Lagunaire), et quelques races trypanosensibles (zébu Peuhl soudanien local, zébu Azawak); les prélèvements sanguins utilisés pour cette caractérisation ont été obtenus au Burkina Faso (Baoulé et Peuhl soudanien), mais aussi en Côte d'Ivoire, au Togo, en Gambie, au Mali, au Niger, au Bénin et au Sénégal.

Pour la sélection des taurins trypanotolérants, quatre systèmes ont été proposés: un système de groupes sanguins (AH), et trois systèmes protéiques ou enzymatiques: albumine (FF), hémoglobine (AA), et transférines (A, D, E). Parmi les travaux conduits par le CRTA, on peut également citer l'analyse des groupes sanguins et les contrôles de filiation, l'étude du polymorphisme des caséines du lait bovin (zébus surtout) du Burkina Faso, la fourniture d'ADN bovin à divers laboratoires en Europe et en Afrique.

Au Burkina Faso le CRTA/CIRDES reste le seul centre de recherche équipé pour la caractérisation des races par les marqueurs génétiques. Il a souvent collaboré avec l'Université de Ouagadougou pour la recherche et la formation (Congo, 1990; Bambara, 1984), et a récemment entrepris une coopération avec l'INERA pour la caractérisation des ovins locaux.

Sur un plan plus pratique, la Banque de semences du CRTA dispose déjà d'une collection (25 000 paillettes) provenant de N'Dama, Baoulé et Zébu, et testées pour leur trypanotolérance et leurs performances zootechniques. La capacité moyenne de production du CRTA est estimée à 10 000 doses par saison (CRTA, 1992).

4.3 Au niveau de l'Institut d'études et de recherches agricoles (INERA)

L'INERA opère seulement sur les ovins, et ceci dans deux directions à l'heure actuelle: la caractérisation des races locales et le croisement.

En ce qui concerne la caractérisation des races, l'INERA a constitué deux cellules informatives sur deux races bien représentées au Burkina Faso: une pour la race ovine du nord à la station de Katchari (275 km au nord de Ouagadougou), et une pour la race ovine du sud à la station de Saria (80 km au sud-ouest de Ouagadougou).

Les opérations menées sont des mensurations diverses et la description des robes pour la caractérisation phénotypique. Une enquête de terrain sur les critères traditionnels de choix des ovins reproducteurs vient appuyer cette action. Dans le cadre de la collaboration, le CRTA/CIRDES assure le volet analyse en laboratoire des paramètres sanguins.

Pour le croisement, l'INERA a installé deux troupeaux d'essais: l'un à Koare (260 km à l'est de Ouagadougou), l'autre à Kamboinse (15 km de Ouagadougou). Dans le cas de Koare, il s'agit d'un croisement de création partant du mouton Mossi et du mouton Bali-Bali, avec pour objectif d'aboutir à une race intermédiaire plus performante que la race Mossi, et avec une adaptation suffisante pour les conditions écologiques de la zone soudanienne. Ce programme a démarré en 1991 et se poursuit toujours.

Dans le cas de Kamboinse, il s'agit d'un croisement d'absorption Bali-Bali x Mossi, dans le but de produire un Bali-Bali adapté aux régions humides du Burkina Faso. Ce programme a également démarré en 1991 et se poursuit toujours.

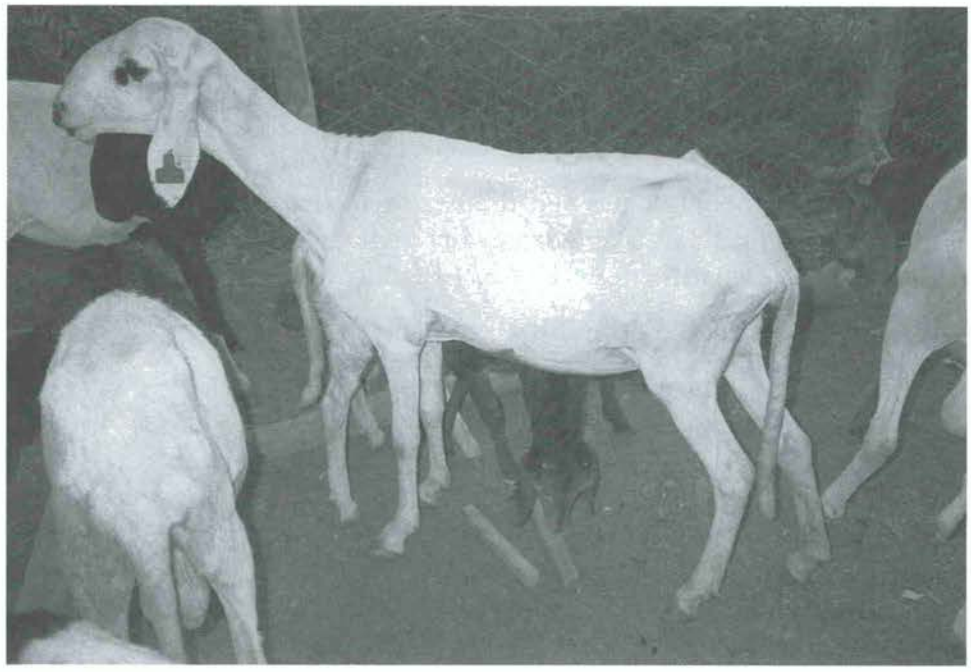
Au niveau des perspectives, l'INERA envisage d'aborder:

- la caractérisation d'autres espèces domestiques;
- la sélection, notamment ovine et bovine.

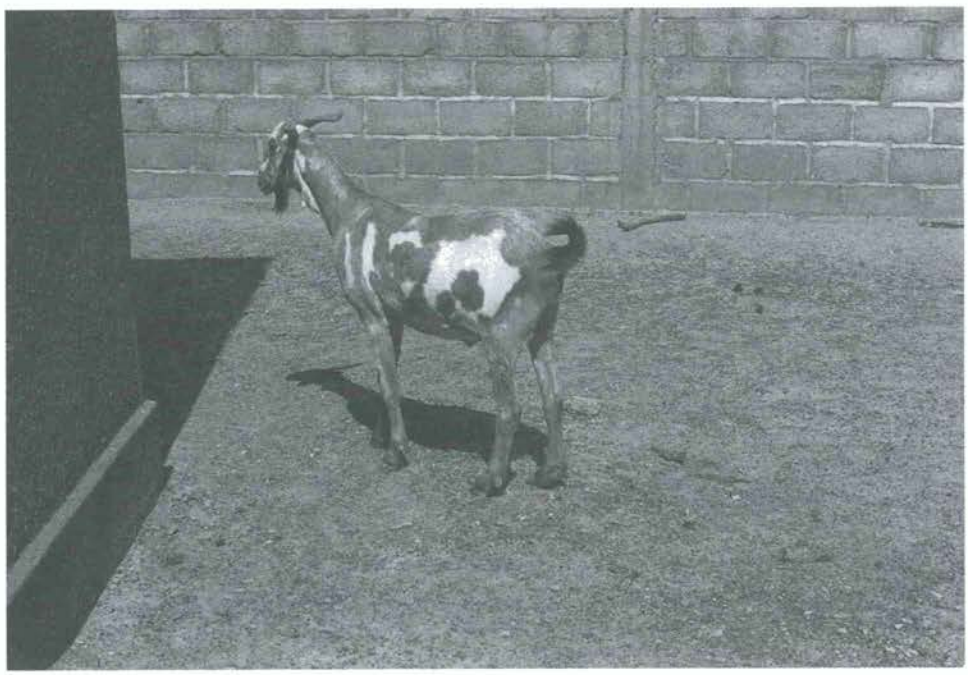
5.0 CONCLUSION

On peut considérer que la plus grande partie du travail de recherche reste à faire pour ce qui concerne le Burkina Faso, étant donné le caractère limite des références disponibles. Le plus urgent peut-être serait la mise en place de structures de conservation des races locales; ces structures permettraient d'abord la caractérisation et la sauvegarde des souches existantes (ce qui éviterait des situations désagréables, prévisibles avec les croisements incontrôlés que l'on constate actuellement). Elles permettraient par la suite la réalisation de programmes d'amélioration génétique plus cohérents et plus rationnels.

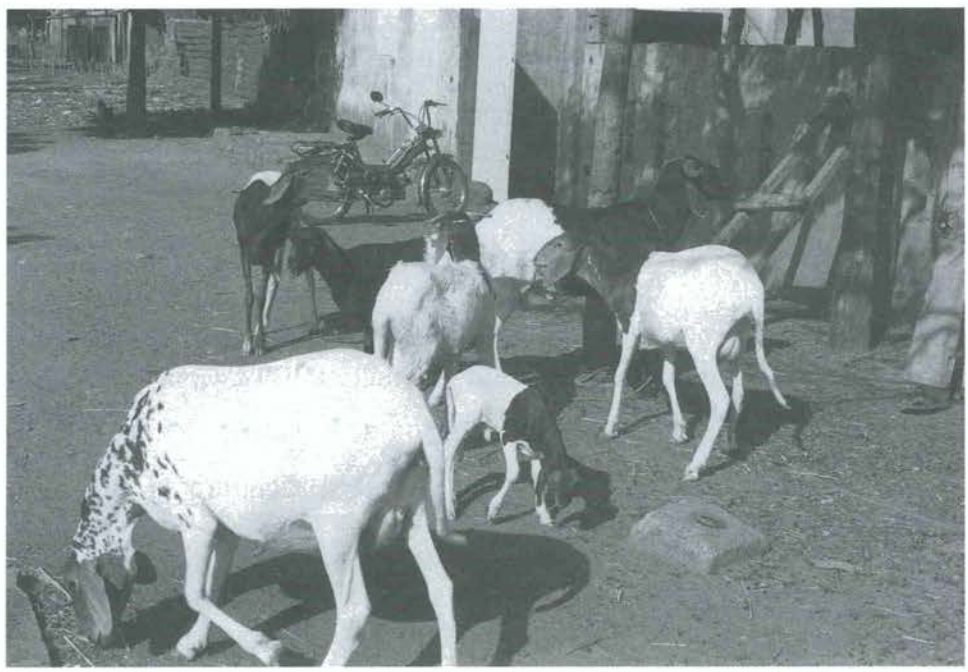
Bélier Mossi



Brebis Bali-Bali



Bouc du Sahel Voltaïque



Moutons du Sahel Burkinabé

6.0 REFERENCES

Bambara L. 1984. Détection électrophorétique des polymorphismes biochimiques chez les bovins. Mémoire de fin d'études IDR/Université de Ouagadougou.

Bourzat D. 1979. Projet Petits Ruminants. Rapport semestriel 1979. Min. Développement Rural, Ouagadougou

CIPEA. 1979. Monographie 2. Le bétail trypanotolérant d'Afrique occidentale et centrale. Tome 2. Situations nationales. CIPEA, Addis Abeba.

Congo I. 1990. Caractérisation immunogénétique de la population taurine Baoulé trypanotolérante du Pays Lobi par le polymorphisme biochimique de l'hémoglobine. Mémoire de fin d'études IDR/Université de Ouagadougou.

CRTA. 1992. Rapport Succinct d'Activité. Centre de Recherches sur les Trypanosomiases Animales. Bobo-Dioulasso, 90p.

Doutressoulle G. 1947. L'élevage en Afrique Occidentale Française. Paris, Lasore.

Dumas R. et Raymond H. 1975. L'élevage des petits ruminants dans les circonscriptions de Kaya, Ouahigouya et du Sahel. Paris, CEDES.

IEMVT. 1988. Manuel vétérinaire des agents techniques de l'élevage. Ministère de la Coopération et du Développement. 533p.

INERA. 1994. Synthèse des recherches sur la production animale au Burkina Faso. Programme Production Animale. INERA/CNRST, Ouagadougou. 176p.

MAE. 1990. Enquête nationale sur les effectifs du cheptel (ENEC). Secrétariat d'Etat à l'Elevage. Ministère de l'Agriculture et de l'Elevage (MAE). Ouagadougou. 77p.

MAE. 1991. Etude prospective du sous-secteur élevage. Rapport de synthèse, tome I. Secrétariat d'Etat à l'Elevage. Ministère de l'Agriculture et de l'Elevage (MAE). Ouagadougou. 281p.

MDCRA. 1991. Bulletin annuel statistique de l'élevage. Ministère Délégué charge des ressources animales. MAE, 49p.

Neya S. B. et Nianogo A.J. 1994. Répartition géographique, effectifs et productivité des bovins au Burkina Faso. Programme Production Animale, INERA/CNRST.

Some D.A. 1991. Le Centre d'élevage et de formation de l'Oudalan: 26 ans d'expérience. 33p.

Winrock International. 1992. Assessment of Animal Agriculture in Sub-Saharan Africa. Winrock International. 125p.

Tableau 1: *Effectif des races de ruminants au Burkina Faso*

Espèces	Races	Population	Taux de croissance	Sexe ratio	Utilisation
Bovins	ZPS ZPS XT TB AZ ND	2 485 355 885 590 724 955 1 000 100	2%	F: 70% M: 30% C: 15%	Travail Viande Lait Cuir Fumier
Ovins	Peuhl Mossi** Bali-Bali	567 000 4 333 000 -	3%	M: 29,4% F: 70,6%	Viande Peaux Fumier
Caprins	Sahéliens Mossi	1 339 000 5 031 000	2,5%	M: 29,4% F: 70,6%	Viande Lait Fumier Peaux

ZPS Zébu Peuhl Soudanais ou Zébu Peuhl Soudanien
T Taurin
TB Taurin Baoulé
AZ Azawack ou Azaouak
ND N'Dama
** Djallonké type Mossi
Source: Chiffres déduits à partir des résultats de l'ENEC par province, et de la répartition géographique connue pour les ruminants. Ces éléments sont valables pour l'ensemble de l'espèce concernée.

Tableau 2: *Effectifs des races de bétail monogastrique au Burkina Faso*

Espèce	Population	Taux de croissance	Utilisation
Porcins	493 000	2,2	viande, fumier
Asins	403 000	2,0	travail, viande
Equidés	22 000	1,0	travail, sport, viande
Camélidés	12 000	1,6	travail, sport, viande, lait
Poules	13 740 000	2,5	chair, oeufs
Pintades	2 775 000	2,5	chair, oeufs
Dindons	37 000	2,5	chair
Canards	127 000	2,5	chair, oeufs
Lapins	67 000	non disponible	viande

Source: Chiffres déduits à partir des résultats de l'ENEC par province.

Tableau 3: *Principales caractéristiques des races bovines du Burkina Faso*

Race	HG (cm)	PDSM (kg)	PDSF (kg)	RDTC (%)	Lait l/j	Cuir sec (kg)	PRE. (%)	FER. (%)	FEC. (%)
ZPS	120 à 140	300 à 350	250 à 300	48 à 50	2-3	6-7	51	54	50.0
TB	90 à 110	200	190	48 à 52	2	3-4	47	nd	50.5
AZ	130 à 135	300	250	48 à 50	6-8	6-8	nd	nd	nd

HG: Hauteur au garrot
PDSM: Poids mâles
PDSF: Poids femelles
RDTC: Rendement carcasse
PRE: Précocité
FER: Fertilité
FEC: Fécondité
ND: Non déterminé

Tableau 4: *Principales caractéristiques des races de petits ruminants au Burkina Faso**

Races	HG (cm)	PDSM (kg)	PDSF (kg)	RDTC (%)	APMB (mois)
MPV	70-80	35-40	30-35	45-50	15-17
MM	50	25	25	40	11
CSV	70	30	25-30	45-48	14
CM	40-50	20	18		11,5
MBB	75-85	35-50	30-45		

MPV: Mouton Peuhl Voltaïque
MM: Mouton Djallonké de type Mossi
CSV: Chèvre du Sahel Voltaïque
CM: Chèvre Djallonké de type Mossi
MBB: Mouton Bali-Bali
APMB: Age à la première mise-bas
*D'autres caractéristiques des races de petits ruminants sont indiquées au tableau 5

Tableau 5: *Caractéristiques extérieures des races de petits ruminants au Burkina Faso*

Caractère	MPB/MPV	MM	CSB/CSV	CM/CMHV	MBB
Allure	élancée	trapue	élancée	ramassée	élancée
Tête	forte et longue avec un bourrelet de nuque	forte	petite et triangulaire	-	forte
Chanfrein	convexe	légèrement busqué	rectiligne ou subconcave	-	légèrement busqué
Cornes	bien développées et horizontales chez le mâle	prismatiques dirigées vers l'arrière en bas puis en avant	assez longues	assez développées	très développées chez le mâle et irrégulières chez la femelle
Oreilles	moyennes et pendantes	minces et étroites	courtes, parfois tombantes	longues, fines et étroites, parfois horizontales	longues et pendantes
Cou	musclé	long	mince et allongé	court	court et musclé
Poitrine	-	-	étroite et descendue	longue	serrée
Croupe	ronde chez les sujets gras	courte, très fuyante	courte et inclinée	-	inclinée
Squelette	-	-	fin	-	-
Poil	ras	court	fin et ras	ras	-
Crinière	inexistante	présente, avec camail	présente	peu développée	-
Robe	généralement claire	blanche ou pie	variée	variée	blanche avec lunettes
Membres	solides et longs	jambes plates et courtes	fins et longs	courts et musclés	longs et grêles
Dos	légèrement plongeant	court et légèrement creusé	-	droit	plongeant
Garrot	saillant	non proéminent	-	noyé	saillant
Front	-	-	-	large	large et plat

Tableau 6: *Projets à composante génétique*

Projet	Objectifs	Espèces/races en cause	Observations
Projet d'amélioration des petits ruminants dans la région de Thiou	Injecter par 240 Bali-Bali pour améliorer la race locale	Ovins Bali-Bali	Clos
PDRI/Séguénéga	Introduire des races plus performantes	Bovins (Azawak), ovins (Bali-Bali), volailles (RTR et Leghorn)	Clos
Projet petits ruminants et aviculture (PPRA)	Sélection sur les races locales	Ovins (Mossi), caprins (Mossi)	Elimination des sujets déclassés par la castration
Centre d'élevage de Loumbila	Multiplier et diffuser les géniteurs Azawak en milieu encadré	Bovins Azawak	A remplacé le CEFO de Marakoye
Monastère de koubri	Croisement de races locales avec des races européennes; croisement du porc de Korogho avec la locale pour une production semi-intensive	Bovins (zébus Peuhl soudaniens, Azawak, Brune des Alpes, etc.); porcins (locales, Korogho)	
Projet Lapin de Bobo	Création de la race Bobo	Lapins locaux et étrangers	
Centre d'élevage et de formation (CEFO) de Markoye	Multiplier, sélectionner et diffuser des Azawak, puis des petits ruminants performants (chèvre, Rousse de Maradi, Bali-Bali, Mouton à laine du macina)	Bovins (Azawak), ovins (Bali-Bali et mouton à laine), caprins (Rousse de Maradi)	Fermé

Tableau 7: *Liste des institutions de recherche compétentes en matière d'élevage au Burkina Faso*

Institutions	Statut ou Affiliation	Principales tâches	Stations de recherche	Espèces présentes sur les stations
INERA	Public	Recherche appliquée	Di, Farakoba, Kamboinse, Katchari, Koare, Niangolonko, Saria	Bovins, ovins, caprins, asins, volailles
IDR	Public	Recherche et enseignement supérieur	Gampela, Leo	Bovins, ovins, caprins, volailles
LNE	Public	Diagnostic et dépistage	Milieu réel	
ONAVET	Public/privé	Distribution d'intrants et multiplication d'Azawak	Loumbila	Zébus Azawak
CRTA/CIRDES	Régional	Recherche appliquée	Banakeledaga, Samandeni	Taurins
ANTENNE SAHELIENNE	Projet privé	Recherche appliquée	Milieu réel	

Ane local

NOTE ON THE FOUNDING OF THE ASSOCIATION FOR THE CONSERVATION OF THE EARLY DOMESTICATED ANIMALS OF SOUTHERN AFRICA

J. Bester

The Association for the Conservation of the
Early Domesticated Animals, (ACEDA SA), SOUTHERN AFRICA

SUMMARY

South Africa is a major livestock region of the African continent and a country rich in local animal genetic resources (AnGR). Archaeological research and the important rock paintings found in the region confirm the existence of domesticated ruminant populations, at least back to 300 AD. The dwindling of the pool of AnGR in recent years justifies the creation of ACEDA, which can and should play a major role in AnGR conservation policy and activities.

RESUME

L'Afrique du Sud est un des pays plus importants en élevage du continent africain, et un pays riche en ressources génétiques animales locales (AnGR). Les recherches archéologiques et les peintures sur roche trouvées dans la région, confirment l'existence de populations animales domestiquées déjà en 300 AD. La diminution récente de AnGR justifie la création de ACEDA, qui pourra jouer un rôle important dans la politique et les activités de conservation des AnGR.

1.0 INTRODUCTION

In March 1994 a new society, dedicated to the conservation of the early domesticated animals of southern Africa, came into being. ACEDA SA can lay claim to an approach unique to African conservation as it combines both scientific and socio-anthropological fields. This broad approach to the problem of diminishing animal resources should prove more effective for long term planning.

2.0 DOMESTICATION AND AnGR CONSERVATION

The history of domestication began about 9000 years ago at the beginning of the Holocene when humans first realized the potential of keeping animals as a food source. The incentives for domestication, the actual processes involved and the initial relationship between man and the wild counterparts of our domesticated animals is unclear and various schools of thought exist.

Domesticated animals were already present in Egypt between 7000 and 6000 years ago. Through trade and migrations, domesticated animals made their way to Central and East Africa. From there they spread southwards with Iron Age migrants passing through some of the most inhospitable areas of the continent. Present knowledge indicates that these Iron Age communities and their domesticated animals arrived in South Africa nearly 2000 years ago, when South Africa was inhabited by hunter-gatherer communities. This livestock is not, therefore, indigenous in the true sense of the word, although this term is often used in the literature. The term "early domesticated" is therefore used in preference.

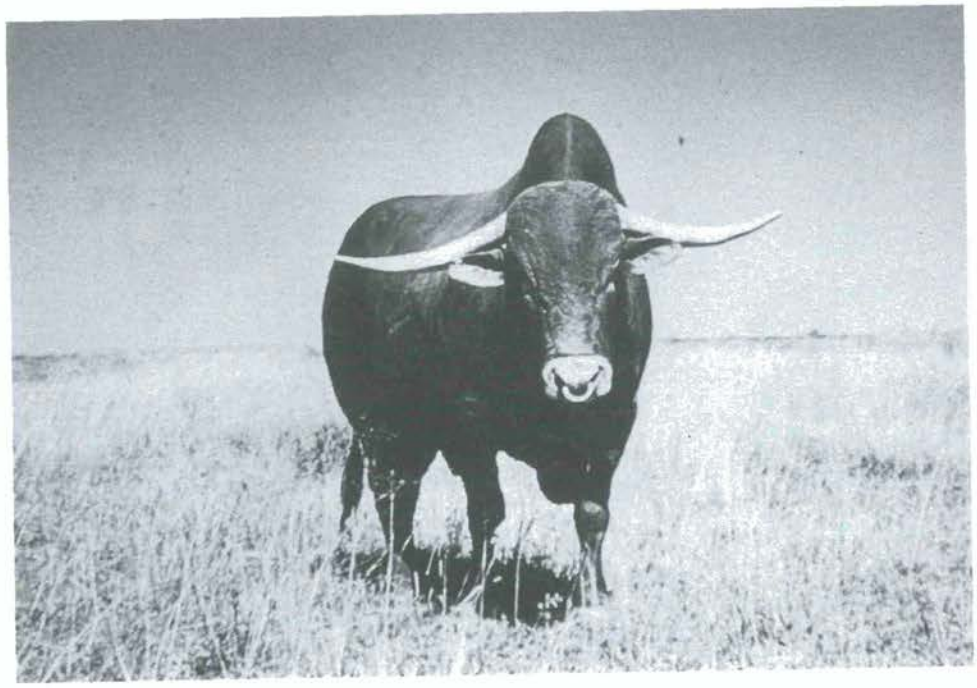
These early animals consisted of cattle, sheep and goat breeds. Remains of these animals in Southern Africa have been identified from archaeological sites dating to 300 AD and dogs and chickens to 650 AD. The status of pigs is uncertain but there are indications that pigs were present before European contact. A second wave of introduction occurred during the 16th and 17th centuries when settlers introduced their European farm animals.

A similarity between these ancient breeds and their modern counterparts can be seen in the rock art of South Africa. More recent historical records in the form of paintings by the early settlers and in their writings indicate not only the continuing similarities but also breeds which have since disappeared.

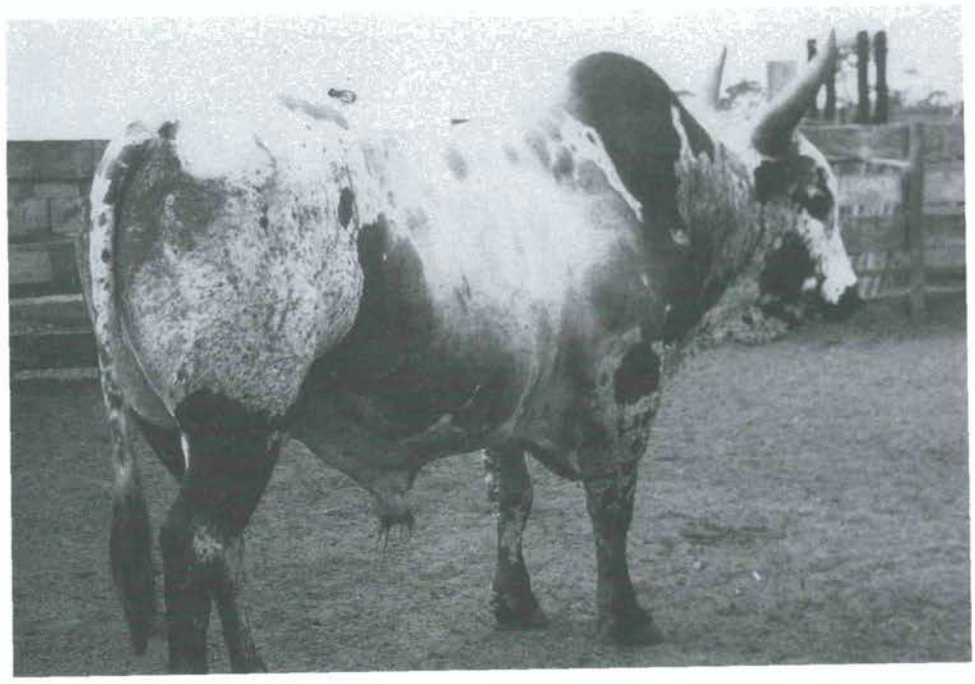
This dwindling of breeds has continued to this day and is a cause for concern.

The present day remnants of these early domesticated animals exhibit a wealth of genetic diversity which enables them to adapt to the harsh African environment. Like other breeds of indigenous livestock in Africa they are disease and heat tolerant and can survive on marginal grazing.

Some of the chicken, sheep and goat breeds have, in addition, developed predator evasion techniques. Despite these advantages their numbers are decreasing rapidly and their genetic diversity is being eroded by interbreeding with imported breeds which are expensive to maintain and are largely unsuited to local conditions.

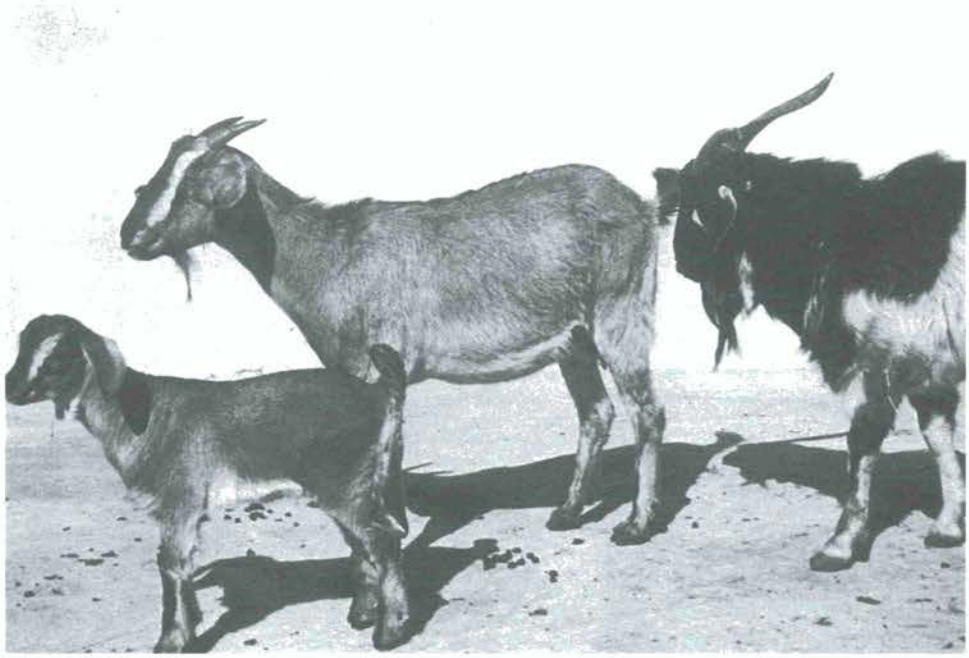


Afrikaner



Nguni

Boer goat



Local Bapedi goats

This concern was heightened during the last decade when scientific investigation highlighted the potential of early domesticated animals for modern markets and cottage industries. The successful improvement and commercialization of the Nguni and Afrikaner cattle breeds is proof of this potential.

3.0 THE ROLE OF ACEDA SA

The Association, realizing the value of the animals, set itself the task of conserving the original "unimproved" animals to protect the original gene pool. The archaeological information will be collated to establish the animals' original appearance and location and to provide a background to traditions and customs of their owners. This should reinforce the historical information which, in turn, will provide valuable information about more recent customs. This approach should bring the conservation effort closer to all the cultures of this "rainbow land". The scientists and agriculturalists can provide management policies and develop the animals' potential for small industry - an aspect of vital concern in a country plagued by hunger and unemployment. All this information will be stored on a central database, available to interested parties.

ACEDA SA has already started to locate and collect some of the more endangered species and has exhibited them at agricultural shows. The public has shown enthusiasm and interest - and a great deal of ignorance!

Education is a priority! A series of publications in magazines and the hope of future television programmes should help to highlight the plight of the endangered breeds. The Association has contact with the Agricultural Research Council, the Department of Agriculture and the different museum services on a national, provincial and local level. Through these contacts it is hoped to establish the status of each breed, to collect nucleus herds of endangered unimproved animals and to preserve their germplasm.

Problems are many and varied. As an NGO in a country of transition, funds are not readily available. The size of the country and the remoteness of the rural areas where these breeds still exist, makes the collection of data and animals difficult and sometimes even dangerous. The problems are probably no different than those faced by the other countries of Africa and, hopefully, they can be overcome by innovative ideas. The members of ACEDA SA are willing to tackle these problems with all the enthusiasm and ability at their disposal.

4.0 REFERENCE

Davis S. 1987. The Archaeology of Animals. London. B.T. Batsford Ltd.

Epstein H. 1971. The Origin of the Domestic Animal of Africa. 2 vols. New York. Africana Publ. Co.

Grigson C. and Clutton-Brock J. 1984. Animals and Archaeology. Vol. 3. Early Herders and their Stock. BAR International Series 202. Oxford.

Hemmes H. 1990. Domestication. New York. Cambridge University Press.

Kotze A., Bester J., Kusel U.S. and Plug I. 1994. Early Domesticated Animals of Southern Africa. Proc. 3rd Global Conf. on Cons. Dom. Anim. Resources, Kingston, Canada, 1994. In press.

Plug I. 1994. The faunal remains from a Late Iron Age site, Northwestern Transvaal. Research by the National Cultural History Museum, 3:119-129.

Plug I. 1993. The faunal remains from Nanda, an Early Iron Age site in Natal. Natal Museum Journal of Humanity, 5:99-107.

Plug I. and Voight E.A. 1985. Archaeozoological studies of Iron Age communities in southern Africa. In: Wendorf, F. and Close, A.E. (eds.). Advances in world Archaeology. vol. 4:189-239. New York. Academic Press.

Ramsay K.A., Reed D.S., Bothma A.J. and Lepen J.M. 1994. Profitable and environmentally effective farming with early domesticated livestock in Southern Africa. Proc. Conf. of Early Dom. Anim. of S.A., Pretoria, R.S.A. 1994.

Nooitgedacht pony

LES POPULATIONS DE BETAIL PRESENTES AU TOGO

Y.N. HADZI

PNPE, **Atakpame**, TOGO

RESUME

Le cheptel togolais se compose de bovins, de petits ruminants, de porcins et de volailles. Les deux régions septentrionales et la région centrale du pays abritent plus de la moitié du cheptel bovin. La population de petits ruminants est composée essentiellement d'ovins et de caprins; ces derniers sont principalement concentrés dans les deux régions méridionales où leur viande est plus appréciée que celle des ovins. Les élevages traditionnels de porcins sont répartis dans tout le pays, mais sont plus concentrés dans la région Maritime. La race locale prédomine car l'introduction des races améliorées a été faite sur une échelle très limitée. L'élevage de volailles de races locales est aussi très répandu, mais la densité rapportée au nombre de ménages agricoles est plus élevée dans le nord que dans le sud du pays.

SUMMARY

In Togo, the livestock is formed by cattle, small ruminants, pigs and poultry. More than half of the total cattle livestock lays in the two Northern and Central regions of the country. The small ruminants population is mainly composed by sheep and goats; the last ones are predominantly concentrated in the two Southern regions, where this meat is more appreciate than those of the sheep. The traditional pig livestock is distributed in all round the country, but more concentrated in the Maritime region. The local breed is predominant because the introduction of imported breeds has been made in a limited scale. Livestock of local breeds is widespread, but density compared with the number of households is prevailing in the north than in the south of the country.

1.0 LES PETITS RUMINANTS PRESENTS AU TOGO

1.1 Les caprins

La population caprine est estimée à 1 154 000 têtes environ.

1.1.1 *La chèvre naine guinéenne*

. Synonyme: la chèvre naine d'Afrique de l'ouest ou "la chèvre Djallonké".

. Les effectifs: la chèvre naine guinéenne représente 86,80% de la population caprine au Togo, soit un peu plus de 1 000 000 de têtes.

. Les caractères physiques et ethniques: la chèvre naine guinéenne est du type concave bréviligne, éllipométrique. La hauteur au garrot est de 41,92 cm. Le profil de la tête est concave et les oreilles sont portées horizontalement. Les mâles et les femelles sont cornus excepté une minorité, les cornes sont de petite taille; chez les femelles elles sont droites, alors qu'elles ont la forme arquée et sont dirigées vers le bas chez les mâles entiers. Les pis des femelles sont sphériques quels que soient leurs statuts de reproduction. Les robes unies et la couleur noire sont les plus fréquentes. Il existe des sujets à robe blanche avec des taches noires.

. Les principales utilisations: la chèvre naine guinéenne est élevée pour sa viande (la viande est plus appréciée que celle des ovins dans les régions méridionales du pays). La chèvre est recherchée pour diverses cérémonies des croyances traditionnelles.

. Les systèmes de conduite: trois modes de conduites sont pratiqués:

- la divagation toute l'année;
- la divagation en saison sèche et la claustration ou aux piquets en saisons des pluies;
- la claustration toute l'année.

. L'alimentation: le pâturage naturel est l'aliment de base. Les différents compléments alimentaires souvent distribués sont les déchets de cuisine, les épluchures de manioc et d'igname, les sons de maïs et de sorgho, les sous-produits agricoles (les fanes) et les sous-produits industriels (graine de coton), les pierres à lécher, le sel de cuisine.

. Les types d'habitat: trois types d'habitat existent:

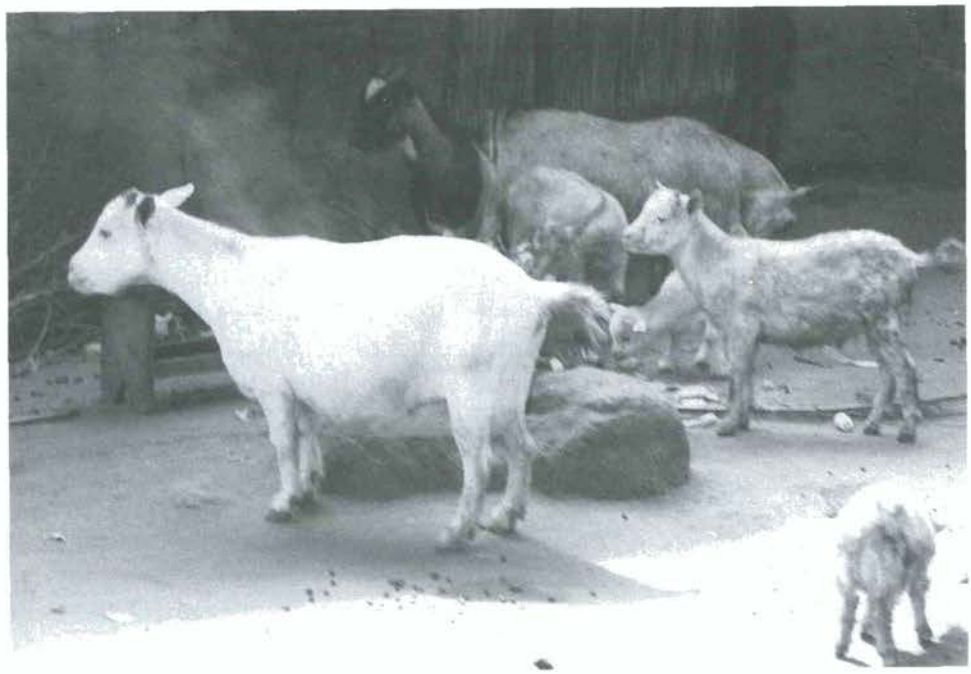
- enclos avec un abris rudimentaire dans les concessions;
- case aérée (case ronde dans les régions nord du pays);
- chèvrerie améliorée.

1.1.2 *La chèvre des zones sahéliennes*

. Synonyme: la chèvre du Sahel. Ce nom désigne plusieurs races de caprins du Sahel.

. Les effectifs: 1,50% des caprins.

. Caractères physiques et ethniques: la chèvre du Sahel est du type rectiligne, hygrométrique, longiligne et de grande taille. Le profil de la tête est rectiligne ou convexe. Les oreilles sont tombantes. Les mâles et les femelles sont cornus; chez les femelles les



Chèvres naines guinéennes

Moutons Djallonké

on trouve des cornes hélicoïdes et longues. Les deux sexes ont souvent la barbe et les pendeloques. Le chanfrein est souvent convexe. Les femelles en lactation ont souvent des pis en forme de bouteille. La robe unie blanche est la plus fréquente, elle peut être également noire ou brune. Cette description se rapproche plus de celles faite par Epstein (1971).

. Les principales utilisations: la chèvre du Sahel est élevée pour sa chair et est exploitée pour le métissage sur une faible échelle (chèvre naine guinéenne x chèvre du Sahel).

. Les systèmes de conduites: les pratiques sont les mêmes que celles de la chèvre naine. En générale, ces animaux font partie de troupeaux mixtes (troupeaux d'ovins et de caprins), du fait de leurs effectifs réduits dans certaines régions du pays. Elle est présente dans les zones où l'infection de trypanosomiase est très faible ou nulle.

1.1.3 *La chèvre rousse de Maradi*

. Synonyme: Red Sokoto

. Les effectifs: 0,54% des caprins.

. Les caractéristiques physiques et ethniques: la chèvre rousse de Maradi est harmonieuse, assez élancée, du type médiolique, enmétrique. Le profil de la tête est rectiligne, les oreilles sont portées horizontalement. Les mâles et les femelles sont cornus. Les cornes sont arquées et de petite taille. Les femelles en lactation ont des pis en forme de bouteille. La robe est unique: rousse uniforme. Le pelage est court.

Cette description correspond aux points de vue de Charray *et al.* (1980) et de Zakara (1985).

. Les principales utilisations: la chèvre rousse de Maradi est élevée pour sa chair.

. Les systèmes de conduite: la chèvre rousse de Maradi fait l'objet d'un élevage sur une échelle réduite. Son aire d'habitation est limitée à une localité et ses environs (Kpékplémé et ses environs).

i) ils sont gardés dans des enclos avec abris;
ii) ils sont conduits au pâturage avec les ovins et reçoivent les mêmes aliments complémentaires que les moutons, notamment les épluchures de manioc et d'igname, les sons de maïs, les graines de coton et les pierres à lécher.

1.1.4 *Métis: chèvre naine guinéenne et chèvre du Sahel*

. Les effectifs: 9,93% des caprins.

. Les caractères physiques et ethniques: le profil de la tête est rectiligne et les oreilles sont horizontales pour la plupart. Les femelles et les mâles sont cornus; les cornes sont arquées et de taille moyenne. Les fréquences de pendeloques et de barbe au sein de ce type génétique sont moins élevées que celles constatées chez les caprins du Sahel, et sont plus élevées que celles notées chez les caprins Djallonké.

Certaines femelles en lactation ont des pis en forme de bouteille. Les robes unies et la couleur fauve sont plus fréquentes.

1.1.5 ***Métis: chèvre naine guinéenne et chèvre rousse de Maradi***

. Les effectifs: 1,22% des caprins

. Les caractères physiques et ethniques: le profil de la tête est rectiligne et les oreilles sont portées horizontalement. Les mâles et les femelles sont cornus. Les deux tiers des caprins de ce type génétique portent la même robe que les caprins Maradi. Le pelage est aussi court.

. Les principales utilisations: deux types de caprins sont élevés pour leur chair. Ils constituent une partie de la dot dans certaines ethnies.

. Les systèmes de conduite: les modes de conduite sont identiques à ceux déjà décrits.

1.2 Les ovins

L'effectif est d'environ 1 048 000 têtes (Propat-Domingo, 1988).

1.2.1 ***Le mouton Djallonké***

. Synonyme: Le mouton du Sud

. Les effectifs: le mouton Djallonké représente environ 85,60% de la population ovine du Togo, soit approximativement 898 000 têtes.

. Les caractères physiques et ethniques: c'est un mouton hypométrique, rectiligne médioligne. La tête est forte, à front plat et chanfrein légèrement busqué chez le mâle, le crâne est large, la face de longueur moyenne, le museau épais. Les cornes du bélier sont moyennement développées, prismatiques, larges à la base, dirigées en arrière, puis en avant, formant une spirale et demie. Elles sont fines et courtes chez la femelle et le mouton, le plus souvent absentes. L'oeil est gros, l'orbite elliptique à saillies peu prononcées, les oreilles minces et étroites, tombantes. L'encolure est longue. Le dos est droit, la croupe courte, à fesse ronde. La queue longue (25 cm en moyenne), forte à la base, s'amincit à l'extrémité qui atteint le jarret. Le tronc est cylindrique, la cuisse assez fournie, la jambe plate et courte, les sabots fins.

L'ensemble est trapu et les caractères de féminité plus accusés que dans les races ovines du Sahel. La robe est blanche, le plus souvent pie (noir ou roux); les deux couleurs sont mêlées de façon variable, mais le plus fréquemment le foncé couvre le train antérieur. Le pelage est à poils ras, mais le mâle porte crinière et camail et souvent une manchette de poils allant de la gorge à l'interars et sur les côtes de la poitrine. C'est un mouton de petite taille: 0,40 à 0,60 m, d'un poids moyen de 20 à 30 kg chez la femelle, 25 à 35 kg chez le mâle, très rustique. Les brebis ne sont pas traites, sauf rares exceptions; elles sont par ailleurs mauvaises laitières, donnant rarement plus de 0,25 litre de lait par jour. La lactation dure 5 mois environ. Il existe cependant des sujets dont les aptitudes sont beaucoup plus développées. Certaines femelles, notamment dans les régions de la Guinée, sont remarquablement prolifiques, les naissances gémellaires étant de règle, les naissances triples fréquentes. Ces femelles élèvent parfaitement leurs agneaux, signe d'une production laitière plus importante que celle indiquée ci-dessus.

Par ailleurs, bien conformée pour la boucherie, la race du Fouta Djallon fournit une viande de bonne qualité. Les rendements sont satisfaisants: 46 à 48 pour cent en moyenne, mais le poids des carcasses est faible (10 à 15 kg en moyenne).

Moutons de Vogan

Résultats obtenus au Centre d'Appui Technique de Kolokopé (PNPE)

Poids moyen des brebis	24 à 31 kg
Poids moyen des béliers	30 à 45 kg
Taille	53 à 64 cm

. Les principales utilisations: le mouton Djallonké est élevé essentiellement pour sa chair. Le bélier entier est recherché et immolé pendant les fêtes musulmanes, la Tabaski. Le mouton Djallonké est également recherché pour constituer une partie de la dot dans certaines régions du pays.

. Les systèmes de conduites sont les suivants: conduits en troupeaux au pâturage toute l'année par un berger; en divagation en saison sèche et en gardiennage sur pâturage pendant les saisons pluvieuses; et en claustration partielle ou permanente (petits effectifs).

Les animaux exploitent les pâturages naturels et reçoivent des compléments alimentaires: les épluchures de manioc et d'igname, les sons de maïs et de sorgho, les fanes d'arachide, les graines de coton et les pierres à lécher.

Ils sont abrités dans trois types d'habitat:

- case traditionnelle mal aérée;
- enclos avec un abri sommaire dans les concessions;
- bergerie améliorée.

1.2.2 ***Le mouton de Vogan (Amegbe, 1983) = le métis (mouton Djallonké et mouton Sahélien)***

. Les effectifs: la population était en 1981 de 130 000 et en 1993 de 190 000 têtes environ.

. Les caractères physique et ethniques: c'est un animal de grand format, de type convexiligne, longiligne, eumétrique. Le front est plat, le chanfrein légèrement busqué. C'est un animal à poil, sans laine.

La robe est de couleur variée. Les robes les plus fréquentes sont parfois délimitées à l'avant. Certains sujets sont entièrement marrons. La robe totalement noire est très rare, probablement sous-estimée et donc éliminée par sélection artificielle.

On rencontre aussi l'association des trois couleurs, pie, noir et marron et parfois des robes truitées. Ces résultats sont obtenus par un relevé systématique des robes rencontrées.

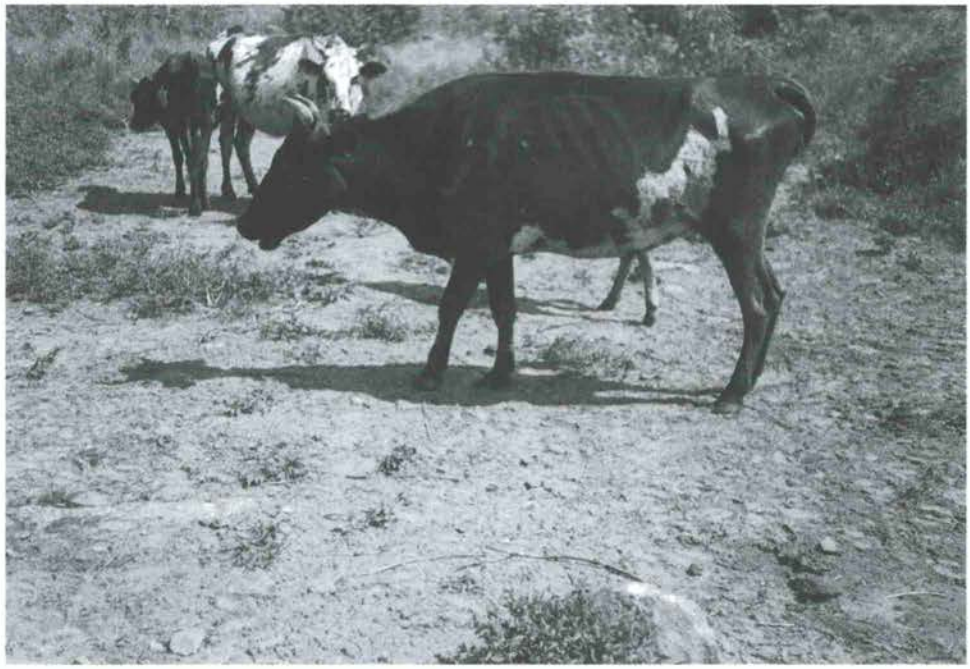
Les cornes sont prismatiques, bien développées chez le mâle, lâchement spiralées chez l'adulte. Elles atteignent 30 à 40 cm. Tous les mâles sont cornus. Seulement 5,58% des femelles (581 observations) portent des cornes peu développées; ce qui montre que le caractère cornage est influencé par le sexe. Les oreilles sont longues, larges et pendantes. Elles atteignent 14 cm de long en moyenne.

Les pendeloques ou pampilles sont plus ou moins développées et peuvent atteindre 10-12 cm chez certains sujets. Elles existent dans les deux sexes dans une proportion d'environ 2 pour cent (1,85% chez les mâles avec n = 216 et 1,99% chez les femelles avec n = 501, soit 1,99% pour l'ensemble des 717 observations).

La queue est longue et atteint souvent le jarret (30 à 40 cm de long). Elle n'a pas de réserve de graisse. La tête est longue (24 x 14 cm), les yeux globuleux. Le cou est long, la poitrine haute, les côtes plates. Le garrot et le dos sont saillants, le bassin large et court (25 x 18 cm chez le mâle, 23 x 16 cm chez la femelle), le gigot est plat. Cet animal n'est pas éclaté.

La hauteur au garrot atteint 73 cm chez le bélier et 69 cm chez la brebis. Les autres mensurations figurent au tableau 1.

Le poids moyen des adultes est de 40 kg chez les brebis (30 à 45 kg, n = 120) et de 45 kg chez les béliers (40 à 55 kg n = 29). Certains sujets atteignent un poids de 60 à 80 kg. Ils ressemblent déjà à la race pure sahélienne.



Bovins Somba

Tableau 1: *Eléments métriques du mouton de Vogan*

	Poids (kg)	Hauteur au garrot (cm)	Hauteur au passage des sangles (cm)	Périmètre thoracique (cm)
Brebis	40 (30-45)	69 (60-80)	32 (26-40)	84 (75-98)
Bélier	45 (40-55)	73 (65-90)	36 (31-40)	85 (76-105)

. Les principales utilisations: ce mouton de grand format est élevé pour sa chaire et pour servir d'animal de sacrifice à la Tabaski.

. Les systèmes de conduite sont les suivants:

a) Les troupeaux du mouton de Vogan sont d'effectifs réduits (7 à 8 brebis en moyenne) et sont conduits par un berger (6 heures de temps en moyenne de pâturage par jour).

b) Les champs après récolte et quelques jachères leur offrent de beaux pâturages. Les terres étant surexploitées, certains éleveurs ont éduqué leurs bêtes à brouter uniquement l'herbe sauvage parmi les plantes cultivées. La plupart des paysans-éleveurs emmènent leurs animaux (2 ou 3 brebis avec leurs suites) au champ quand ils vont travailler. Certains éleveurs distribuent les épluchures séchées de manioc ou de son de maïs.

c) Tous les paysans possèdent pour les animaux un enclos fermé dans lequel se trouve une case.

1.2.3 *Le mouton du Sahel (toutes races confondues dans le contexte togolais)*

Il est présent en nombre très limité dans des troupeaux d'ovins Djallonké et dans des zones où la trypanosomiase est pratiquement inexistante.

1.2.4 *Importance économique*

Les petits ruminants ont une grande importance économique dans les ménages ruraux. Ils représentent une source de revenu monétaire facile à mobiliser pour faire face aux diverses dépenses (banque où on procède à des retraits quand il y a des besoins d'argent dans les familles).

2.0 LES RACES BOVINES PRESENTES AU TOGO

Le cheptel bovin comptait environ 237 756 têtes en 1988 et est presque uniquement constitué de taurins (*Bos taurus*) trypanotolérants. On rencontre aussi des zébus (*Bos indicus*) et les produits de croisement zébus-taurins.

2.1 Les taurins

2.1.1. *La race des Lagunes*

. Synonyme: Lagunaire

. Les caractères physiques et ethniques: les Lagunaires sont des animaux de petite taille, en moyenne 0,80 m chez les veaux d'un an, 0,95 m chez les vaches adultes de 5 à 10 ans; quelques sujets exceptionnels atteignent 1,05 m. Notons que la taille augmente légèrement quand on quitte la côte vers l'intérieur.

Ces taurins frappent aussi par leur petit format. La longueur scapulo-ischile, atteint en moyenne 1,20 m; ce sont des animaux très bas sur pattes avec parfois un ventre volumineux. La hauteur au sangle ne dépasse pas 0,47 m, et la longueur du canon antérieur n'atteint pas 0,20 m. La robe est souvent noire, généralement pie-noir. Il n'est pas rare de rencontrer des sujets pie-rouge ou rouge. Le poids moyen de ces animaux varie de 188 kg à 280 kg chez les adultes de 5 ans et atteint parfois 320 kg chez les animaux plus âgés.

La race des lagunes présente une longue tête au profil rectiligne, un front plat ou légèrement concave. Le chanfrein est rectiligne, le chignon droit avec une dépression médiane. Les orbites sont saillantes avec le pourtour des yeux noirs. Le mufle épais et également noir. Les cornes sont courtes (14 à 24 cm en moyenne). Elles s'évasent à partir du chignon et sont arquées en haut et en avant. Elles sont claires à la base et noires aux extrémités, leur surface est rugueuse.

Le cou est de longueur moyenne, mince chez la vache et plus épais chez le taureau. La ligne du dessus paraît être inclinée vers l'avant chez la vache, la fesse est étroite chez la femelle, plus musclée chez le mâle. La queue est d'une longueur dépassant souvent la pointe du jarret et arrivant au milieu du canon postérieur. Elle est terminée par un toupillon d'au moins 10 cm. Les membres sont courts, l'ossature légère. Chez la femelle non gestante ou qui n'allaite pas, les mamelles sont réduites à des plis de peau que l'on aperçoit à peine entre les cuisses. Cela donne déjà une idée de ce que sera l'aptitude laitière de cette race.

. Les principales utilisations: les Lagunaires ne sont utilisées que pour la production de viande (rendement moyen 47%).

. Les systèmes de conduite sont les suivants:

i) le mode d'élevage est sédentaire, sémi-sédentaire, extensif. Les animaux sont confiés aux Peuhls et gardés dans les parcs de nuits ou attachés aux piquets;

ii) les bêtes sont conduites au pâturage par des gardiens (élevage gardienné) et reçoivent des suppléments minéraux (sel de cuisine, pierre à lécher).

2.1.2 *La race Somba*

. Synonyme: Atakora

. Les caractères physiques et ethniques: il est souvent très difficile de pouvoir différencier la race Somba de celle des lagunes. Leur taille varie de 0,90 m à 1m. La conformation est sensiblement la même et l'on trouve des sujets nettement inférieurs à certains lagunaires.

La robe est souvent noire, généralement pie-noire. Des sujets rouges ou fauves se rencontrent parfois. On pense que ces sujets rouges ou fauves soient des produits de croisement N'dama-Somba. Des enquêtes menées au Bénin et au Togo pour savoir si à une époque quelconque les N'dama ont été introduits dans les montagnes de l'Atokora, n'ont rien donné de concluant.

La tête est longue et étroite, les cornes sont courtes, minces, arquées au-dessus de la tête, parfois flottantes. Elles sont claires avec les extrémités noires. Le mufle est noir. Le cou est plus mince chez la vache. La ligne du dessus est inclinée vers l'avant chez la femelle et horizontale avec une légère concavité au niveau du dos chez le mâle. La fesse est plate et étroite chez la vache, plus large chez le taureau. Les membres sont fins et courts.

. Les principales utilisations: le Somba est exploité pour la viande et pour des motifs d'ordre social (les animaux sont apportés en dot ou sacrifiés à l'occasion des funérailles).

. Les systèmes de conduite: l'élevage est de type sédentaire ou sémi-sédentaire extensif. Les animaux sont généralement confiés aux Peuhls.

2.1.3 ***Les races du Borgou***

. Le nom international: la race Borgou (région du Borgou de la République du Bénin).

. Les caractères physiques et ethniques: compte tenu des caractères zébus de la race du Borgou, et de la présence dans le Nigéria voisin de zébus qui passent facilement les frontières, nous pensons, pour notre part, que la race Borgou est un produit de croisement entre lagunaire ou Somba-zébu, précisément le zébu White-Fulani.

On groupe actuellement sous le nom Borgou une population peu homogène que l'on peut essayer de classer en deux catégories:

a) Une première catégorie que nous pouvons appeler "Lagunaire grand modèle" et qui nous semble être les vrais Borgou. On les rencontre au Bénin (mais leur nombre diminue), au Nigéria et dans le nord du Togo, dans quelques troupeaux de Somba. Ce sont des animaux à profil rectiligne. La tête est longue avec un front plat. Les cornes, de diamètre plus grand que chez les lagunaires, s'écartent latéralement en demi-croissant d'un chignon droit. Elles sont un peu sombre à la base mais noires aux extrémités et souvent lisses. Le cou est court, épais et présente à son attache avec le tronc un renflement musculaire. La ligne du dessus est droite mais légèrement inclinée vers l'avant. Le dos est long, étroit, la croupe courte, légèrement inclinée vers l'arrière. Les cuisses sont plates. La poitrine est étroite et les côtes plates. Les membres sont plus longs et plus solides que chez les lagunaires, et les mamelles plus développées.

b) Une deuxième catégorie que nous appellerons "Borgou-zébu" c'est-à-dire un produit du croisement Borgou-zébu, qui, en définitive, est un sujet chez lequel la proportion de sang zébu est plus importante que chez les précédents issus eux-mêmes d'un croisement entre zébu et la race des lagunes. Ce sont des animaux qui ont plus une conformation de zébu que de taurin. La tête est plus épaisse, le front légèrement convexe. Le chanfrein est rectiligne à convexe.

Les cornes solidement implantées, bien rondes à la base et de longueur atteignant en moyenne 30 cm. Elles se dirigent en croissant vers le haut, la pointe est noire légèrement tournée vers l'extérieur. Le corps est court, robuste et marqué d'une ébauche de bosse plus ou moins visible. Le dos est court, concave. La poitrine solide. Le fanon assez bien développé, commence au niveau du menton et s'arrête au niveau du poitrail.

. Les principales utilisations: les Borgous sont élevés pour leur viande et pour la dot. Ils sont de bons animaux de traits (bien utilisés pour la culture attelée).

. Les systèmes de conduite: les animaux sont élevés dans les mêmes conditions que les Sombas ou les lagunaires.

2.1.4 ***La race N'Dama***

Le bétail N'Dama au Togo est constitué de troupeaux en très faible quantité numérique provenant essentiellement des importations à partir de la Guinée, du Mali, de la Côte d'Ivoire et du Zaïre.

. Les effectifs: en 1986, le nombre de N'Dama était environ de 1 409 têtes.

. Les caractères physiques et ethniques: la race N'Dama au Togo est d'un profil rectiligne. L'animal est trapu mais d'une conformation harmonieuse. La tête est courte avec un chignon droit, un front plat et un chanfrein droit. Les cornes sont insérées dans le prolongement de la ligne du chignon. C'est donc un bovin de type orthocéros. La section des cornes est circulaire. Chez les taureaux les cornes sont en forme de croissant plus ou moins ouvert.

La ligne dorso-lombaire est horizontale avec une tendance à se relever vers l'arrière. La fesse est plate et les membres sont courts, minces et grêles. Du point de vue de la couleur, les cornes sont brun-clair sur les deux tiers de leurs longueur en partant de leur base, alors que le dernier tiers est noir et se termine par une pointe nacrée. Leur longueur varie entre 25 cm et 40 cm avec une moyenne de 32,33 cm. La circonférence moyenne à la base de la corne est de 23,53 cm et va de 21 cm à 26 cm. Les robes sont variées.

La taille chez les adultes d'au moins 4 ans est de 94 à 115 cm au garrot pour les vaches et de 107 à 116 cm pour les taureaux. Le taureau est particulièrement massif avec une encolure courte et puissante et un fanon très peu développé.

Les robes sont variées. On peut les classer en trois groupes:

a) Les robes uniformes:
   . fauve
   . fauve claire
   . fauve foncé
   . rouge-brun
   . noire

b) Les robes tachetées:
   . fauve tachetée de blanc
   . truitée

c) Les robes conjuguées:
   . pie-rouge

Bovins N'Dama

. Les principales utilisations: les mâles sont utilisés pour le métissage avec d'autres races de taurins. Les N'Dama sont élevés pour la viande et pour la traction animale.

. Les systèmes de conduite: les N'Dama sont élevés dans les mêmes conditions que les races précédentes.

2.2 Les zébus

Ils sont présents au Togo du fait de la transhumance pendant la période allant de novembre à mai ou juin. Les éleveurs et leurs troupeaux proviennent des pays sahéliens. Une partie des troupeaux est destinée aux abattoirs.

Selon la classification des zébus ouest africain proposée par Mason, on trouve:

a) les zébus à courtes cornes qui comprennent:
   . le zébu Sokoto ou Sokoto-Gudali ou Bokoloji
   . le zébu Shuwa-aral ou Fellatat ou Wadara.

b) les zébus à cornes en lyres moyennes:
   . le zébu White Fulani ou Bima ou Bimaji

c) les zébus à cornes en lyres hautes:
   . le zébu Mbororo ou Red Fulani ou Red-longhorn

2.3 Les produits de croisements

On rencontre au Togo des types génétiques divers, issus de croisements entre:

a) Races de taurins
   . N'Dama - Lagunaire
   . N'Dama - Somba
   . N'Dama - Borgou

b) Taurins et zébus
   . N'Dama - zébus
   . Borgou - zébus

3.0 LES RACES PORCINES PRESENTES AU TOGO

La population porcine au Togo est estimée à 233 200 têtes (Domingo, 1988).

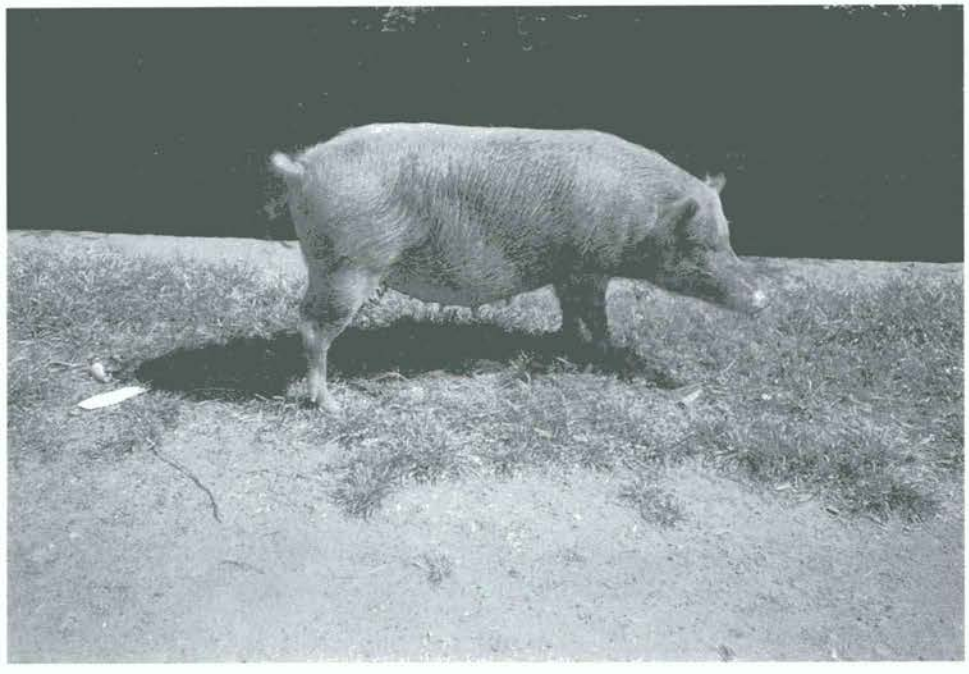
3.1 Le porc de race locale

. Synonyme: "Ashanti Dwarf pig" ou "Bush pig" (porc sauvage).

. Les caractères physiques et ethniques: ce sont des animaux de petit format et tardifs. Ils ont un front court, un groin allongé, de petites oreilles portées horizontalement ou légèrement dressées. Le corps, plutôt étroit, est porté par des membres assez longs, les animaux étant de type "coureur", la croupe est inclinée et les jambons relativement peu musclés. La robe est noire ou pie-noire, parfois grise.

. Les principales utilisations: ce type de porc est élevé pour la boucherie (consommation familiale et pendant les fêtes, les ménages, les funérailles). Il est vendu en cas de besoin d'argent.

Porc de race locale (petit porc noir)



Porc de Dapaong

Les systèmes de conduite: l'élevage du porc local est du type traditionnel. C'est un système extensif ou semi-extensif avec présence d'enclos et d'abris rudimentaires. Les animaux sont autorisés à errer sur les tas d'ordures ou dans les champs en quête de nourriture. L'éleveur peut les rassembler (par un son particulier) en vue de leur distribuer les aliments (tubercules, sons, déchets de cuisines).

3.2 Le "Porc de Dapaong" (préfecture de Tone)

C'est probablement le produit de croisement entre le porc local et le Large white et il estW considéré comme un type génétique fixé.

. Les caractères physiques et ethniques: le porc de Dapaong est un animal haut sur pattes, longiligne, la longueur du corps est d'environ 0,80 m avec une taille moyenne de 0,56 m. Il possède une tête forte avec un groin cylindre-conique plus ou moins long selon les individus. Les oreilles sans être trop petites par rapport à la taille de la tête sont dressées ou portées horizontalement dans quelques rares cas. Le dos est à peu près rectiligne, les jambons peu fournis, les membres longs et grêles; les animaux sont de type coureur. Les yeux sont petits, le cou peu long reliant fortement la tête au tronc; la queue est aussi petite.

La robe est généralement blanche, parfois noire, pie-noire, grise ou même rousse; il est assez poilu. Le mâle paraît légèrement plus développé que la femelle.

. Les principales utilisations: il est élevé pour la viande (consommation familiale, fêtes, mariages, funérailles). Il représente une source de revenu monétaire.

. Les systèmes de conduite: l'élevage est du type traditionnel. Les animaux sont en liberté en saison sèche. En saison pluvieuse, ils sont soit à l'attache, soit intégrés à la soukala, soit dans les porcheries.

3.3 Les races importées

Deux races européennes sont exploitées au Togo:

. Le porc Large White
. Le porc Land Race

Leur mode d'élevage est du type moderne et sémi-moderne dans les stations et dans les fermes d'éleveurs privés.

4.0 OBJECTIFS OPERATIONNELS

Le Programme National Petit Elevage (PNPE) a démarré son programme de sélection ovine en 1986 au Centre d'Appui Technique de Kolokopé (CAT-K).

Ce programme de sélection vise l'augmentation de la production de viande et la diversification des sources de revenu des paysans-éleveurs.

. Accroître la productivité numérique et pondérale des ovins Djallonké du Centre.
. Diffuser le progrès génétique au niveau des élevages encadrés, notamment les fermes ovines améliorées (FOA).

5.0 ACTIONS ENTREPRISES

. L'amélioration de la vitesse de croissance et le format à l'âge adulte des animaux.
. L'amélioration des caractères de fécondité et de prolificité des brebis ainsi que la viabilité des agneaux.
. La production d'animaux bien conformés et rustiques.
. Le projet a procédé en 1983 et en 1988 à importations de béliers sélectionnés du Programme National de Sélection Ovine (PNSO) de Bouaké - Côte d'Ivoire.
. Il a exécuté deux opérations d'insémination artificielle en 1988 et en 1992. Les brebis Djallonké du CAT-K ont été fécondées avec les semences fraîches (sperme frais) des meilleurs béliers du PNSO.

Il est prévu l'ouverture d'une base de sélection au niveau des Fermes Ovines Améliorées (FOA) performantes pour permettre à un plus grand nombre d'élevages de bénéficier du progrès génétique réalisé au Centre.

6.0 LES ACTIVITES MENEES AU CAT-K

6.1 Contrôle des performances

Les principaux paramètres de performance sont: la vitesse de croissance et le poids à des âges types (à la naissance, à 30 jours, à 90 jours, à 180 jours, etc.)

Autres critères: la bonne conformation et le potentiel de trypanotolérance.

6.2 Optimisation des critères de sélection

Le poids des agneaux est ajusté en fonction de l'âge type au sevrage (20 jours): poids à âge type (PAT) et en fonction du type de naissance (cet ajustement est indiqué surtout pour les nés multiples).

6.3 Méthode de sélection

6.3.1 *Sélection des mâles*

. Première présélection au sevrage (90 jours) en tenant compte les poids ajustés: PAT.
. Deuxième présélection à 6 mois (180 jours).
. Sélection: le bélier est définitivement sélectionné à 12 mois d'âge après les pesées mensuelles de 6 mois à 1 an. Les béliers sont classés en 1ère, 2ème et 3ème catégorie.

6.3.2 *Sélection des femelles*

. Présélection au sevrage en calculant le poids ajusté.
. Sélection: elle a lieu définitivement entre 9 et 10 mois.

7.0 DIFFUSION DU PROGRES GENETIOUE

La diffusion des géniteurs (mâles 150 à 500 et femelles 500 à 800 tous les ans) en milieu rural permet au cheptel national ovin de bénéficier de l'amélioration génétique réalisée au CAT-K.

8.0 LE CENTRE DE TESTAGE OVIN DU CAT-K

Le testage concernera les agneaux mâles présélectionnés dans les troupeaux constituant la base de sélection et les béliers seront indexés selon leur performance.

9.0 REFERENCES

Adanlenhoussi A. 1986. Caractéristiques du bétail N'Dama du CRESAT. Mémoire d'Ingénieur Agronome. Décembre 1986.

Akakpo A.J. 1976. Contribution à l'étude de l'hématologie des bovins de l'Afrique de l'ouest. Thèse de Doctorat Vétérinaire d'Etat. Janvier 1976.

Agbemelo K.T. 1983. Contribution à l'étude des races bovines autochtones du Togo: la race des Lagunes. Mémoire d'Ingénieur des Sciences Appliquées. Décembre 1983.

Amegée Y. 1983. Le mouton de Vogan (Djallonké x Sahélien) au Togo. Rev. Elev. Méd. Vét. Pays trop. 36(1):79-84.

Domingo A.M. 1988. Enquête statistique sur les élevages au Togo. Tome I et II pour la promotion des productions animales au Togo (PROAT).

Domingo A.M. 1976. Contribution à l'étude de la population bovine des Etats du Golfe du Bénin. Thèse de Doctorat Vétérinaire d'Etat. Janvier 1976.

Guidjerbe B. 1986. Elevage traditionnel du porc local dans la préfecture de Toné. Mémoire d'Ingénieur Agronome. Janvier 1986.

IEMVT. 1980. Les petits ruminants d'Afrique centrale et d'Afrique de l'ouest. Synthèse des connaissances actuelles.

Toudji L.K. 1993. Contribution à l'étude des ressources génétiques caprines au Togo: cas des régions maritimes et des plateaux. Mémoire d'Ingénieur Agronome. Novembre 1993.

Traore B. Optimisation du programme de sélection chez les ovins du Centre d'appui technique de Kolokopé.

ANIMAL GENETIC RESOURCES IN BOTSWANA

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RESUME

Cet article fait le point sur l'état des ressources génétiques animales du Botswana, notamment après plusieurs années de sécheresse. Sont également présentés les résultats de comparaison des performances des principales races locales entre elles, avec des races importées et avec des animaux croisés. Grâce à leur grande adaptation aux conditions locales, les animaux de race Tswana restent les plus productifs.

SUMMARY

This article presents the current situation of animal genetic resources in Botswana, particularly following several years of drought. Likewise, a series of results is presented comparing the yields between the main local breeds and also between them and imported and crossed animals. Due to their greater capacity of adaptation to local conditions, the Tswana breed animals continue to be the most productive.

1.0 BACKGROUND

Before independence (1966), the livestock industry contributed substantially to both agricultural production and export earnings. The native livestock were the main breeds. While cattle played a major role in the economy, small ruminants contributed significantly at household level, providing meat for home consumption, milk and cash from the sale of live animals. Cattle provided milk, draught power and a major source of household income to those who owned them. Livestock production was very important in economic and social status. After independence, the Ministry of Agriculture launched Artificial Insemination, Bull and Ram Subsidy Schemes with the aim of improving growth rates and overall productivity. The operation involved mating native female stock to various imported bull and ram breeds. In cattle, the Brahman and Simmental became the most popular breeds, whereas in small ruminants the Boer goat and Dorper sheep were preferred. The schemes were open to all farmers, without targeting either farmer groups or production systems. Their presence was viewed as an opportunity to improve production, without considering the negative consequences of replacing the native breeds.

Since breeding stock were allocated by raffle, some applicants submitted several applications in order to improve chances of success. Annual lists of applications exceeded the number of available stock up to ten times. Some farmers privately imported exotic breeding stock from neighbouring countries. Some progeny from private importations, AI, Bull and Ram Subsidy Schemes were sold as breeding stock, further reinforcing the crossbreeding operations. In cattle, at least 15 imported breeds (in total) have been used through AI, Bull Schemes and private importations.

2.0 INTRODUCTION

Animal products such as eggs, meat, milk, hides and skins are essential in the life of a human being. Domesticated animals provide draught power and manure which fertilizes crop fields, and in some cases serve as a form of social security. The demand for animal protein has risen due to urbanization and general population increase, which has also resulted in serious competition for land. These factors have compelled farmers to improve productivity per animal. Breeds that are not very productive are therefore left out and run the risk of becoming extinct.

Experience has shown that although indigenous breeds may not be very productive, they possess a valuable trait, adaptability. In Sub-Saharan Africa such as Botswana, the production environment is suboptimal. Droughts and disease outbreaks are common and thus breeds of cattle, sheep and goats from temperate countries find it difficult to survive. The indigenous breeds should be utilized and conserved. Conservation should be aimed at preserving their adaptive traits as well as genetic diversity.

Although some traits may seem not to be valuable, they may become valuable in future as market trends change.

It is for these reasons that the FAO and UNEP have encouraged conservation of animal genetic resources. Botswana is aware of the need to conserve biological diversity, and thus supports the idea of conservation of animal genetic resources. The aim of this paper is to look at the population trends of indigenous breeds in the different species and suggest remedial action where the breeds are endangered.

3.0 TRENDS IN LIVESTOCK POPULATIONS

3.1 Cattle

Cattle in Botswana play an important role in the economy. Beef exports earn the country substantial foreign exchange (200 pula per year). Cattle also provide milk and draught power. The cattle population increased from just above 1 million in 1966 to about 3 million in 1982. During the drought in the 1980's, the cattle population was drastically reduced to 2.3 million, but it is increasing towards 3 million again. There are several breeds of cattle found in this country, but no accurate population estimates are available. Among the beef breeds are:

. **Tswana:** This is the indigenous breed of Botswana, with a variety of coat colours and horn shapes. It is used for multipurposes.

. **Tuli:** The breed was developed in Zimbabwe through selection of local and Tswana cattle. It has a light brown to yellow coat colour. It is used for pure and cross breeding.

. **Bonsmara:** This is a composite breed developed from Afrikaner and Shorthorn cattle in South Africa. It has a dark brown coat colour. In Botswana, it is used for pure and cross breeding.

. **Brahman:** A wellknown improved tropical breed. It is popular in both pure and cross breeding.

. **Simmental:** A temperate breed from Germany, used for crossbreeding.

. **Afrikaner:** The breed was developed from the local cattle in South Africa. The coat colour varies from light brown to yellow. The breed used to be popular in pure and cross breeding in Botswana, but has lost fame because of the introduction of Brahman and European breeds.

Other breeds are commonly used for crossbreeding such as Charolais, South Devon, Sussex and Santa Gertudis. There are some dairy breeds which make an insignificant proportion of the national herd. These are, Friesian/Holstein, Brown Swiss and Jersey.

Cattle in Botswana are mostly owned by the traditional sector (80 percent of the national herd). Cattle in this sector are kept in the communal areas where overgrazing is a problem. Large European breeds find it difficult to survive and produce in this suboptimal environment. Animal Production Research Unit (APRU) has evaluated the productivity of Tswana, Bonsmara, Brahman, Tuli and Afrikaner under ranch conditions.

Despite its good productivity, the Tswana breed is reducing in proportion to the national herd. Setshwaelo (1992), estimated that Tswana cattle made up 50% of the national herd. Although the Tswana is not yet endangered, there are clear indications that it will be soon. Uncontrolled crossbreeding has drastically reduced the population of Tswana cattle and commercial farmers have no interest in the breed. Artificial insemination has made it easy for farmers to use semen from imported bulls. The popular breeds are Brahman and Simmental, and to a limited extent Charolais, Sussex, South Devon and Santa Gertrudis.

3.2 Horses and donkeys

Horses and donkeys are used for transport and draught power. The general development of infrastructure and technology advancement have rendered the use of donkeys and horses unnecessary in some parts of the country. Horses are mostly used in the Western and Maun Region because roads there are poor and sandy. Donkeys are mostly used for draught power and horses for riding.

. **Donkeys:** The donkey population has increased from 130 000 in 1980 to 158 000 in 1990 (Agricultural Statistics, 1990). The donkey population did not reduce during the drought years. This may be due to the fact that donkeys are not culled, mostly because they are not eaten. There is no controlled breeding in donkeys and thus the donkey population is randomly mated without selection. There is no information on importation or exportation of donkeys. It has been estimated that 98% of the donkeys are on traditional farms.

. **Horses:** The horse population increased from 11 000 in 1970 to 34 000 in 1990. The reasons for increase are probably the same as that of donkeys. Approximately 82%of the horses are on traditional farms. The horses are not indigenous to Botswana and most of them are probably imported from South Africa. There is limited controlled breeding but little is known about breeds of horses found in Botswana.

3.3 Pigs

According to Agricultural Statistics reports from 1970 to 1990, the pig population has increased steadily from 8 000 to 16 000. Of the 16 000 pigs, 12 500 were confined to rural areas. The pork quality of indigenous pigs is of low grade because of excessive fat which also limits its marketability. The lard from indigenous pigs was used to produce soap but due to infrastructure development and general improvement in the standard of living, the demand for this soap has virtually ceased to exist. Commercial pig breeds are kept by both commercial and traditional pig producers. The common breeds are Large White, Landrace and Duroc. These breeds are either bred pure or crossed amongst each other.

Although some of the local people do not eat fresh pork due to religious and traditional reasons, the demand for pork, bacon and processed pork products continues to grow. According to the Central Statistics Office, in 1992, Botswana imported 98.7 tons of fresh pork and bacon/ham. It is because of this demand that commercial pig production is encouraged. The indigenous pig has no role to play in this market and thus runs the risk of being left to perish. Government should therefore make an effort to preserve indigenous pigs and also their performance should be evaluated. There is considerable variation within indigenous pigs and thus further characterization is essential.

3.4 Small ruminants

In 1970 there were nearly 400 thousand sheep and over 1 million goats. During the course of the decade, small ruminant population dropped severely due to droughts combined with cold weather such that at the end of the decade (1979) there were 152 000 sheep and 616 000 goats. The decline caused great concern among livestock producers. However numbers grew steadily during the 1980s despite the droughts which killed cattle and other livestock. The ability of small ruminants to withstand droughts, together with reproductive efficiency, stimulated many producers to undertake small ruminant production. This was

enhanced by government financial assistance on small ruminant projects. Common goat breeds are the local Tswana whose proportion is estimated at about 80 percent of the goat population, while the rest are Boer and crossbred goats. About 90 percent of the sheep population are the local Tswana, while the rest are Karakul, Dorper and crossbred sheep.

3.5 Poultry

Native poultry have been important in supplying limited quantities of eggs and meat, thus supplementing human protein intake from large stock. Sales for cash were common during the pre-independence period, but earning inadequate cash for family needs because of the small numbers of birds available for either eggs or meat production. During the 1970's, commercial breeds of White Leghorn, Plymouth Rock, Rhode Island Red and their crosses were introduced and profitable poultry was encouraged. Commercial birds were to be maintained under a healthy confinement system, while indigenous poultry foraged in the range near the homesteads. Currently, among the commercial layer breeds used in the country are the Hi-line and Isa Brown. The broiler breeds (for meat production) include the Ross, Cob and Indian River. Poultry numbers have increased over the past two decades as a result of importation of commercial flocks. The indigenous flocks are still important in the traditional production system.

Table 1: *Trends in Livestock Populations (x 1 000)*

Year	Cattle	Sheep	Goats	Donkeys	Horses	Pigs	Poultry
1970	1 221	392	1 112	42	11	8	390
1979	2 840	152	616	127	18	6	740
1980	2 911	148	637	130	22	6	833
1981	2 967	140	621	127	24	5	1 046
1982	2 979	140	635	138	24	5	1 146
1983	2 818	164	783	142	23	5	960
1984	2 685	167	889	139	23	7	714
1985	2 459	200	1 137	146	23	9	1 028
1986	2 332	229	1 332	142	24	11	1 178
1987	2 264	240	1 469	147	24	11	1 282
1988	2 408	258	1 691	150	28	13	1 809
1989	2 543	286	1 897	151	32	15	2 013
1990	2 696	317	2 092	158	34	16	2 126

Source: Botswana Agricultural Statistics, 1970-1990.

Table 2: *Trends in average herd size according to production system*

	Traditional				Commercial			
Year	**Cattle**	**Sheep**	**Goats**	**Poultry**	**Cattle**	**Sheep**	**Goats**	**Poultry**
1980	42	10	14	12	1 341	104	87	289
1982	43	10	13	13	1 397	141	97	1 717
1983	41	12	16	10	1 190	146	104	1 500
1984	40	12	17	9	1 116	120	123	1 071
1986	37	15	22	12	741	121	119	2 245
1987	37	14	23	12	793	113	117	2 100
1988	37	15	26	14	871	135	136	2 667
1989	38	15	27	14	921	131	146	2 803
1990	40	15	30	15	932	144	156	2 884

Source: Botswana Agricultural Statistics 1980-1990.

Table 3: *Trends in population proportion (%) according to production system*

	Traditional				Commercial			
Year	**Cattle**	**Sheep**	**Goats**	**Poultry**	**Cattle**	**Shee p**	**Goats**	**Poultry**
1980	84	90	98	94	16	10	2	6
1981	84	87	97	90	16	13	3	10
1982	84	83	97	82	16	17	3	18
1983	85	85	97	69	15	15	3	31
1984	85	86	97	79	15	14	3	21
1986	84	87	97	62	16	13	3	38
1987	82	85	97	59	18	15	3	41
1988	82	84	97	56	18	16	3	44
1989	82	84	97	54	18	16	3	46
1990	82	84	97	54	18	16	3	46

Source: Botswana Agricultural Statistics, 1980-1990.

4.0 A REVIEW OF COMPLETED STUDIES ON CATTLE AND SMALL RUMINANTS

4.1 Cattle

Animal Production and Range Research Unit, has evaluated the productivity of Tswana, Bonsmara, Brahman, Tuli and Afrikaner under extensive ranching conditions. The results are summarized bellow.

Table 4: *Performance of Tswana and other breeds studied in Botswana*

Breed	Calving (%)	Mortality %	18 months wt. (kg)
Tswana	80	9.4	293
Bonsmara	83	17.5	315
Tuli	87	7.2	287
Brahman	72	18.6	309
Afrikaner	67	13.5	278

Source: Animal Production and Range Research Unit, 1980.

These results proved the Tswana a highly productive breed despite the fact that it has not been selected. It has further been demonstrated that crossing Tswana with Brahman and Simmental productivity was improved (APRU 1980).

4.2 Small ruminants

4.2.1 *Studies on breed performance*

From 1976 to 1984 the Animal Production Research Unit monitored the performance of indigenous small ruminants (Tswana sheep and goats) together with that of imported Boer goats and Dorper sheep. The aim was to evaluate the productivity of these breeds for meat production under local conditions and recommend future breeding strategies. A summary of results follows.

Table 5: *Performance Tswana, Boer goats and Crossbreeds*

Trait	Tswana	Boer	Crossbred
Reproduction:			
Kidding rate per doe bred	1.21	1.27	-
Kidding rate per doe kidding	1.5	1.71	-
% of does kidding	80	74	-
Mortality:			
From birth to weaning (4 mths)	9	25	11
From birth to 12 months (%)	24	42	26
From birth to 18 months (%)	30	46	29
Growth:			
Weaning wt. (4 mths) kg	13.4	14.9	14.4
12 months wt. kg	29.6	33.3	31.5
18 months wt. kg	34.5	36.5	36.1

Source: Animal Production and Range Research Unit, 1983-84.

The difference between Tswana and Boer goats in kidding rate per doe bred was not significant. Both breeds have the ability to produce twins as reflected in the kidding rate which was greater than 1.0, but the Boer goat had a higher twinning rate. The percentage of does kidding indicates fertility rate, which was higher in the Tswana goat.

The level of mortality among the Tswana and crossbred was moderate, at weaning, at 12 months and at 18 months.The Boer goat on the other hand had a very high mortality rate at weaning, 12 months and 18 months.

The growth of the three breeds was impressive up to weaning, 12 months and 18 months. The Boer goat and crossbred were not significantly different in live weights, but were significantly heavier than the Tswana. Combining the three traits of reproduction, survival rate and growth, the Tswana goat would have higher productivity.

Table 6: *Performance of Tswana, Dorper and Crossbred sheep*

Trait	Tswana	Dorper	Crossbred
Reproduction:			
Lambing rate/ewe bred	0.86	0.74	-
Lambing rate/ewe lambing	1.02	1.09	-
% of ewes lambing	84.00	68.00	-
Mortality %:			
From birth to weaning	11.00	39.00	8.0
From birth to 12 months	25.00	58.00	21.0
Growth (kg):			
Weaning wt.	17.10	20.70	19.6
12 months wt.	26.70	30.80	30.4
18 months wt.	34.10	38.20	38.2

Source: Animal Production and Range Research Unit, 1983-84.

The Tswana sheep had a higher lambing rate per ewe bred than the Dorper. Lambing rates per ewe lambing indicate low twinning rates of 2% and 9%, for the Tswana and Dorper, respectively. The Tswana sheep had a higher fertility rate as expressed by percentage of ewes lambing. Mortality of the Tswana and crossbreeds was similar and at acceptable levels, at weaning, at 12 months and at 18 months, but the Dorper on the other hand, had an extremely high mortality rate at those stages. The mortality of the Dorper on the other hand was extremely high, at weaning, 12 months and 18 months. Mortality rates at these levels, would be a major problem limiting the production of pure Dorper sheep under conditions where the study was conducted.

Like the goat breeds, all three sheep breeds had satisfactory growth rates as reflected in their liveweights at various stages. The Dorper and crossbred had similar weights at weaning, 12 months and 18 months. The Tswana on the other hand weighed lower but satisfactorily the three stages. The combined traits of reproduction, survival rate and growth would give the Tswana sheep a higher productivity index.

4.2.2 *Seasonal Performance of Tswana goats*

From 1985 to 1991, APRU observed the influence of season of kidding on goat performance at the Lesego Ranch. Each year, one group of Tswana goats was bred to kid in autumn while the other was bred to kid in spring. The aim of the study was to find the extent to which seasonal differences would affect production traits in goats kept under extensive farming conditions. The following table summarizes the results.

Table 7: *Seasonal performance of Tswana goats*

Trait	Spring	Autumn
Reproduction:		
Kidding rate per doe bred	1.66	1.39
Kidding rate per doe kidding	1.79	1.71
% of goats kidding	93.00	81.00
Mortality %:		
Birth to weaning (4 mths)	15.00	7.00
Birth to 12 months	27.00	17.00
Growth (kg):		
Birth wt.	2.50	2.60
Weaning wt.	17.40	17.10
12 months wt.	30.00	29.00

Source: Animal Production and Range Research Unit, 1991.

In general, the results show a satisfactory production performance when goats kidded in either spring or autumn. However, spring kidding had a higher kidding rate per doe bred and per doe kidding. The differences in reproductive performance could result from the level of nutrition during the mating period. Mortality rates were higher in spring, at weaning and at yearling age. Preweaning losses contributed significantly to mortality differences at 12 months. Higher mortality rate in spring kids could result from lack of adequate feeding at the early postnatal stages of kid development during that season.

Weaning weights were not significantly different. Autumn lambs were expected to weigh heavier because they were born during the peak of forage growing season. Nor were the yearling weights different. Whether born in spring or autumn, kids had to go through a dry period of limited forage availability at some stage before attaining the yearling weight. This could have contributed to similar yearling weights.

5.0 ON-GOING PROJECTS

5.1 Cattle

5.1.1 *Breeding and Selection of Tswana Cattle*

Although there is no set policy to conserve Tswana cattle, the Department of Agricultural Research has started a selection programme of Tswana cattle. The aim of the project is to improve the productivity of Tswana cattle by selecting for reproduction, growth rate and maternal ability. Two herds, each consisting of 300 cows, have been assembled for selection. In one herd, emphasis for selection is placed on weaning weight adjusted to 210

days. This is aimed at increasing the maternal performance of Tswana for calf preweaning growth. In the herd, selection is for 18 months weight adjusted to 540 days. This is aimed at increasing the post-weaning weight gain.

5.1.2 *Beef Cattle Recording Scheme*

As a pilot project, the beef cattle recording scheme has been started to record performance of cattle and hence facilitate selection. It is hoped that the Recording Scheme will promote the establishment of Breed Societies which will include the breeders of Tswana cattle. There is considerable variation within the Tswana and thus it is necessary to study and characterize the breed in more detail.

5.2 Sheep and Goats

5.2.1 *Breeding and Selection of Indigenous Sheep and Goats*

. Objectives

a) To improve the productivity of the native sheep and goats for meat production.
b) To establish a basis for preservation of the native stock.

Status: Two sheep flocks have been established at the Goodhope and Morale ranches, about 330 km apart. A third herd consisting of goats only has been established at Sunnyside, about 70 km from Goodhope. Between 250 and 300 breeding females and 15 to 20 rams are maintained at each ranch.

. Selection Criteria

Replacement stock are selected for growth, body conformation and structural soundness (feet, mouth, genitals etc). Does and ewes are selected for fertility, mothering instinct, kid/lamb survival, kid/lamb growth, structural soundness and ability to maintain mature body weight.

. Flock Management

Management of flocks is extensive. Flocks derive their food intake from natural pastures on fenced farms. Vaccinations and antibiotic treatments are used to control common diseases. Internal and external parasites are controlled by regular drenching and plunge dipping respectively. The breeding system is that of random mating and multi-sire. Rams/bucks are introduced into the breeding flocks for two months, once a year.

5.2.2 *Future*

More flocks will be established in order to widen the genetic pool and make both conservation and improvement more meaningful.

6.0 SUGGESTED CONSERVATION STRATEGIES

Botswana is committed to the ideas of conservation of biological diversity. Some achievements have been made in conservation of wildlife, indigenous plants and rangelands. It is regretted that presently there is no clear policy for conservation of domestic animal diversity. Based on existing infrastructure and facilities, and with possibilities of further development, the following methods seem appropriate for the conservation of animal genetic resources:

a) *In-situ* (conservation of live animals). This method requires a large number of animals to avoid inbreeding and thus a substantial amount of land on which the animals are to live, feed and breed. In order for this method to succeed, co-operation of farmers should be sought.

b) Cryo-preservation (storage of frozen semen and embryos) Under the present conditions, cryo-preservation may be restricted to semen. The embryo technology has not yet been developed.

The Department of Agricultural Research has among others, suggested the following points to the Ministry of Agriculture for consideration.

a) That appropriate legislation and institutional structures be developed to facilitate conservation of animal genetic resources.

b) That the Department of Agricultural Research be assigned responsibility to develop and monitor a national programme aimed at preservation, conservation and utilization of animal genetic resources. Presently, a plant germplasm section has been established in the department.

c) That crucial information be collected on the nature and characteristics of indigenous breeds of livestock. Populations should be monitored.

d) That the farming community should be sensitized on the importance of conserving the animal genetic resources, particularly the indigenous breeds.

7.0 REFERENCES

Animal Production and Range Research Unit. 1991. Range Research in Botswana. Annual Report. Agriculture, Botswana.

Animal Production and Range Research Unit. 1983/84. Range Research in Botswana. Annual Report. Agriculture, Botswana.

Animal Production and Range Research Unit. 1980. Ten years Animal Production and Range Research in Botswana. Ministry Agriculture, Botswana.

Botswana Agricultural Statistics. 1970-1990. Annual Reports. Ministry of Agriculture, Botswana.

Central Statistics Office. 1992. External Trade Statistics, Annual Report. Ministry of Finance and Development Planning, Botswana.

Setshwaelo, L.L. 1992. A case for conservation of animal genetic resources in Africa. Department of Agricultural Research, Annual Seminar. Ministry of Agriculture, Botswana.

ETUDE DES RESSOURCES GENETIQUES CAPRINES DE L'ALGERIE DU NORD A L'AIDE DES INDICES DE PRIMARITE

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RESUME

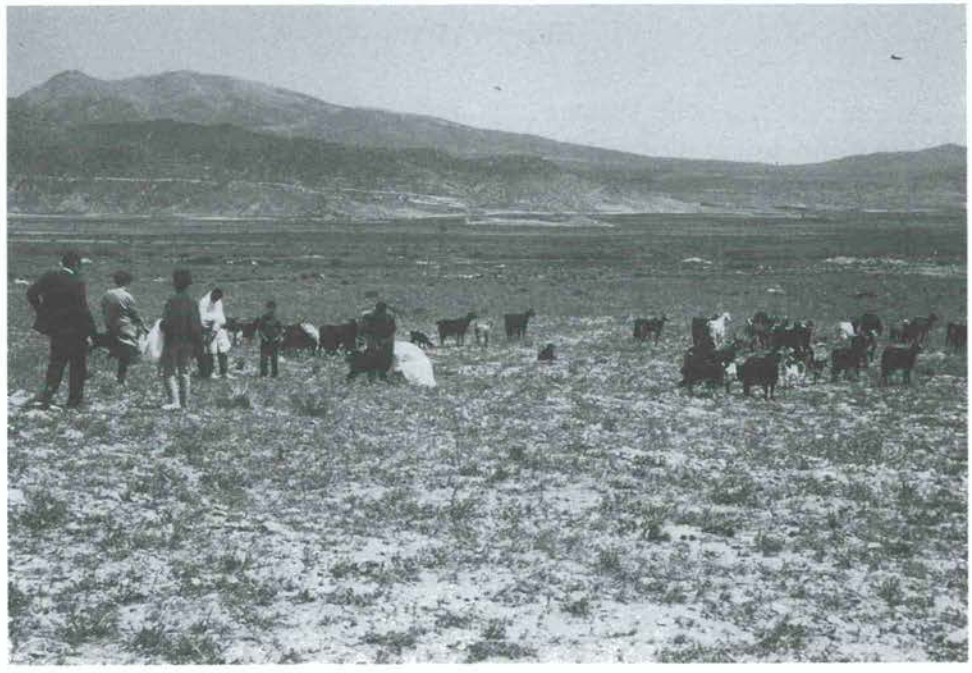
Les ressources génétiques caprines (*Capra hircus* L.) d'Algérie n'ont pas fait l'objet d'une attention particulière comparativement au reste des populations de l'espèce du Bassin méditerranéen. En témoigne la méconnaissance de leur degré d'appartenance à l'une des trois catégories de la classification évolutive des animaux de ferme qui comprend espèce sauvage, population primaire - initialement population traditionnelle - et race standardisée. Des données relatives à la variabilité génétique de douze loci à effets visibles sont considérées pour caractériser les populations caprines des Monts Dahra et Aurès. Ces travaux se basent sur l'emploi de deux indices récemment introduits: l'indice de primarité **loci en ségrégation** (IPs) et l'indice de primarité **allèles au locus Agouti** (IPa). Les résultats obtenus plaident en faveur de l'appartenance de ces populations à la catégorie de population primaire.

SUMMARY

The Algerian goat genetic resources (*Capra hircus* L.) have received no particular attention in comparison to the other goat populations in the Mediterranean area. There is no knowledge as to which one of the three categories of farm animal evolutive classification they belong. This classification includes wild species, primary population -initially traditional population- and standardized breed. Data relative to the genetic variability of twelve loci with visible effects are considered to characterize the goat populations of the Dahra and Aurès mountains. This work is based on two recently introduced indexes: the index of primarity *loci in segregation* (IPs) and the index of primarity *Agouti locus* (IPa). The results obtained show that these goat populations belong to the primary population category.

1.0 INTRODUCTION

La population caprine d'Algérie compte environ 3,6 millions de têtes localisées dans les zones montagneuses (28,8%), la Steppe (41,1%) et le sud (22,5%). Le cheptel caprin comprend également, mais en faible proportion (7,6%), des chèvres améliorées importées d'Europe (Saanen, Alpine, Murcienne, Maltaise, Toggenbourg) et les produits de leurs croisements rencontrés principalement au sein des exploitations d'Etat (Chellig, 1978). Ceci est dû au fait que les éleveurs traditionnels, auprès de qui les prospections ont été menées, ne sont pas favorables au sein de leurs troupeaux à la présence de chèvres, ne leur ayant pas été léguées par la voie de l'héritage ancestral. Cette attitude à l'égard de chèvres "étrangères" traduit, selon Laurans (1989) et Flamant, Audiot et Vallerand (1991), la participation de la chèvre locale à l'identité collective de la communauté. Cet article, qui rapporte les résultats des investigations relatives à l'identification de la variabilité génétique visible des populations caprines algériennes des Monts Dahra et Aurès, tente de quantifier le degré d'appartenance de ces populations à un terme de classification évolutive des animaux de ferme en utilisant les indices de primarité récemment introduits (Lauvergne, 1993; Lauvergne *et al.*, 1993; Machado *et al.*, 1992). Il répond, en quelque sorte, au récent regain d'intérêt manifesté à l'échelle internationale à l'égard des ressources génétiques animales exprimé par un grand nombre d'auteurs, à l'exemple de Steane (1993).



Troupeau de caprins dans les Aurès

2.0 MATERIEL ET METHODES

2.1 Choix des zones d'échantillonnage

Ce choix s'est d'abord basé sur la délimitation de deux zones connues pour leur peuplement caprin et suffisamment distantes pour donner une idée de la primarité des chèvres du nord de l'Algérie. De plus, l'existence dans les montagnes du nord rapportée par Chellig (1978) d'une population ou race caprine communément appelée Naine de Kabylie nous a semblée intéressante à retenir comme critère de choix des Monts Dahra, cette population caprine n'ayant pas fait l'objet d'une étude portant sur l'inventaire de sa variabilité génétique visible comme dans le cas des chèvres des Aurès. Nous devons ajouter que le choix porté sur les Monts des Aurès est justifié par l'existence d'une remarquable industrie artisanale à base de fibres caprines qui caractérise les activités humaines de cette région, particulièrement celles de la zone comprenant le Balcon du Roufi.

2.2 Situation géographique des zones échantillonnées

Les Monts Dahra, situés entre 36° et 37° de latitude nord, entre 0° et 2° de longitude est, constituent une chaîne montagneuse côtière n'excédant pas 1 500 m d'altitude. Les Monts Dahra sont situés dans l'étage bioclimatique sub-humide. Les Aurès, compris entre 35° et 36° de latitude nord, entre 6° et 8° de longitude est, forment un massif compact où les crêtes rectilignes sont séparées par des vallées profondes. Le point culminant est atteint au Djebel Chelia (2 328 m). La juxtaposition de deux étages bioclimatiques, sub-humide et semi-aride à aride, caractérise les Aurès (Seltzer, 1946).

2.3 Réalisation de l'échantillonnage

Les investigations réalisées en deux campagnes, de décembre 1991 à mai 1993, considèrent 17 troupeaux de taille variable répartis entre les Monts Dahra (D_i, i = 1:7) et Aurès (A_i, i = 1:10). Tous les échantillons sont réalisés, d'un commun accord préalable avec les éleveurs, tôt le matin à l'intérieur de la *z'riba* (enclos de fortune) avant la sortie des animaux vers les pâturages, ou en fin de journée dès leur retour. Au total, 1 097 caprins âgés de plus d'un an ont fait l'objet d'une caractérisation phénotypique: 488 pour les Monts Dahra et 609 pour les Aurès (tableau 1).

2.4 Mesure de la primarité

La reconnaissance de la variabilité génétique visible utilise la notion récente d'indice de primarité présentée par Lauvergne (1993) et appliquée dans le cas des chèvres du Brésil (Machado *et al.*, 1992), du Nord Cameroun et Tchad (Lauvergne *et al.*, 1993). La primarité désigne le premier stade d'évolution d'une espèce après sa domestication. La domestication atténue la pression de sélection naturelle sur les mutants à effet visible permettant leur accumulation qui génère inéluctablement une variabilité génétique visible facilement remarquable. Une population primaire - nommée originellement traditionnelle - est une population dans laquelle on n'a pas encore procédé à des sélections avec création d'isolats génétiques. Il y a lieu, cependant, pour vérifier l'existence de cette primarité, de s'assurer de certaines conditions: situation de panmixie, pas de conséquences dues aux effets de dérive génique et pas de croisements anarchiques entre races standardisées pouvant avoir généré la variabilité génétique observée (Lauvergne *et al.*, 1993).

2.5 Les loci considérés

L'identification considère douze loci à effet visible susceptibles de ségréger. Cinq sont relatifs à la coloration de l'animal: *Agouti (A), Brown (B^+, B^b; wild vs brown), Frosting (Fr^+, Fr^R; wild vs frosting), Roan (Rn^+, Rn^R; wild vs roan)* (Alexieva *et al.*, 1990; Millar et Lauvergne, 1990) et le locus pressenti *Spotting (S^+, S^S; wild vs spotting)* (Lauvergne *et al.*, 1993). La détection de la présence des allèles au locus *Agouti* multiallélique utilise l'échelle visuelle donnée par Lauvergne, Renieri et Audiot (1987), et Lauvergne *et al.* (1993). Les données de ségrégation relatives au locus *Agouti* (Millar et Lauvergne, 1990) et le principe de l'homologie interspécifique (Lauvergne, 1983) nous autorisent à tenir compte des allèles suivants: *nonagouti (A^a), badgerface (A^b), black and tan (A^t), black and tan balck belly (A^{tb}), red cheek (A^{rc}), mantled (A^m), reverse mantled (A^{rm}), red (A^r)* et *wild (A^+)*. Les autres loci concernent les caractères autres que ceux de la coloration: *Beard (Bd^+, Bd^b; wild vs bearded), Ear Carriage (EC^+, EC^P; wild vs pendulous), Ear Curling (ECr^+, ECr^C; wild vs curled), Ear Length (EL^+, EL^L; wild vs reduced), Horns (H_{o+}, Ho^P; wild vs polled), Hair Length (HL^+, HL^L; wild vs long), Wattles (Wa^+, Wa^W; wild vs wattles)* (COGOVICA/COGNOSAG, 1989). Il nous faut signaler que certains animaux n'ont pas pu faire l'objet d'une caractérisation phénotypique. Ceci est généré par certaines interactions complexes entre les gènes allèles au locus *Agouti* d'une part, d'autre part par les interactions possibles de type épistatique survenant entre certains loci. Ce qui est à l'origine de certaines différences observables entre les effectifs des tableaux 1, 2 et 3 pour le même échantillon.

3.0 RESULTATS

Le tableau 2 présente les estimations de l'indice de primarité **loci à effet visible en ségrégation** (IPs) pour chacun des sites échantillonnés et pour chaque regroupement de sites opéré à l'intérieur de chacune des zones.

Chèvre des Aurès à poils longs et oreilles longues

Le tableau 3 donne les estimations de l'indice de primarité **allèles au locus Agouti** (IPa) pour chaque site échantillonné pris isolément et pour chacune des zones après regroupement.

4.0 DISCUSSION

4.1 Primarité des populations caprines d'Algérie

Les tableaux 2 et 3 traduisent sans équivoque la primarité des populations caprines des Monts Dahra et des Monts Aurès d'Algérie. Il n'est pas exclu d'admettre que cette primarité se rencontre chez la majorité des chèvres d'Algérie, comme en témoigne les résultats déjà obtenus dans le cas des populations ou races caprines **Arabia** (Steppe, région de Laghouat) et **Mekatia** (Oasis du désert, région de Ghardaïa) (Khemici *et al.*, 1994). La primarité des populations caprines d'Afrique ayant déjà été, en effet, pressentie et implicitement évoquée par différents auteurs comme Epstein et Mason (In: Lauvergne *et al.*, 1993).

4.2 Situation par rapport au reste des populations examinées

Les valeurs des indices de primarité des populations caprines du nord de l'Algérie, comme celles du sud de ce pays (Khemici *et al.*, 1994) sont du même ordre de grandeur que celles du Brésil (Machado *et al.*, 1993), du nord Cameroun et Tchad (Lauvergne *et al.*, 1993) et du Bassin méditerranéen nord (Lauvergne *et al.*, 1993). La similitude des indices de primarité estimés pour des populations aussi éloignées que prochés plaide en faveur de l'hypothèse émise par Lauvergne *et al.* (1993). Cette hypothèse envisage l'existence déjà ancienne d'une population primaire qui se serait répandue sur les grands espaces où elle existe actuellement.

Chèvre des Aurès de coloration noire

4.3 Particularités des populations caprines examinées

Le nanisme de la chèvre des Monts Dahra lui a valu l'appellation **Naine de Kabylie** (Chellig, 1978). Ce nanisme semble la distinguer qualitativement de la chèvre des Aurès. Force est de constater, à ce propos, la nécessité de procéder à une étude portant sur les aspects morpho-biométriques pour quantifier le pouvoir discriminant de la hauteur sur pattes, en intégrant l'**indice de gracilité** (rapport du vide sous-sternal à la profondeur du thorax) et l'**indice auriculaire** (rapport de la longueur de l'oreille à la profondeur du thorax) récemment introduits par Bourzat *et al.* (1993). Nous adopterons, dans le cadre de cette discussion et pour la distinction des deux populations caprines étudiées, l'autre appellation **Montagnarde des Aurès** attribuée par les éleveurs de la région au savoir-faire traditionnel non négligeable.

Des différences notables entre ces deux populations ou races caprines portant sur la diversité phénotypique méritent d'être signalées. Ces différences sont relatives aux loci **Ear Length** (**EL**, longueur de l'oreille) et **Hair Length** (**HL**, longueur des poils). L'absence de ségrégation au locus **EL** et **HL** chez la **Montagnarde des Aurès** semble différencier celle-ci de la **Naine de Kabylie**. L'absence de ségrégation au locus **EL** correspond à l'absence du variant mendélien $\mathbf{EL}^{R}$, à l'origine des oreilles de taille réduite n'excédant pas 2 cm, variant observé chez la majorité des échantillons des Monts Dahra (tableau 2). Ce fait traduirait un avantage sélectif de l'allèle $\mathbf{EL}^{+}$ (oreille longue) dans les Aurès. Cet avantage sélectif s'exprimerait par l'allongement de l'oreille qui constitue une défense contre la chaleur et la sécheresse en facilitant l'exportation de calories dégagées par le métabolisme par échange thermique de contact plutôt que par exportation de vapeur d'eau dans une zone sèche (Robertshaw, 1982). Ceci témoignerait de l'adaptation de cette chèvre aux conditions de chaleur et de sécheresse qui caractérisent une grande partie des Aurès. Ce qui ne semble pas être le cas dans les Monts Dahra où les conditions bioclimatiques sont du type sub-humide. Bourzat *et al.* (1993) rapportent une étroite association positive entre l'allongement de l'oreille et la gracilité qui varient quasi linéairement avec le degré de latitude nord chez les chèvres du nord Cameroun et Tchad. La remontée du nord Cameroun vers le Tchad s'accompagne d'une raréfaction du couvert végétal. Selon ces auteurs, l'allongement de l'oreille, mesure de défense contre la chaleur et la sécheresse (Robertshaw, 1982), accompagne l'augmentation du vide sous-sternal en soustrayant l'animal à la réverbération de la chaleur par un sol de plus en plus dénudé lorsque le couvert végétal se raréfie. On est tenté de penser que la situation est analogue chez les chèvres des Monts Dahra (étage sub-humide, présence du variant $\mathbf{EL}^{R}$) et Aurès (étage semi-aride à aride, absence totale du variant $\mathbf{EL}^{R}$) à condition de retenir l'hypothèse d'un pouvoir discriminant dû à la hauteur sur pattes entre les deux populations étudiées.

Le monomorphisme au locus **HL** observé chez la moitié des échantillons des Aurès, conséquent probablement à des effets de fondation, correspond à l'homozygotie pour l'allèle $\mathbf{HL}^{L}$ (poils longs) (tableau 2). Ce fait est manifestement lié à la remarquable industrie artisanale à base de fibres caprines qui caractérise les activités humaines de cette région, comme déjà signalé, et que l'on ne retrouve pas dans les Monts Dahra.

Chèvre naine des Monts Dahra

Chèvre des Monts Dahra aux oreilles réduites

5.0 CONCLUSION

Les résultats de ces travaux s'ajoutent à ceux déjà obtenus lors d'un précédent inventaire des ressources génétiques caprines de la Steppe (population **Arabia**) et des oasis de Ghardaïa (population **Mekatia** ou **Chèvre du M'zab**) (Khemici *et al.*, 1994). Les estimations des indices de primarité **loci en ségrégation** (IPs) et **allèles au locus Agouti** (IPa) de même ordre de grandeur que ceux obtenus chez les chèvres **Arabia** et **Mekatia** attestent de la primarité des populations ou races caprines d'Algérie. Ces résultats plaident en faveur de l'hypothèse d'une population primaire ancienne qui s'est répandue sur les espaces où on la rencontre actuellement (Lauvergne *et al.*, 1993). Ils ont besoin, cependant, d'être complétés par une étude morpho-biométrique qui considère la hauteur au garrot, l'indice auriculaire et l'indice de gracilité (Bourzat *et al.*, 1993) pour l'obtention d'une cartographie plus exhaustive des ressources génétiques caprines d'Algérie qui permettra l'identification des principaux groupes ethniques.

6.0 FINANCEMENT DES TRAVAUX

Ces travaux, financés à leur début par le Rectorat de l'Université de Blida dans le cadre de l'avant-projet sur les ressources génétiques ovicaprines d'Algérie conçu en janvier 1991, ont pu être poursuivis grâce à l'agrément et au financement, depuis février 1993, par le Ministère de l'Enseignement Supérieur et de la Recherche Scientifique (code projet: H 0934/03/93).

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8.0 REFERENCES

Alexieva S.A., Aliev G.A., Bourzat D., Denis B., Dolling C.H.S., Lauvergne J.J., Lundie R.S., Malher X., Millar P., Rachkovsky M.L., Rae A.L., Renieri C., Sponenberg D.P. et Tucker E.M. 1990. General procedure for listing loci and alleles of sheep and goats (1989). In: Loci for coat color of sheep and goats (1989) (Lauvergne J.J. ed.), COGOVICA/COGNOSAG, Clamart, France, p.9-13.

Chellig R. 1978. La production animale de la Steppe. In: Congrès sur le nomadisme en Afrique, Addis-Abbéba, 6-10 février.

Flamant J.C., Audiot A. et Vallerand F. 1991. Les populations humaines gestionnaires des populations animales. In: Les exploitations agricoles et leur environnement. Essais sur l'espace technique et économique (Brossier, Valceschini, eds.). INRA, Versailles, p.31-40.

Khemici E., Lounis A., Mamou M., Sebâa-Abdelkader M. et Takoucht A. 1994. Indices de primarité des populations caprines de la Steppe (Arabia) et du désert (Mekatia) d'Algérie. Genet. Sel. Evol. (soumis pour publication).

Laurans R. 1989. Le concept de race: approche ethnozootechnique, approche biologique. In: La gestion des ressources génétiques des espèces domestiques animales (Lavoisier ed.) p.31-40.

Lauvergne J.J. 1992. Breed development and breed differentiation. In: Proc. CEC Workshop and Training Course, Hannover 7-9 Decembre 1992, p.53-64.

Lauvergne J.J. (ed). 1989. Goats allelic series 1987. Visible traits other than color. In: Standardized genetic nomenclature for sheep and goats (1987). Loci for visible traits other than color and blood and milk polymorphisms. COGNOSAG/COGOVICA, Paris, B.R.G., p.125-135.

Lauvergne J.J. 1983. Utilisation du principe d'homologie interspécifique pour l'étude du déterminisme de la couleur du pelage des ruminants domestiques: l'exemple du locus Agouti. Bull. Soc. Zool., 108:201-243.

Lauvergne J.J., Bourzat D., Souvenir Zafindrajaona P., Zeuh V. et Ngo Tatia A.C. 1993. Indices de primarité de chèvres au nord Cameroun et au Tchad. Rev. Elev. Méd. Vét. Pays trop., 4:651-665.

Lauvergne J.J., Renieri C. et Audiot A. 1987. Visible genetic profile to estimate genetic erosion in Provence traditional goat population. J. Hered., 78:307-314.

Machado T., Lauvergne J.J. et Souvenir Zafindrajaona P. 1992. Le scénario de peuplement caprin brésilien depuis la découverte. Arch. Zootec. Cordoba, 41:455-466.

Millar P. et Lauvergne J.J. 1990. Loci for coat color of goats. In: Loci for coat color of sheep and goats (1989) (Lauvergne J.J., ed.), COGOVICA/COGNOSAG, Clamart, France, p.59-66.

Robertshaw D. 1982. Concepts in animal adaptation, thermoregulation of the goat. In: Proc. Int. Conf. Goat, Goat, Production and Disease, p.395-397.

Seltzer P. 1946. Le climat de l'Algérie. Travaux de l'Institut Météorologique Physique Globale. Alger.

Steane D. 1993. More attention to animal genetic resources (Comment). World Anim. Rev., 76(3).

Tableau 1: *Sites d'échantillonnage des Monts Dahra (D_i) et Aurès (A_i)*

Zones	Localités	Sites	Effectif mâles	Effectif femelles	Total
Monts Dahra	Aghabal	Zadra (D_1)	28	50	78
	Messelmoune	Bouzérou (D_2)	27	65	92
	Damous	T'baint (D_3)	19	39	58
	Mouzaïa	Aïn-Romana 1 (D_4)	9	30	39
		Aïn-Romana 2 (D_5)	9	32	41
		Aïn-Romana 3 (D_6)	37	30	67
	Zaccar	Chéraga (D_7)	31	82	113
Monts Aurès	Timgad	El-Merfi (A_3)	6	40	46
		Ouled-Bedda (A_1)	28	82	110
	Batna	Condorcet (A_2)	12	75	87
	Bouhmama	Bohmama (A_4)	5	35	40
		Assoul (A_5)	4	46	50
		Bouzouamel (A_6)	2	53	55
		Takaneghir (A_7)	8	42	40
		Ilmathen 1 (A_8)	19	61	80
		Ilmathen 2 (A_9)	9	42	51
		M'sara (A_{10})	9	31	40

Tableau 2: *Indice de primarité loci en ségrégation (IPs) des populations caprines des Monts Dahra et Aurès*

Loci à effet visible	Monts Dahra							Total	Monts Aurès										Total
	D_1	D_2	D_3	D_4	D_5	D_6	D_7		A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	
A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
B	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
Fr	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Rn	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bd	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
EL	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
EC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ECr	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
H_o	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
HL	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0	0	1
Wa	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
S	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
Nls[3]	12	12	12	11	11	11	12	12	11	11	11	10	8	11	11	10	10	9	11
Nlc[4]	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
IPs[5]	1	1	1	0,91	0,91	0,91	1	1	0,91	0,91	0,91	0,83	0,66	0,91	0,91	0,83	0,83	0,75	0,91
TT[6]	78	92	52	39	41	67	113	485	110	87	46	40	40	56	50	80	50	40	599

[3] Nls: nombre de loci en ségrégation

[4] Nlc: nombre de loci considérés

[5] IPs = Nls/Nlc

[6] TT: taille du troupeau

Tableau 3: *Indice de primarité allèles au locus Agouti (IPa) des populations caprines des Monts Dahra et Aurès*

Allèles en Agouti	Monts Dahra							Total	Monts Aurès										Total
	D_1	D_2	D_3	D_4	D_5	D_6	D_7		A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	
A^a	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A^b	0	1	0	1	1	1	1	1	1	1	1	0	0	1	0	1	0	0	1
A^t	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
A^{th}	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A^{rc}	1	1	1	1	1	0	1	1	1	1	0	1	0	0	0	0	0	1	1
A^m	0	1	0	0	1	0	1	1	0	0	0	0	1	1	0	0	0	0	1
A^{rm}	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	1
A^r	1	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1
A^+	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Nao[1]	5	9	4	5	7	4	8	9	5	6	5	5	4	7	4	6	4	6	8
Nac[2]	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	6	4	6	8
IPa[3]	0,55	1	0,44	0,55	0,77	0,44	0,88	1	0,55	0,66	0,55	0,55	0,44	0,77	0,44	0,66	0,44	0,66	0,88
TT[4]	78	90	39	34	41	67	103	452	64	82	45	40	40	55	50	80	50	40	546

[1] Nao: nombre d'allèles observés

[2] Nac: nombre d'allèles considérés

[3] IPa = Nao/Nac

[4] TT: taille du troupeau

THE STATE OF POULTRY GENETIC RESOURCES IN RUSSIA

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SUMMARY

This paper presents a review of past and present effort for the maintenance and improvement of breeds of chicken. This involves what is done on large state farms, in research institutes and by fancy breeders. The present sate of this genetic resources is illustrated by a long table listing all the breeds with the available information.

RESUME

Cet article présente une revue des efforts menés actuellement et dans le passé dans le but de conserver et améliorer les races de poules. Il illustre les travaux réalisés dans les fermes d'Etat, dans les instituts de recherche et par les améliorateurs. Les ressources génétiques actuellement disponibles sont indiquées dans une longue liste avec les différentes races et l'information disponible sur celles-ci.

1.0 INTRODUCTION

The development of civilization is accompanied not only by great scientific and technological discoveries and achievements in all spheres of human being but also by the appearance of a lot of serious problems which have not been satisfactorily solved so far. One of such problems is the increasing reduction of species diversity. 3 to 5 out of 45 000 species of vertebrate animals existing on the Earth die out annually. The tempo of disappearance of species is constantly increasing. According to FAO information, one breed of domestic animals disappears every week. Analogous processes reducing the genetic diversity of livestock animals occur in Russia as well, and their unfavourable consequences are aggravated by a general economic recession.

The present publication informs of the state of the genetic resources of poultry husbandry (chicken breeding, in particular) in Russia. Some of the data concerns the territory of the former USSR. It is apparent that poultry husbandry involves other species of domestic fowl besides chickens. There is an abundant gene pool of native goose and pigeon breeds in Russia. Its description, however, may be the subject of another publication.

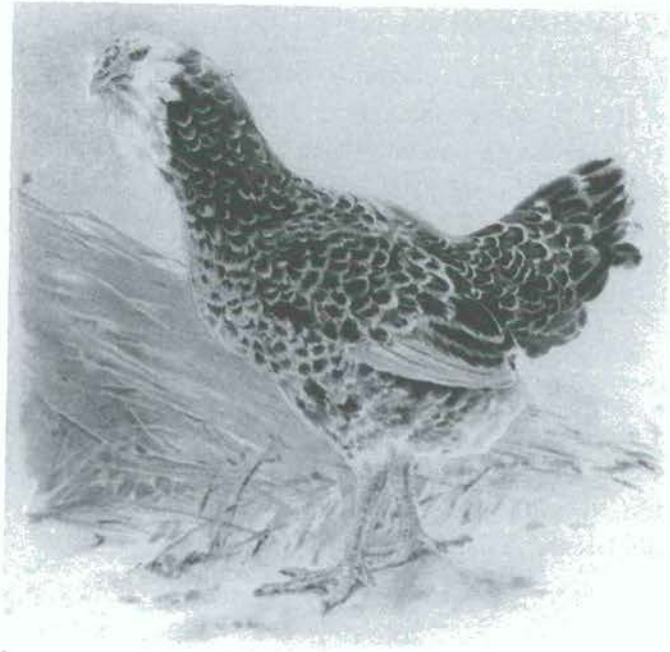
Poultry breeding in Russia, as well as in other developed countries, exists in two forms: commercial and farmyard poultry. A variety of the latter is fancy poultry and together with its specificity is the main source of genetic resources of domestic poultry.

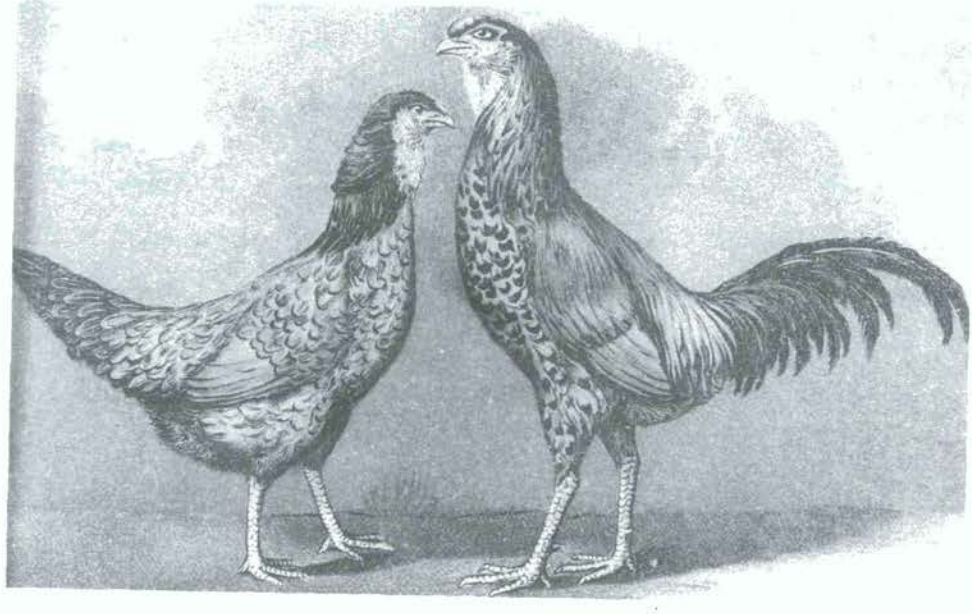
2.0 COMMERCIAL POULTRY BREEDING

The basis for the development of commercial poultry breeding in the country was the organization in the late 1920s of large breeding farms and in the 1930s of poultry factories. Since 1964 the USSR government has adopted resolutions to practise poultry breeding on an industrial basis. The commercial poultry breeding in Russia (as formerly in the USSR) is based on chicken lines imported from other countries. Many of the imported lines have been improved in the course of adaptation to new conditions, and new crosses have been produced as a result of crossing between chicken lines purchased in different countries and belonging to different crosses.

On January 1st 1994 the total number of chickens in the system of Ptitseprom (poultry industry) of the Russian Federation made up: in egg crosses - 207 011 100, in meat crosses - 144 979 000, in meat-egg breeds - 1 543 100. As compared to 1990, the total number of chickens in egg crosses decreased by 6.35%, in meat crosses the quantity of birds increased by 15.65% and the size of meat-egg breeds remained constant.

In 1993, nine crosses were used in egg poultry and 6 crosses in meat poultry. The number of birds in some of them make up less than 1% of the total number and therefore such crosses do not play an important role in the gene pool of commercial poultry breeding. In 1993 egg crosses were mainly composed of Belarus-9, Lohmann Brown and P-46 (30.2; 22.2 and 21.4% respectively). Meat crosses were composed of Smena and Broiler-6 (48.6% and 24.7%). The initial breeds of Belarus-9 are Leghorn White and Californian Gray, Lohmann Brown consists of Leghorn White, Rhode Island Red and Plymouth Rock White, P-46 includes only Leghorn White; Smena and Broiler-6 involve Plymouth Rock White and Cornish White. Thus, the main part of the gene pool of commercial crosses consists of 5 breeds only, which is a negligible portion (0.33%) of the world gene pool of chicken breeds (assuming that there are about 1 500 chicken breeds in the world).





3.0 FANCY POULTRY BREEDING

For understanding the processes currently occurring in amateur poultry breeding in the country, it is necessary to cite some data about how it developed and what we possessed previously. Up to 1917, there were about 80 chicken breeds, varieties and populations of home production and selection (the information from fanciers). Some of them gained world recognition (Orloff, Pavlov). During the Soviet years about 22 breeds, breed groups[1] and their varieties were produced, 4 of which (Russian White, Yerevan, Moscow, Kuchino Jubilee) were registered in the USSR Ministry of Agriculture as breeds.

Almost all our breeds are synthetic or, in other words, produced by crossing foreign breeds with each other or with local chickens. The origin of some old breeds is unknown. In the past, Russian native breeds were produced using Asian chickens brought from Persia and Mediterranean breeds reared by the populations of the Greek colonies on the Black Sea coast. However, the first flow of genes was more significant and therefore our local peasant chickens had many traits of the Asian fowl.

Without going into the details of the development of fancy poultry breeding for the whole period of its existence, we shall note only the major events for the past two decades. The first known collections of chicken breeds in the former USSR existed in the fifties and sixties of this century in the Ukrainian Research Institute of Poultry (now Poultry Research Institute of the Ukrainian Agrarian Academy of Sciences) (NIIP, Borki, Kharkov region, Ukraine) and since 1963 in the Poltava Agricultural Institute. Since the mid seventies the state organs of the USSR made attempts to preserve and extend the available pool of native and foreign breeds. In this connection, in 1976 the Ptitseprom of the USSR issued an edict about the establishment of chicken breed collection farms which were organized in the All-Union (now All-Russian) Research and Technological Institute of Poultry (VNITIP, Sergiyev Posad, Moscow region, Russia), in the All-Union (now All-Russian) Research Institute of Animal Breeding and Genetics (VNIIRGZH, Pushkin, St-Petersburg, Russia), at the State Breeding Farm "Kuchinsky" (Moscow region). Small collections of chickens and other birds were available in educational institutes such as those belonging to the K.A. Timiryazev Moscow Agricultural Academy, St-Petersburg State University, etc.

The measures undertaken promoted the activity in fancy and farmyard poultry breeding. This found its expression in the creation or reorganization of societies or clubs of poultry fanciers. Some of them may be considered the successors of analogous societies (for example, in Moscow, St-Petersburg, Riga, etc.) existing before 1917. In 1990, the All-Union (now All-Russian) association of all fancy fowl clubs was formed. In 1991 the club of native fowl breed fanciers was registered with this society. The clubs of poultry fanciers carry out the work on the conservation, reproduction and search for rare fowl breeds. They organize expeditions and exhibitions, issue special literature and help fancy fowl breeders providing them with pure breeding material.

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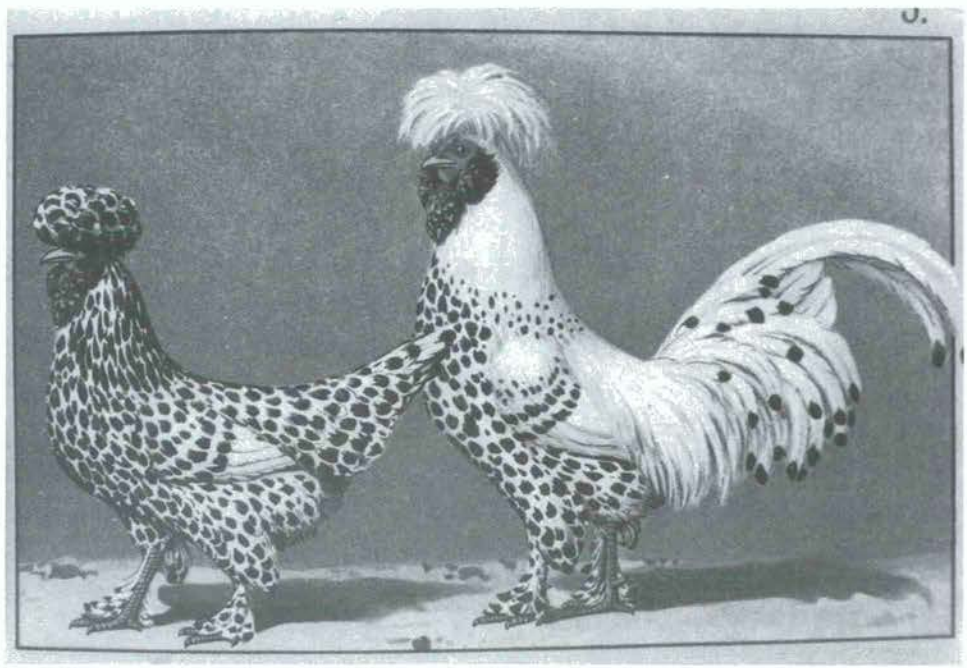
[1] The term "breed group" means the group of fowl formed in the process of creating a breed but does not satisfy all breed requirements.



At present, about 40 native chicken breeds and populations are reared in Russia: VNIIRGZH farm - 18; VNITIP - 23; the fanciers rear about 18. The size of populations on some farms has sharply reduced in the past two years, for instance, at the VNIIRGZH farm from 2 181 individuals in 1991 to 1 525 in 1993, i.e. by 30%. At the VNITIP farm there are 4 195 individuals of native fowl without essential changes in recent years.

In addition to the reduction in the number of birds composing breeds, whole breeds or breed varieties also disappeared. 10 breeds have been lost and there is no information about the existence of 25 out of 72 native breeds recorded in the Breed Data Bank of N.I. Vavilov Institute of General Genetics of the Russian Academy of Sciences (IOGen) (Moscow, Russia). These losses constitute nearly 50% of the decrease of genetic resources with respect to breed composition. Many other breeds are on the verge of extinction (see table).

Scientists of research institutes and amateur poultry breeders make attempts to preserve and restore native chicken breeds. The Orloff breed, which is the pride of Russia like the game breeds in England, has been regenerated. The Moscow Game breed is being maintained. The Russian Black Bearded breed has been found and now reared. The Jurlov Crower breed[2] was reproduced from a few birds remaining after World War II. On the basis of old drawings the Pavlov breed is being restored. At the Exhibition of Poultry breeding (November 1993) organized by the Moscow Regional Club of Fancy Fowl rare breeds were demonstrated: Russian Crested, Muffed, and Russian Butterfly.

To increase genetic diversity in a single population, experimental groups of chickens with a wide spectrum of genes are produced at gene pool farms of research institutes. For example, in VNITIP randomized populations of chickens with barred feather patterns have been produced on the basis of the following breeds: Californian Gray, Amroks, Kirgiz; population of chickens with black coloured plumage on the basis of Minorka Black, Moscow, Australorp and Pantsirev Black. Red birds have been produced on the basis of Rhode Island Red, New-Hampshire, Yerevan Red, Poltava Clay; the population with the Columbian restriction pattern of feather colour has been obtained on the basis of Sussex Light, Adler Silver, Pervomai.

Several populations have been produced in VNIIRGZH: Australorp Black Speckled, Leningrad Golden Gray, Plymouth Rock Barred Speckled, Pushkin Barred Speckled. In NIIP, heterogeneous populations have been obtained by crossing several strains of Poltava Clay and of Leghorn White.

Some fancy poultry breeders work to create new forms. For example, at the exhibition organized by the Moscow Regional Club of Fancy Poultry Breeders in February of 1990 chickens under the name of Zaryanka (beautiful birds with pink feathers recalling the colour of dawn) were demonstrated.

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[2] Cocks of the Jurlow Crower breed have a strong and pleasant voice. Among them "tenors", "baritones" and "basses" are distinguished. The best singers can sustain a note for up to 25 seconds.

4.0 RESEARCH IN POULTRY GENETICS

Besides practical work with chicken breeds, studies of the biological, genetic and economic characteristics of breeds are carried out at research institutes. Blood group studies in different chicken breeds were carried out in IOGen and NIIP; electrophoresis of egg, blood, seminal fluid and cardiac muscle proteins were performed in IOGen, NIIP, Institute of Zoology and Physiology of the Moldavian Academy of Sciences (Kishinev, Moldova); screening of DNA polymorphism - in the Institute of Gene Biology of the Russian Academy of Sciences (Moscow) and in VNIIRGZH; chicken genome mapping- in the St-Petersburg University; studies of discrete mendelian morphological characters (comb type, plumage colour, the presence of a crest, muffs and beard, neck feathering, etc.) and quantitative characters (body dimensions, serum esterase activity, parameters of egg quality) were carried out in IOGen; genetic analysis of breeds by the traits included in the breed standard as well as by the feathering rate, the age of sexual maturity was carried out in VNITIP. In VNIIRGZH, methods to preserve cock sperm have been developed and genealogical trees of individual breeds are being constructed.

The most systematic studies on genetics of native and foreign chicken breeds have been carried out during several decades in IOGen. By the present time, the scientific workers of this Institute have prepared a data bank including evidence on the origin, genetic, morphological and economic characteristics of 260 breeds, breed groups and varieties (among them 72 native populations of the former USSR). The data was taken from their own investigations and from literature. The data bank is used in studying the level and structure of genetic diversity of native chicken breeds as compared to foreign and wild chickens (Red Jungle Fowl) and in establishing genetic similarity and relations between breeds and different groups of breeds.

Using genetic markers, the current systems of breed classifications are assessed and hypotheses on the origin of individual chicken breeds and groups of breeds as well as on the centres of their origin and formation are checked. The available data on biochemical markers and discrete morphological characters make it possible to carry out genogeographical studies of native and foreign chicken breeds.

Three books with materials describing native chicken breeds have been published in our country.

5.0 CONCLUSIONS

The material presented demonstrates that in our country the work on the production of chicken breeds and populations and studies of their features have been carried out rather extensively. However, achievements of selection and science in this field could not be fully realized because of social-historic events constantly occurring in the territory of Russia and the former USSR since the beginning of this century. Unfortunately, nor does the present economic recession in Russia favour the preservation of poultry genetic resources at the level of the developed countries. Some unreasoned decisions, such as the bans on cock-fighting repeatedly imposed by the Society for Animal and Plant Protection (the last one was accepted in 1992), lead to the disappearance of game breeds or to the loss of their fighting qualities.

As a result of the above mentioned and other unfavourable factors, the number of chickens and chicken breeds as well as the genetic diversity of preserved but small-sized

breeds have been decreased. The total number of chickens in fancy poultry has decreased for the past 2-3 years by about 30%. We do not possess exact data with respect to the number of individuals in particular breeds and a possible degree of their inbreeding since a corresponding estimation in amateur poultry breeding over the vast territory of our country is rather difficult. However, it can be assumed that the level of inbreeding is undoubtedly high in breeds consisting of only several dozens of birds (for example, there are only about 50 Moscow Game cocks and 300 hens in the whole country). The loss of breeds (10 out of 72) for the 50-100 year period has made up nearly 14% and with the breeds about whose existence we have no information (25) this estimate constitutes nearly 50%. 13 breeds out of the remaining 37 are considered endangered or critical, which may decrease the breed genetic resources even more than by 35%. The latter include such chicken breeds as Orloff, Moscow Game, Jurlov Crower, Russian Black Bearded and others which are of aesthetic, sport and economic value and which are living material monuments of human culture and the genetic heritage of the past centuries. Destruction of these monuments leads to irreplaceable losses since they cannot be fully regenerated in the future. In connection with this, it is desirable to include endangered and critical chicken breeds in the International Register of rare and disappearing animal breeds. They need to be protected.

This work has been supported by the Russian Foundation of Basic Research and the Russian State Scientific Programme "Biological Diversity".

6.0 ACKNOWLEDGMENTS

I am grateful to A.A. Sevastaynova (VNITIP), N.D. Philippova (VNIIRGZH), G.P.Shevyreyva (fancier) and S.G. Ryzhov (fancier) for providing me information about native Russian chicken breeds.

7.0 REFERENCES

Karimov K.K. 1976. Local and indigenous chicken breeds. Catalogue of native local breeds of livestock and fowl in the USSR. Ivanova K.M.L. (Ed.). All-Russian Research Institute of Animal Breeding and Genetics. p.112-135.

Loftus R. and Schere B. 1993. World Watch List for Domestic Animal Diversity. Rome, Italy. p.376.

Moiseyeva I.G. 1992. Native chicken breeds. Farm animal resources: rare and endangered breeds. Zakharov I.A.M. (Ed.). Nauka. p.11-112.

Paronyan J.A. and Yurchenko O.P. 1989. Domestic fowl. Animal genetic resources of the USSR. FAO, Rome, Italy. p.401-430

Veprintsev B.N. and Rott N.N. 1991. A strategy of preservation of the animal and plant world of Earth. Conservation of genetic resources. Collected scientific articles. Pushchino. p.5-18.

List of native chicken breeds, breed groups, varieties and populations of the territory of the former USSR

Breed, breed group, population	Variety	Period of origin	State of a breed, breed group, population at the present time
Adler Silver (Adlerskaya serebristaya)		Middle of the XXth century	Distributed widely. Especially in Krasnodar territory, Volgograd region, reared at GPR* of VNIIRGZH and VNITIP
Anatolian Astrakhan (Anatoliyskaya, Astrakhanskaya)		Information is not available	Lost
Andizhan Game (Andizhanskaya Boitsovaya)		Information is not available	Information is not available
Armenian (Armyanskaya)		Long ago	Information is not available
Arzamas (Arzamasskaya)		Information is not available	Lost
Asian Crested (Aziatskaya Khokhlataya)		Information is lost	Information is not avaiable
Australorp Black Speckled (Avstralorp Cherno-Pestryi)		1963-1973	Distributed in the Northern regions of Russia and Karelia, reared at GPF of VNIIRGZH and VNITIP
Azerbaijan (Azerbaijanskaya)	Black Speckled	Information is not available	Both varieties are distributed in Azerbaijan
Bashkir (Bashkirskaya)		Information is not available	Information is not available
Bukhara (Bukarskaya)		Information is not available	Information is not available
Capunok		Information is not available	Lost
Caucassian Silky (Kavkazskaya Shelkovistaya)		Information is not available	Information is not available
Cossack (Kazak)		Information is not available	Information is not available
Georgian Game: crosses of different game breeds (Gruzinskaya boitsovaya)		Information is not available	Endangered. Distributed in Georgia
Georgian local (Gruzinskaya mestnaya)	Vanana Chalispery Chia Cochara Natsara Megrula	Information is not available Information is not available Information is not available Information is not available Information is not available Information is not available	Information is not available Distributed in Georgia Distributed in Georgia Distributed in Georgia Distributed in Georgia Distributed in Georgia, reared at GPF of VNITIP

Breed, breed group, population	Variety	Period of origin	State of breed, breed group, population at the present time
Gilany (Gilanskaya)	Red, Mille-Fleur, White	XVIIIth century	All varieties have been lost
Guzul Crested (Gutsulskaya Khokhlataya)		Information is not available	Information is not available
Ivanov Game: a local population of the Moscow Game breed (Ivanovskaya Boitsovaya)		Information is not available	Lost
Kabardian (Kabardinskaya)		Information is not available	Information is not available
Kirghiz (Kirghizskaya)		The formation of the breed began in 1948	Distributed mainly in Kirghizstan, reared at GPF of VNITIP and VNIIRGZH
Kirghiz local (Kirghizskaya Mestnaya)		Information is not available	Information is not available
Kotlayarevskaya		1960	Endangered. Reared at GPF of VNITIP
Kuchino Jubilee (Kuchinskaya Yubileinaya)		The breed was registered in 1990	Distributed all over Russia
Kulanghi		Long ago	Reared in the former Middle Asian Republics, at GPF of VNITIP and VNIIRGZH
Latvian Red (Latviiskaya Krasnaya)		Information is not available	Reared in Latvia
Leghorn Bantam Barred		1976-1980	Endangered. Reared at GPF of NIIP
Leghorn Bantam Black		1976-1980	Endangered. Reared at GPF of NIIP
Leningrad Golden Gray (Leningradskaya Zolotisto-Seraya)		1978-1983	Endangered. Reared at GPF of VNIIRGZH
Leningrad Mille-Fleur (Leningradskaya Sitsevaya)		1988-1994	Endangered. Reared at GPF of VNIIRGZH
Leningrad White (Leningradskaya Belaya)		1950-1960	Available
Livny (Livenskaya)		Maybe at the end of the XIXth century	Lost
Lvov Royal (Lvovskaya Korolevskaya)		Information is not available	Information is not available
Margilan Game (Margilanskaya Boitsovaya)		Information is not available	Information is not available
Moldavian, Bessarbian (Moldavskaya, Bessarabskaya)		Information is not available	Information is not available

Breed, breed group, population	Variety	Period of origin	State of a breed, breed group, population at the present time
Moscow (Moskovskaya)		The breed was registered in 1980	Distributed widely from the Northern to the Southern regions of Russia, reared at GPF of VNITIP
Moscow Game (Moskovskaya Boitsovaya)		XVIIIth century	Critical. Reared by fanciers, at GPF of VNIIRGZH
Moscow White (Moskovskaya Belaya)		1948-1960	Reared in the Moscow region and at GPF of VNITIP
Muffed, Russian Muffed, Ukrainian Muffed (Ushanka, Russkaya Ushanka, Ukrainskaya Ushanka)		Information is not available	Distributed widely in the South of Russia and in the Ukraine, reared at GPF of VNITIP and VNIIRGZH
Near Carpathian Greenleg (Pricarpatskaya zelenonozhka)	Partridge White	Information is not available	Information is not available
Neck Naked (Golosheinaya)		Information is not available	Reared in the Southern regions of Russia, Ukraine, Georgia, GPF of VNITIP
Nizhnedevitskaya, Buff Black Tailed (Nizhnedevitskaya, Palevaya Cherno-Khvostaya)		Maybe in the second part of the XIXth century	Information is not available
Orloff (Orlovskaya)	Bantam, Mille-Fleur, Bantam Red, Bantam White, Barred, Black, Clay, Mahagony Black Breasted, Mahagony Brown-Breasted, Mille-Fleur, Red Black-Breasted, Red Brown-Breasted, Speckled, White	XVIIIth century	Endangered. Breed varieties are reared by fanciers, at GPF of VNITIP and VNIIRGZH
Pavlov (Pavlovskaya)	Blue-Golden-Silver	Maybe in the XVIIIth century	All varieties have been lost
Pantsirev (Pantsirevskaya)	Black-White	1947-1960	Both varieties are distributed in the Central and Southern regions of Russia, reared at GPF of VNITIP and VNIIRGZH

Breed, breed group, population	Variety	Period of origin	State of a breed, breed group, population at the present time
Pervomai (Pervomaiskaya)		The formation of the breed began in 1935	Reared at GPF of VNITIP and VNIIRGZH
Plymouth Rock Barred Speckled (Plimut Rok Polosato-Pestryi)		1983-1986	Critical. Reared at GPF of VNIIRGZH
Polessian dikastaya (Polesskaya dikastaya)		Information is not available	Information is not available
Poltava	Black Clay Cuckoo	Maybe in the XIXth century	Lost Distributed widely in the Ukraine and Russia, reared at GPF of VNITIP and VNIIRGZH Lost
Pskov Creeper (Pskovskaya Korotkonozhka)		Information is not available	Information is not available
Pushkino Barred Speckled (Pushkinskaya Polosato-Pestraya)		1976-1981	Endangered. Reared at GPF of VNIIRGZH
Rechitsy (Rechitskaya)		Information is not available	Information is not available
Russian Black and Bearded, Galan, Woodgrouse (Russkaya Chernaya Borodataya, Galan, Gluchar)		In the second part of the XIXth century	Critical. Reared by fanciers
Russian Butterfly, Kursk Speckled (Russkiy Korolek, Kurskaya pestrushka)	Golden, Mille-Fleur, Mottled, White	Information is not available	All varieties are reared by fanciers all over Russia
Russian Chicken (Russkaya Kuritsa)		Information is not available	Maybe conserved in the Volgograd region
Russian Crested (Russkaya Khokhlataya)		Information is not available	Endangered. Reared at GPF of VNITIP and VNIIRGZH, by fanciers
Russian White		The breed was registered in 1953	Reared in Russia, at GPF and VNITIP
Samarkand Game (Samarkandskaya Boitsovaya)		Information is not available	Information is not available
Serpukhov Game: a local population of the Moscow Game breed (Serpukhovskaya Boitsovaya)		Information is not available	Lost
Shershetka		XVIII?	Lost

Breed, breed group, population	Variety	Period of origin	State of a breed, breed group, population at the present time
Shpanka Beloushka		Information is not available	Information is not available
Siberian Buff (Sibirskaya Palevaya)		Information is not available	Information is not available
Siberian Shank Feathered (Sibirskaya Mokhnonozhka)		Information is not available	Information is not available
Tarussa the Best (Tarusskaya Uluchshennaya)		Information is not available	Lost
Tsar Chicken (Tsarskaya Kuritsa)		XIXth century	Lost
Turkmen Game (Turkmenskaya Boitsovaya)		Information is not available	Information is not available
Ukrainian Crested (Ukrainskaya Khokhlataya)		Information is not available	Reared in the Ukraine
Voronezh Black and White (Voronezhskaya Cherno-Pestraya)		Maybe at the end of the XIXth century	Information is not available
Yalta Bantam (Yaltinskaya Karlikovaya)	Black-Red	The breed is registered in 1974	Both varieties are distributed in Armenia, reared at GPF of VNITIP and VNIIRGZH
Yurlov Crower (Yurlovskaya Golosistaya)		XIX?	Endangered. Reared at GPF of VNITIP, VNIIRGZH and by fanciers
Zagorsk	Salmon White	1950-1955	Distributed in the Central regions of Russia, reared at GPF of VNITIP and VNIIRGZH Lost

*GPF = Gene Pool Farm

Note: Breed names written after a comma mean synonyms. In parenthesis Russian name written using the English letters.

SITUATION OF INBREEDING IN A RETINTO POPULATION

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SUMMARY

The degree of inbreeding was studied for a subpopulation of the beef cattle breed Retinto from the Cadiz Province in Andalusia (Spain). The pedigree information from 492 female and 25 male breeding animals was analyzed. On the basis of the available information, only the current inbreeding, that is the inbreeding with consideration of three ancestral generations, could be calculated. While close inbreeding is purposely avoided with the bulls, it is of great importance in cows. The average coefficient of inbreeding for cows born in the years 1982 to 1987 was 2.35%, although in the great-grandparent generation only 55% of the ancestors were known. Inbreeding was discovered in 17.7% of the cows; 5.8% of the cows had an inbreeding coefficient of 25%. The rate of inbreeding per generation is very high in comparison with other beef cattle breeds and above all in comparison with dual purpose cattle. Because of the manner in which the bulls are used, also considerable non-current inbreeding has to be expected.

RESUMEN

Se ha estudiado el grado de consanguinidad en una subpoblación de la raza bovina de carne Retinto en la provincia andaluza de Cádiz (España). Se ha analizado la información de ascendencia de 492 hembras y 25 machos seleccionados. Sobre la base de la información disponible, únicamente la consanguinidad corriente, es decir la consanguinidad referida a las tres generaciones pasadas, podría ser calculada. Mientras una consanguinidad elevada no es importante para los toros, resulta de gran importancia para las vacas. El coeficiente medio de consanguinidad para las vacas nacidas entre 1982 y 1987 era de 2.35%, mientras que sólo se conocía el 55% de los progenitores en la generación de los bisabuelos. Se ha encontrado consanguinidad en el 17.7% de las vacas; el 5.8% de la vacas resultó tener un coeficiente de consanguinidad del 25%. La tasa de consanguinidad por generación es muy alta en comparación con otras razas de vacuno de carne, y sobre todo en comparación con los vacunos de doble propósito. Debido a la forma en que se usan los toros, también debe resaltarse una consanguinidad poco corriente.

1.0 INTRODUCTION

Breeding of livestock is based upon the selection of especially suitable appearing parent animals for the forming of the next generation. Inbreeding can result from intentional or unintentional mating of close relatives. In addition, a more or less intense limitation in the number of selected parent animals inevitably leads to the mating of animals with common ancestors and, therefore, also to inbreeding. Within the framework of the characterization of the genetic structure of populations the description of inbreeding is of special importance. Generally, very few investigations about inbreeding in beef cattle can be found. As for the breed Retinto, this is a local Iberian beef cattle breed which is extensively kept as a maternal breed and which is well adapted to the extreme environmental conditions and the low quality pastures in the west of southern Spain (Rodero *et al.* 1992a). The breed is found today mainly in the Extremadura and Andalusia Regions. A herd book for this breed was recently established in 1976, in which 18 346 animals from 390 herds were registered. Today we have a registration of 13 041 female and 377 male breeding animals from 262 herds. Kidd *et al.* (1980) estimated an average inbreeding coefficient of 8% for the breed Retinto by means of a comparison of that observed with the expected frequency of heterozygotes at 7 codominant loci. In the present study the situation of inbreeding in a Retinto subpopulation will be examined by a pedigree analysis. The importance of the results for breeding will be discussed.

2.0 MATERIAL AND METHODS

The basis for this study were the animals of a breeding programme, which has been performed since 1988 in the Province of Cadiz in Andalusia (Spain). At the beginning of the programme there were 9 herds with 680 cows and 54 bulls participating in a reference sire scheme; from the farmers' date of matings and calvings, identification of the parents of the calves born, reproductive data and three weights of the calves until weaning have to be reported (Rodero *et al.* 1992b). Breeding values for the parental animals are routinely estimated by the Department of the first author, which also co-ordinates the whole breeding programme. The Retinto Breeders Association made the pedigree information of the registered breeding animals used in the starting year 1988, i.e. of 492 cows and 25 bulls available to us. The cows were born between 1975 and 1987. The written material received from the breeding society was transferred to a data bank and the accuracy of the data was checked. For the calculation of the coefficients of inbreeding and relationships, computer programmes developed by the second author were used, which are based on the recursive algorithms of Quaas (1976) and Hudson *et al.* (1982). These programmes had already been used in several other studies (e.g. Bollmeier *et al.* 1991, Schmidt *et al.* 1993). Not a certain number of ancestral generations, but all available pedigree information was used in the calculations.

3.0 RESULTS

In the pedigrees of the investigated animals, we found 458 cows and 89 bulls which were a part of the founding herdbook population of 1976.

With regard to the use of sires, one can picture the following description of the breeding policy. The bulls, with two exceptions, were used merely in their own herds. In 1985, four sons from one bull and, in 1986, two sons from another bull were used in different herds. The animals newly registered in the herdbook for a year, generally stem from only one or two sires. Exceptions to this was a herd in 1984, and another herd in the years 1985 and

1986. In the referred herds and years, the registered offspring stemmed from four, three and four sires, respectively. The bulls were normally used for only two mating seasons. Three of the bulls were used for four years and one bull for five years.

Inbreeding, e.g. an inbreeding coefficient greater than zero, was calculated for 60 of the 492 cows, corresponding to a portion of 12% (table 1). The average coefficient of inbreeding calculated amounted to 1.57% and the standard deviation was 5.3%. For the male animals, two out of 25 bulls, e.g. 9%, showed non-zero inbreeding coefficients; these two inbreeding coefficients are 4.69% and 6.26%, respectively. The average coefficient of inbreeding among the bulls was calculated at 0.43%. In the interpretation of these results, one has to consider the completeness of the pedigree information. Among the female animals, for example, the pedigrees show an average completeness of 42.8% for the third ancestral generation and this decreases to 6.0% in the fourth and to 0.2% in the fifth ancestral generation (table 1).

The distribution of the inbreeding coefficients for the female animals is presented in table 2. It is interesting here to note the frequent occurrence of very high individual coefficients of inbreeding. For example, 3.9% of all cows show an inbreeding coefficient of 25%; such an inbreeding coefficient corresponds to a father-daughter mating.

If one considers the average inbreeding coefficient of the cows according to the completeness of the pedigrees, there is a clear increase of the inbreeding coefficient with increasing completeness of the pedigrees. In table 3 the average inbreeding coefficient according to the extent of the information from the third ancestral generation can be found. For cows where at least two out of eight ancestors from the third ancestral generation are known (CG3 >= 25%), the average coefficient of inbreeding amounts to 2.06% and increases then steadily up to 3.32%, when all of the great-grandparents are known.

In viewing the inbreeding coefficients of the cows as regards the years of birth (table 4) - for 10 cows the date of birth was unknown - one observes definite differences between the years 1975 to 1981 and the years from 1982 to 1987. Among the younger cows, between 13.3% and 27.8% of the cows were found to be inbred; the average coefficients of inbreeding ranged from 1.26% to 4.41%. The mean value for the inbreeding coefficient of this group is 2.35%. In contrast, the low grade of inbreeding in the earlier years of birth is clearly due to the highly incomplete pedigree information.

4.0 DISCUSSION

As a result of the incompleteness of the available pedigree information, especially for the fourth and earlier ancestral generations, we were only able to determine the occurrence of inbreeding through the intentional or unintentional mating of close relatives. A completeness of 6% in the fourth ancestral generation means that from 16 ancestors only one may be known. While it was apparent that the use of closely inbred bulls was consciously avoided, a high degree of current inbreeding was found for the cows. In reference to the years of birth 1982 to 1987, inbreeding occurred in 17.7% of all cows. The average coefficient of inbreeding amounted to 2.35%. Neglecting the little information in the fourth and fifth ancestral generation in this group and taking into account the incomplete knowledge of the great-grandparents a "rate of current inbreeding", using the usual approach to calculate the inbreeding rate, of at least 2.35% / 2 generations = 1.18% per generation can be determined.

The high current inbreeding in this group is also evident by the high number of cows with an inbreeding coefficient greater/equal to 12.5% or 25%; the corresponding proportions are 9.8% and 5.8%, respectively. Kidd *et al.* (1980) estimated an average inbreeding coefficient of 8% for animals of the Retinto breed, which they sampled from different herds from different geographical regions. This value is higher than the value which we determined. But the methodical approach used by Kidd *et al.* (1980) was based on the analysis of the degree of heterozygosity. Here one must remember that this approach reacts very sensitively to coincidental or systematic deviations in the frequency of the genotypes. In addition to inbreeding, for example, the existence of subpopulations also leads to a reduction of the degree of heterozygosity. Because of the extensive management of the beef cattle breed Retinto, with the deployment of bulls in natural mating and because of the manner of bull use described, one must undoubtedly assume the formation of subpopulations. On the other hand as already mentioned, it was not possible in our investigation to determine the inbreeding caused by common ancestors in the period before the great-grandparent generation. Considering all these aspects, the calculated inbreeding coefficient of Kidd *et al.* (1980) seems, in comparison, to be a little too low.

A direct comparison of the inbreeding determined with the results from other publications is often very difficult, because the number of ancestral generations in question is either different or not given at all, and the completeness of the pedigrees vary to a high degree. Generally, very few investigations about inbreeding in beef cattle can be found. Willham (1937) found an average inbreeding coefficient of 8.1% in American Herefords, taking into consideration approximately 13 ancestral generations. Stonacker (1943) obtained an inbreeding coefficient of 11.3% for the American Aberdeen-Angus cattle, using 17 ancestral generations. Barker and Davey (1960) determined an inbreeding coefficient of 1.8% (approx. 5 ancestral generations) for Australian Poll Hereford and Davey and Barker (1963) an inbreeding coefficient of 2.6% (12 ancestral generations) for Australian Hereford. Watson (1963) estimated, considering 4 ancestral generations, an inbreeding coefficient of between 1.2% and 2.2% for British Welsh Black breeding animals used in natural mating, and Özkütük and Bichard (1977) came up with an inbreeding coefficient of 5.7% (12 ancestral generations) for Irish Hereford. For these investigations, the rate of inbreeding, i.e. the increase in inbreeding per generation lies between 0.24% and 0.73%. In comparison, the rate of inbreeding for cows which we determined in our study is very high.

Considering the degree of heterozygosity in another Spanish breed De Lidia (Fighting Bull), Kidd *et al.* (1980) calculated an average inbreeding coefficient of 17% and for the Portuguese breed Mertolenga, they obtained a value of 5%.

With dual purpose cattle and the usual artificial insemination - breeding programmes here, one must definitely distinguish between current and non-current inbreeding. As shown in the studies of Schmidt *et al.* (1986), Bollmeier *et al.* (1991) and Schmidt *et al.* (1993) for various populations, inbreeding within the last three ancestral generations is, in general, intentionally avoided. Medium-termed, however, the mating of animals with common ancestors, which is an increase in inbreeding, cannot be avoided. The rates of inbreeding for dual purpose cattle from the literature are, in general, lower than those for beef cattle. Thus, Bollmeier *et al.* (1991) found the rate of inbreeding in Württemberg Brown Cattle (Germany) to be 0.08% to 0.38% per generation for calves born in different years. Schmidt *et al.* (1993) calculated similar rates of inbreeding of 0.12% to 0.27% in Westphalian Red and White cattle

(Germany). The above mentioned rates of inbreeding are representative for the more recent results from the literature for dual purpose breeds (Schmidt, 1990).

High inbreeding coefficients of over 10% or inbreeding rates of over 1% per generation can be found in breeds or individual herds in which, during the twenties and thirties of this century, intentional line breeding or inbreeding was practised. This was done in order to obtain a consolidation of the breed or to promote the genetic contribution of an outstanding single animal for the improvement of the whole population. This occurred within individual herds of famous breeders (Wright, 1923; Lush, 1934 and Stonaker, 1951) as well as in populations, whereby the breeds Shorthorn (Wright, 1923; Mc Phee and Wright, 1925; Mc Phee and Wright, 1926), Hereford (Willham, 1937) and Aberdeen Angus (Stonacker, 1943) must be especially mentioned.

5.0 CONCLUSIONS

Despite the incompleteness of the pedigree information, a very high current inbreeding has been observed in cows. The rate of inbreeding here was greater than normally found in beef cattle and therefore greater than in dual purpose cattle too. In comparison to our results, the higher inbreeding coefficient in the Retinto population calculated by Kidd *et al.* (1980) can be attributed to the genetic isolation of herds, the non-current inbreeding and the methodical approach. Due to the observed breeding policy and the manner of using the bulls, the existence of subpopulations as well as considerable non-current inbreeding has to be expected. The present study can only represent a beginning for the analysis of the genetic structure of the Retinto population. The study is based on a small portion of the population from the Province Cadiz, and one cannot overlook the fact that this breed is distributed over widespread regions of Southwest Spain and Eastern Portugal. Since the calculated current inbreeding coefficients are surprisingly high, it would be very useful to perform a more thorough investigation of the Retinto population. It would be especially worthwhile in the future - the necessary comprehensive pedigrees are not yet available - to strive for an analysis of non-current inbreeding and of relationships among the breeding animals. Such information will allow for a more exact and across-herd evaluation procedure for breeding values, especially now with the onset of artificial insemination in the Retinto population.

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7.0 REFERENCES

Barker, J.S.F. and Davey, G.P. 1960. The breed structure and genetic analysis of the pedigree cattle breeds in Australia. II. The Poll Hereford. Aust. J. Agric. Res. 11, p.1072-1100.

Bollmeier, S., Mayer, M. and Simon, D. 1991. Entwicklung der genetischen Struktur beim württembergischen Braunvieh. Züchtungskunde 63, p.1-11.

Davey, G.P. and Barker, J.S.F. 1963. The breed structure and genetic analysis of the pedigree cattle breeds in Australia. III. The Hereford. Aust. J. Agric. Res. 14, p.93-118.

Hudson, G.F.S., Quaas, R.L. and Van Vleck, L.D. 1982. Computer algorithm for the recursive method of calculating large numerator relationship matrices. J. Dairy Sci. 65, p.2018-2022.

Kidd, K.K., Stone, W.H., Crimella, C., Carenzi, C., Casati, M. and Rognoni, G. 1980. Immunogenetic and population genetic analyses of Iberian Cattle. Anim. Blood Grps. biochem. Genet. 11, p.21-38.

Lush, J.L. 1934. A herd of cattle bred for twenty years without new blood. J. Heredity 25, p.208-216.

McPhee, H. and Wright, S. 1926. Mendelian analysis of the pure breeds of livestock. IV. The British Dairy Shorthorns. J. Heredity 17, p.397-401.

McPhee, H. and Wright, S. 1925. Mendelian analysis of the pure breeds of livestock. III. The Shorthorns. J. Heredity 16, p.205-215.

Özkütük, K. and Bichard, M. 1977. Studies of pedigree Hereford cattle breeding. 1. Herdbook analyses. Anim. Prod. 24, p.1-13.

Quaas, R.L. 1976. Computing the diagonal elements of a large numerator relationship matrix. Biometrics 32, p.949-953.

Rodero, A., Molina, A., Serrano, I., Burgos, A., Mayer, M., Salado, F. and Jimenez, J.M. 1992a. Caracterizació n productiva de la raza vacuna Retinta. Archivos de Zootecnia 41, p.579-586.

Rodero, A., Molina, A., Burgos, A., Serrano, I., Mayer, M., Jimenez, J.M. and Salado, F. 1992b. Actuality and future of a breeding programme in Retinto beef cattle. Archivos de Zootecnia 41, p.569-572.

Schmidt, T. 1990. Analyse der westfälischen Rotbuntzucht bezüglich Inzucht, Verwandtschaft, Fremdgenanteil, Generationsintervall und Zuchtfortschritt. Diss. agr. Bonn.

Schmidt, T., Mayer, M. and Simon, D. 1993. Analyse der westfälischen Rotbuntzucht bezüglich Inzucht, Verwandtschaft und Fremdgenanteil. Züchtungskunde 65, p.102-111.

Schmidt, T., Mayer, M. and Simon, D. 1986. Inzucht, Verwandtschaft und Genanteile in der rheinischen Schwarzbuntzucht. Annual Meeting of DGfZ and GfT in Hannover, Germany, 1986.

Stonaker, H.H. 1951. A uniqué herd of Hereford cattle. J. Heredity 42, p.207-209.

Stonaker, H.H. 1943. The breeding structure of the Aberdeen-Angus breed. J. Heredity 34, p.323-328.

Watson, J.H. 1963. Inbreeding arising through artificial insemination and natural service in Welsh Black cattle. Anim. Prod. 5, p.209-214.

Willham, O.S. 1937. A genetic history of Hereford cattle in the United States. J. Heredity 28, p.283-294.

Wright, S. 1923. The Duchess family of Shorthorns as bred by Thomas Bates. J. Heredity 14, p.405-422.

Table 1: *Mean inbreeding coefficients (F) and percentage of known ancestors in the ancestral generations (G1 to G5)*

Group	N	N (F>0)	F (in %)	G1	G2	G3	G4	G5
Cows	492	60	1.57	92.2	81.4	42.8	6.0	0.2
Bulls	25	2	0.43	96.0	91.0	40.0	5.0	0.7

N: Number of individuals
N (F>0): Number of inbred individuals

Table 2: *Distribution of the inbreeding coefficients (F) of the cows*

F	Frequency	
(in %)	absolute	relative (in %)
0	432	87.8
0.78	1	0.2
1.56	4	0.8
3.13	9	1.8
4.68	1	0.2
5.47	1	0.2
6.25	12	2.4
12.50	10	2.0
15.63	2	0.4
23.44	1	0.2
25.00	19	3.9

Table 3: *Mean inbreeding coefficients (F) of the cows and percentage of known ancestors (G1 to G5) in dependence upon the completeness of information from the third ancestral generation (CG3)*

CG3 (in %)	N	N (F>0)	F (in %)	G1	G2	G3	G4	G5
all cows	492	60	1.57	92.2	81.4	42.8	6.0	0.2
>= 25	363	59	2.06	99.3	95.6	57.5	8.2	0.3
>= 50	261	49	2.13	99.6	98.2	70.3	10.7	0.4
>= 75	146	38	2.65	100.0	99.8	86.3	15.8	0.7
= 100	65	23	3.32	100.0	100.0	100.0	21.7	0.1

N: Number of individuals
N (F>0): Number of inbred individuals

Table 4: *Mean inbreeding coefficients (F) of the cows and percentage of known ancestors (G1 to G5) by year of birth (Total number of cows: 482)*

Year	N	N (F>0)	F (in %)	G1	G2	G3	G4	G5
1987	36	10	1.26	88.9	86.8	71.5	21.2	1.7
1986	67	10	1.98	88.8	86.6	53.2	6.7	0.2
1985	67	14	3.57	95.5	94.4	59.0	6.9	0.1
1984	96	15	1.71	98.4	96.1	55.9	9.8	0.4
1983	45	6	2.50	93.3	85.0	44.4	6.4	0.1
1982	17	3	4.41	94.1	76.5	44.1	2.2	0
1981	31	1	0.10	77.4	69.4	25.0	0.8	0
1980	38	1	0.08	98.7	80.9	25.0	0	0
1979	34	0	0	79.4	62.5	18.4	0.7	0
1978	25	0	0	96.0	74.0	10.0	0	0
1977	13	0	0	96.2	61.5	0	0	0
1976	10	0	0	80.0	15.0	2.5	0	0
1975	3	0	0	100.0	50.0	8.3	0	0

N: Number of individuals
N (F>0): Number of inbred individuals

FREQUENCE DES ALLELES DE LA CASEINE α_{S1} EN RACE POITEVINE

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RESUME

Le polymorphisme de la caséine α_{S1} a été étudié en race Poitevine, dans les 7 élevages au contrôle laitier, sur 388 chèvres et 28 boucs présents en décembre 1993. Chez les chèvres, la fréquence des allèles "forts" en caséine α_{S1} est de 0,04 pour A, de 0,36 pour B et de 0,01 pour l'allèle C présent dans un seul élevage; la fréquence de l'allèle "intermédiaire" E est de 0,48 et celle de l'allèle "faible" F de 0,11. Cette race de petit effectif, traditionnellement élevée pour ses qualités fromagères dans la région Poitou-Charentes, se caractérise par une fréquence élevée du variant B, et l'existence de 3 allèles de type B (B_1, B_2 et B_3). L'allèle B_1 le plus fréquent (q = 0,21) est l'allèle originel de l'espèce caprine, donc le niveau "fort" (Grosclaude *et al.*, 1994), ce qui confirme l'ancienneté de la race Poitevine. Chez les boucs, les fréquences sont peu différentes, mais les risques de dérive génétique sont importants chez les éleveurs utilisant 1 ou 2 boucs et dans le cas d'IA avec un nombre limité de boucs.

SUMMARY

The α_{S1} casein polymorphism of the Poitevine breed was studied in 7 herds in milk control, on 388 goats and 28 bucks, at the end of 1993. For goats, the frequency of "strong" variants is 0.04 for A, 0.35 for B and 0.01 for C which was found in only one herd; the frequency of "medium" and "weak" variants E and F are 0.48 and 0.11 respectively. The small population, traditionally bred for the cheese ability of its milk, is characterized by the high frequency of the B variant and the existence of 3 types of B alleles (B_1, B_2, B_3). The B_1 allele, the most frequent (0.21), is the original allele of the species, thus confirming the "ancienneté" of the Poitevine breed. For the bucks, the frequencies are almost similar, but the risks of genetic drift are important due to the small flock size and the limited number of AI. bucks.

1.0 HISTORIQUE

La Poitevine est une race de petit effectif, traditionnellement élevée en vue de produire un lait dont les qualités fromagères ont fortement contribué à donner à la région Poitou-Charentes sa spécificité et son image de marque en matière de fromages de chèvre. En 1967, M. Toussaint a retracé l'histoire de cette race, en rappelant les différentes tentatives pour assurer son développement et son amélioration. "Dès 1906, il existait dans la région de Bougon, des chèvres se caractérisant par leur grande taille, le poil long, des raies blanches de chaque côté du chanfrein et le dessous du ventre blanc; elles devaient justifier à cette époque la création d'une fromagerie coopérative. On notait déjà une sélection sur le caractère motte. A la suite d'une épidémie de fièvre aphteuse en 1920, une introduction de chèvres alpines était réalisée dans cette région et se situait à la base des premiers croisements. Dès cette période, cette chèvre était considérée comme une excellente fromagère. A partir de 1947, les fromageries coopératives des départements des Deux-Sèvres et de la Vienne (dont Bougon et la Mothe Saint-Héray) constituent une Union de Coopératives, en vue de mettre en place un contrôle laitier fromager et un Livre Généalogique. Le standard de la race est défini en 1949. Cette organisation évolue à partir de 1964, avec la création des organismes départementaux de contrôle laitier et la constitution d'un syndicat d'éleveurs chargé de la gestion du Livre Généalogique. Pour favoriser l'expansion de la race, le Livre Généalogique est élargi à des produits nés de mères non inscrites mais de pères inscrits et, en 1967, le standard de coloration est assoupli afin d'admettre de nouveaux coloris. A ce moment, le nombre d'éleveurs adhérant au Livre Généalogique est de 52, soit près de 800 chèvres dans 5 départements".

En dépit de ces initiatives et face au développement des troupeaux Alpins et Saanen plus productifs, le renouvellement des boucs et des familles est menacé, ce qui justifie en 1977 la mise en place d'un programme de gestion de la population avec 11 familles réparties dans 12 élevages de 2 départements, les Deux-Sèvres et la Vienne (Malafosse, 1977). En 1986, l'UPRA CAPRINE ne compte plus que 545 chèvres dans 6 élevages dont 110 au Lycée de Melle, ce qui motive la création de l'Association pour le développement de la chèvre Poitevine (ADCP: Rousseaux, 1991) qui mobilise de nombreux adhérents. Ceux-ci soulignent les atouts de leur race: tempérament calme, résistance à la chaleur, aptitude au pâturage et au parcours, etc.; par ailleurs, le grain des fromages fermiers serait plus fin, donc plus apprécié. En 1992, l'effectif au contrôle laitier n'est plus que de 440 chèvres dans 7 élevages, d'où l'initiative d'un plan de sauvegarde prévoyant un volet technique pour conforter la population contrôlée et un volet scientifique consacré à l'étude du polymorphisme de la caséine α_{S1}. En fait, cette recherche avait déjà été amorcée en 1986 par le Département de Génétique Animale de l'INRA, en même temps que dans les races Alpine et Saanen, mais l'identification précise de certains allèles n'a été possible qu'après l'introduction des techniques les plus modernes de la génétique moléculaire, en particulier pour distinguer les allèles E, B_1, B_2 et B_3. Désormais, la détermination des allèles de la caséine α_{S1} se fait avec la mise en oeuvre parallèle de deux techniques, l'électrophorèse des laits et le typage de l'ADN par la méthode "PCR". Ces travaux ont permis d'arriver à une connaissance plus complète des variants génétiques et de leur phylogénie (Fig. 1), d'où des retombées possibles pour l'ensemble des races.

En 1994, l'ADCP a entrepris un nouvel inventaire de la race qui concernerait environ 1 100 chèvres dans 56 élevages (O. Rosset, c.p.).

2.0 RAPPEL SUR LE POLYMORPHISME GENETIQUE DE LA CASEINE α_{S1}

On retrouve chez la chèvre les mêmes caséines que chez les bovins: α_{S1}, α_{S2}, ß et γ. Les travaux du Laboratoire de Génétique biochimique et de Cytogénétique de l'INRA (F. Grosclaude, G. Brignon, M.F. Mahé, C. Leroux *et al.* cf, Martin, 1993) ont permis d'étudier le polymorphisme de certaines d'entre elles, dont la caséine α_{S1}. Celle-ci présente des aspects tout à fait inhabituels. En effet, elle se distingue par un fort polymorphisme et surtout par le fait qu'il existe, entre allèles ou groupes d'allèles, de nettes différences de niveau de synthèse protéique. Ce polymorphisme est déterminé par au moins 7 allèles, correspondant à 4 niveaux de synthèses différents: 3 allèles "forts" associés à une teneur élevée en caséine α_{S1} (A, B - maintenant subdivisé en B_1, B_2, B_3 - et C), 1 allèle moyen (E), 2 allèles "faibles" associés à une faible teneur en caséine α_{S1} (F et D subdivisé maintenant en D et G), et 1 allèle nul qui entraîne l'absence de caséine α_{S1} à l'état homozygote. On sait maintenant que le niveau de synthèse "fort" est le niveau d'origine, normal chez la chèvre, et que les allèles E, faibles et nuls, sont des mutants défectifs. Par ailleurs, comme il existe une forte corrélation entre la teneur en caséine α_{S1} et la teneur en caséine totale des laits individuels, les allèles "forts" ont, en moyenne, un effet très favorable sur le taux de protéines des laits, donc sur les qualités fromagères et le rendement fromager, comme cela a été clairement démontré dans les expérimentations récentes conduites à la Station Caprine de Moissac et en fermes (Grosclaude *et al.*, 1994; Remeuf, 1993; Manfredi *et al.*, 1993; Mahaut et Korolczuck, 1993; Vassal *et al.*, 1994).

3.0 POLYMORPHISME DE LA CASEINE α_{S1} ET FREQUENCES ALLELIQUES EN RACE POITEVINE

Cette étude concerne 388 chèvres de 1 à 8 ans et 28 boucs de 1 à 6 ans présents en décembre 1993 dans les 7 élevages au contrôle laitier, 6 dans le département des Deux-Sèvres et un 7ème dans le Morbihan.

3.1 ***Chez les chèvres***, l'allèle E est majoritaire (q_E = 0,48) devant les allèles B (0,36), F (0,11), A (0,04) et C (0,01), alors que l'allèle nul est présent chez un seul animal à l'état hétérozygote. Parmi les allèles B, B_1 est le plus fréquent (0,21), devant B_2 et B_3 (0,05, 0,10). L'allèle A est présent dans 5 élevages sur 7 et l'allèle C n'est présent que dans le seul élevage du Morbihan. En effet, l'allèle C était encore présent dans les Deux-Sèvres en 1986 lorsque nous avons réalisé nos premières observations, mais il a disparu depuis par suite de la réduction des effectifs (chèvres et boucs). Il a été récupéré dans l'élevage du Morbihan, lors de sa création en 1983, grâce à l'achat de reproducteurs nés dans les Deux-Sèvres dont un bouc fondateur de génotype B 3/C qui a été largement utilisé (plus de 80 filles contrôlées), de sorte qu'en 1993, la fréquence de l'allèle C était de 0,19 dans cet élevage. Cette fréquence élevée illustre un double phénomène de migration et de dérive génétique, et permet de supposer le retour probable de cet allèle "fort" C dans les élevages des Deux-Sèvres.

3.2 ***Chez les boucs***, l'allèle A est absent, les fréquences alléliques de B, C, E et F sont respectivement de 0,45, 0,02, 0,46 et 0,07: 9 boucs sur 28 (32%) ne sont pas porteurs d'allèles "forts", d'où le risque de dérive génétique chez les petits éleveurs n'utilisant qu'un seul mâle pour le renouvellement. Parmi les 28 boucs, 6 ont été inscrits au catalogue des boucs d'IA en 1992 et 1993: 2 sont porteurs de l'allèle B_1, mais aucun des 6 n'est porteur des autres allèles "forts" A, B_2, B_3 et C. Cette non représentativité des boucs retenus pour l'insémination en semence congelée, démontre la nécessité de typer préalablement les jeunes boucs, si l'on ne veut pas risquer de dégrader les fréquences des allèles favorables, voire d'entraîner la disparition de certains d'entre eux. D'où l'intérêt d'augmenter le nombre d'élevages et de

boucs ainsi que les effectifs au contrôle laitier, pour disposer d'échantillons de reproducteurs représentatifs au niveau des allèles de caséines et des autres caractères.

4.0 DISCUSSION

Les reproducteurs Poitevins se caractérisent par une fréquence élevée du variant fort B (q = 0,36 chez les chèvres; q = 0,45 chez les boucs) et l'existence de 3 allèles de type B (B_1, B_2, B_3). L'un de ces allèles B_1, le plus fréquent (q = 0,21 chez les chèvres; q = 0,34 chez les boucs), est supposé être l'allèle originel de l'espèce caprine, donc le niveau fort, ce qui confirme également "l'ancienneté" de la Poitevine. Si les fréquences alléliques dans cette race sont très différentes de celles observées dans les races Alpine ou Saanen en ce qui concerne les allèles B, rares dans ces 2 races, on remarquera une similitude des fréquences avec les races du Sud de l'Espagne, Malagueña (à poil long), Murcia et Granadina (Grosclaude *et al.*, 1994). Faut-il pour autant donner raison "aux auteurs qui remontent aux invasions arabes pour expliquer la similitude de la longueur du poil de la Poitevine avec de nombreuses races du bassin méditerranéen?" (Toussaint, 1967). Ou considérer que la Poitevine est "la dernière représentante d'un type indigène commun", implanté depuis longtemps dans cette région de Bougon et la Mothe Saint-Héray où le récent Musée des Tumulus nous fait revivre une civilisation datant de 4 700 ans avant notre ère?

En fonction des animaux disponibles, il importe de mettre en place un programme permettant d'étudier la valeur fromagère et les caractéristiques physico-chimiques des laits homozygotes B_1, B_2 et B_3 comparés aux laits homozygotes A ou E, afin de mesurer l'intérêt de ces types génétiques de laits, comme cela a été fait pour les laits homozygotes A, E et F (Remeuf, 1993; Vassal *et al.*, 1994; Jaubert *et al.*, 1993). Si les effectifs contrôlés le permettent, nous chercherons également à estimer les effets de ces allèles B sur les performances laitières (quantité de lait et taux).

Les élevages au contrôle laitier dans les Deux-Sèvres sont en nombre insuffisant pour assurer le renouvellement des boucs et sauvegarder valablement le noyau d'éleveurs laitiers dont le rôle est essentiel, même s'il subsiste, dans ou en dehors du berceau de race, beaucoup de petits élevages dispersés, mais sans contrôle laitier et sans origine contrôlée. Pour éviter la dégradation de la situation, il faudrait - à l'image de ce qui a été fait au Lycée de Melle pour sauvegarder la race bovine Parthenaise - obtenir l'adhésion de nouveaux élevages au contrôle laitier et mettre en place un centre d'élevage pour récupérer les jeunes boucs issus des meilleures mères des élevages représentatifs, en tenant compte des familles, des allèles de caséine α_{S1}, d'une certaine sélection sur la croissance en centre d'élevage. Il faut donc typer régulièrement les reproducteurs pour éliminer progressivement les allèles faibles comme cela est proposé maintenant en race Alpine (Manfredi *et al.*, 1995), redéfinir des familles, organiser le choix des mâles et les accouplements en s'aidant de l'IA si nécessaire, indexer les chèvres comme dans les autres races (matière protéique et taux de protéines) en utilisant des facteurs de correction spécifiques aux Poitevines, ceci afin de sauvegarder les caractères de la race, notamment les allèles forts en caséine α_{S1} qui constituent une des originalités de cette population et expliquent probablement la qualité fromagère de son lait.

Le centre d'élevage est une nécessité pour les "sélectionneurs" laitiers qui doivent renouveler leurs boucs. En effet, ces éleveurs sont très sollicités pour vendre des jeunes mâles, aussi ces ventes se font aux dépens d'un bon renouvellement dans les élevages contrôlés qui représentent le véritable noyau de sélection. A l'avenir, les élevages dispersés pourront constituer une réserve pour le renouvellement du noyau, à condition de mettre en place une

identification des animaux et un contrôle simplifié. Il s'agit là de mesures urgentes pour éviter la disparition de cette race qui serait une "perte irréversible et dommageable".

5.0 REMERCIEMENTS

Nous tenons à remercier J.C Sauze, de l'ADCP, qui a réalisé une grande partie de prélèvements de laits et de sangs dans les Deux-Sèvres, ainsi que H. Coutineau (lycée Jacques Bujault de Melle) et les éleveurs Poitevins que nous avons sollicités directement ou indirectement pour mener à bien cette étude et qui ont toujours répondu à nos demandes.

6.0 REFERENCES

Grosclaude F., Ricordeau G., Martin P., Remeuf F., Vassal L. et Bouillon J. 1994. Du gène au fromage: le polymorphisme de la caséine α_{S1}, ses effets, son évolution. INRA Prod. Anim., 7(1), p.3-19.

Jaubert A., Gay-Jacquin M.F. et Jaubert G. 1993. Valeur fromagère et valeur nutritive de nouveaux types de lait de chèvre génétiquement différents en caséine α_{S1}. Rapport "Institut technique des produits laitiers caprins" (ITPLC), Surgères, décembre 1993, 16pp.

Mahaut M. et Korolczuck J. 1993. Effect of genetic variants of casein on the recovery of milk proteins in fresh and soft cheeses obtained by ultra-or microfiltration from goat's milk. In: Cheese yield and factors affecting its control. Intern. Dairy Federation. p.174-178.

Malafosse A. 1977. Le programme Poitevin. Document U.N.L.G., U.P.R.A Caprine, INRA, ITOVIC. Décembre 1977. 30p.

Manfredi E., Ricordeau G., Barbieri M.E., Amigues Y. et Bibé B. 1995. Génotype caséine α_{S1} et sélection des boucs de testage en race Alpine et Saanen. Genet. Sel. Evol. (à paraître).

Manfredi E., Barbieri M.E., Bouillon J., Piacère A., Mahé M.F., Grosclaude F. et Ricordeau G. 1993. Effets des variants de la caséine α_{S1} sur les performances laitières des chèvres. Le Lait, 73, p.567-572.

Martin P. 1993. Polymorphisme génétique des lactoprotéines caprines. Le Lait, 73, p.511-532.

Remeuf F. 1993. Influence du polymorphisme génétique de la caséine α_{S1} caprine sur les caractéristiques physico-chimiques et technologiques du lait. Le lait, 73, p.549-557.

Rousseaux E. 1991. Races en sursis. La chèvre Poitevine. In: Races de pays en Poitou et Vendée. Geste Ed., p.108-135.

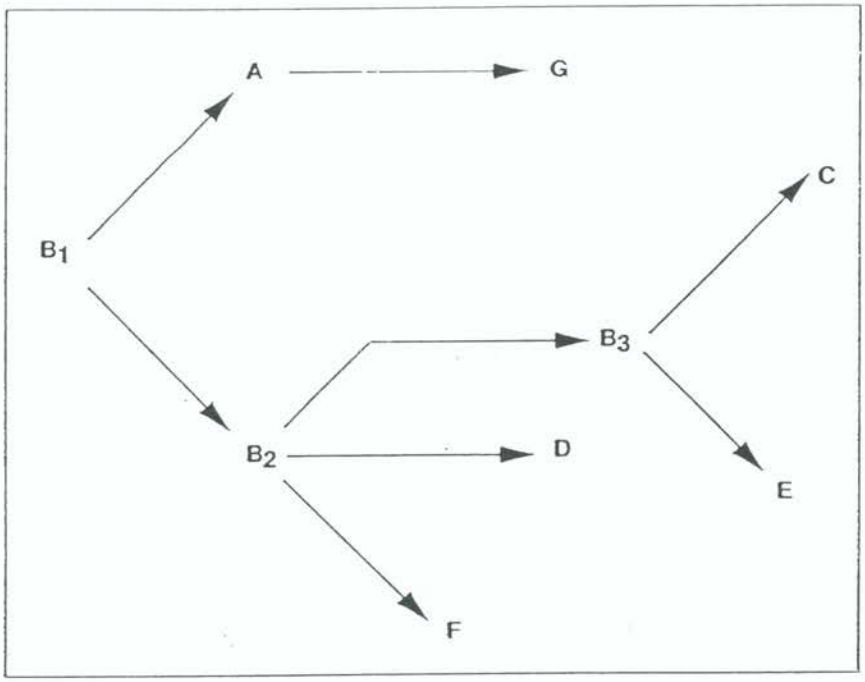
Toussaint M. 1967. Historique de la race Poitevine. La technique laitière, 575, p.25-31.

Vassal L., Delacroix-Buchet A., Bouillon J. 1994. Influence des génotypes AA, EE et FF de la caséine α_{S1} caprine sur le rendement fromager et les caractéristiques sensorielles des fromages traditionnels: premières observations. Le lait, 74, p.89-103.

Tableau 1: *Fréquences alléliques en caséine α_{S1} des reproducteurs de race Poitevine, dans 7 élevages au contrôle laitier, en décembre 1993*

Allèles de cas α_{S1}	388 chèvres		28 boucs	
A	0,04		0	
{B1	0,21}		0,34}	
{B2	0,05}	0,36	0,02}	0,45
{B3	0,10}		0,09}	
C	0,01		0,02	
E	0,48		0,46	
F	0,11		0,07	
O	Σ		0,00	
porteurs d'allèles forts	65%		68%	

Figure 1: *Phylogénie des variants génétiques de la caséine α_{S1} caprine. Le type originel, B_1, ainsi que les variants B_2, B_3, A et C sont les variants "forts". Les variants B_3 et E ont la même structure primaire mais un taux de synthèse différent. D'après F. Grosclaude et al., 1994.*



BHADAWARI BUFFALOES IN INDIA

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SUMMARY

Bhadawari buffaloes are reputed for high milk fat and are found in the Agra & Etawah districts of Uttar Pradesh and the Bhind & Morena districts of Madhya Pradesh. Information on the status, management practices, morphological characteristics, body measurements and performance of the Bhadawari breed were recorded from its breeding tract. Animals true to the breed are copper in colour and have a white ring on the lower side of the neck. The population of this breed is declining at a fast pace and efforts are needed for its conservation. Strategies for its improvement and conservation are also discussed.

RESUME

Les buffles Bhadawari sont reconnus pour leur contenu élevé en gras dans le lait. Les animaux se trouvent dans les districts de Agra et Etawah de Uttar Pradesh et dans les districts Bhind et Morena de Madhya Pradesh. Les informations sur l'état, les modes de conduites, les caractéristiques morphologiques, les mesures corporelles et les performances de la race Bhadawari ont été enregistrées dans les stations d'amélioration. Les animaux purs sont de couleur cuivre avec un anneau blanc à la base du cou. La population de cette race est en nette diminution et il est nécessaire d'entreprendre des actions afin de la conserver. On présente également les stratégies pour l'amélioration et la conservation de cette race.

1.0 INTRODUCTION

The term Bhadawari was coined from its place of origin "Bhadawar Estate", which comprised the Agra and Etawah districts of Uttar Pradesh (UP) and Bhind & Morena districts of Madhya Pradesh. This breed is well adapted to the extremely hot humid climate of the area. These buffaloes have a distinct advantage, being of medium structure and size with a high feed efficiency and thus can be reared even by marginal and landless farmers.

As compared to other breeds of Indian buffaloes, Bhadawari produces less milk but this is well reputed for high butter fat percentage which goes up to 13% (Singh and Desai, 1962). The males of the breed are frequently used for draught and are superior than that of other breeds with respect to speed and heat tolerance. Because of the high butter fat percentage and high efficiency of converting coarse vegetation of the area into milk fat, this breed is suitable and profitable in the remote areas, where transportation and preservation facilities are not available. The Bhadawari buffaloes for the last two decades are being upgraded with Murrah for increasing milk production as a result of which the population of this breed in the area has declined to a large extent and needs immediate attention for its conservation.

2.0 POPULATION-STATUS AND NEED OF CONSERVATION

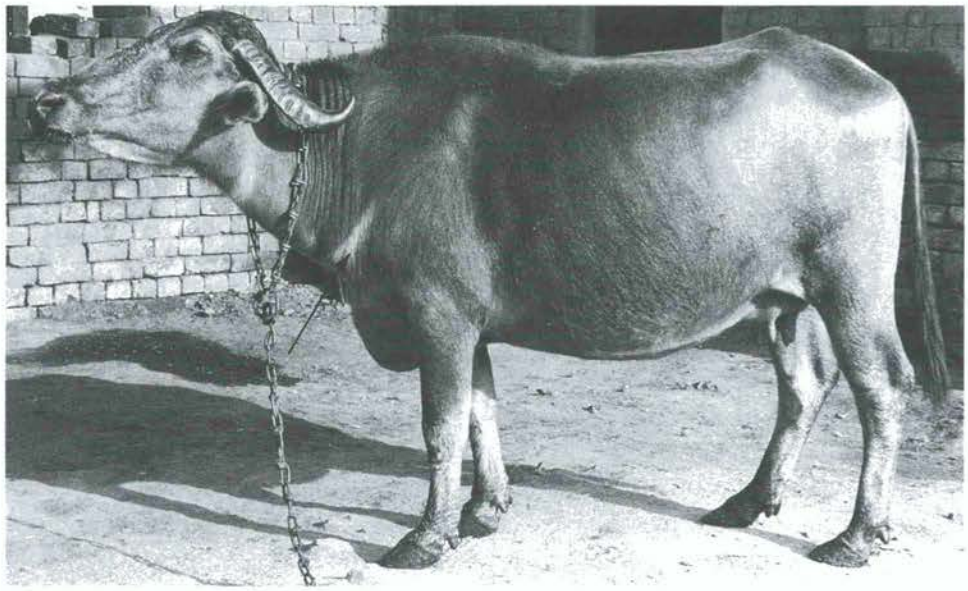
Bhadawari buffaloes in U.P. constituted 0.82 percent of total Indian buffaloes in 1977, which then declined to 0.54 percent in 1991 (Report,1991 U.P. Govt., cited from Singh *et al.* 1993) showing an overall decline of 13.78 percent in its population (table 1). During the same period, the buffalo population of India increased by 8.16 percent and that of U.P. by 30.9 percent. Taking into consideration the trend of the buffalo population in U.P., the Bhadawari population in 1991 was less by 34.13 percent from its projected population of 1.491 lacs.

Table 1: *Population trend of Bhadawari buffalo*

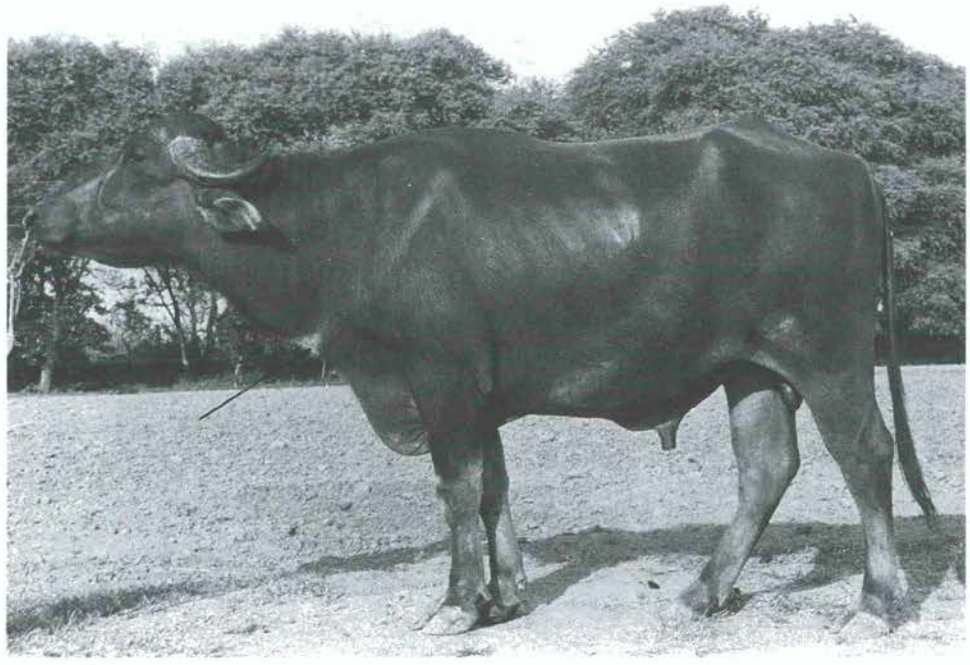
Year/trend	Total buffaloes (lacs)*		Bhadawari buffalo (UP) (lacs)
	India	Uttar Pradesh	
1977	619	139	1.139
1991	770	182	0.982
% change (1977-91)	+ 8.16	+ 30.9	- 13.78

* 1 lac = 100 000

A similar trend was also reported by Singh *et al.* (1993) who made a preliminary survey covering three blocks of Agra, one block of the Etawah and Bhind districts. In all 40 villages, 8 from Pinnahat block (Agra), 11 from Bah block (Agra), 7 from Jaitpura block (Agra), 4 from Brahpura block (Etawah) and 10 villages of Bhind district were surveyed. It was observed that none of the surveyed villages had even 20 Bhadawari buffaloes excepting the Pachhay village of Brahpura block. It was also observed that only 11 percent of the buffaloes reared by farmers were Bhadawari buffaloes. The population of this breed is declining day by day and is only at a few thousand.



Bhadawari buffalo



Bhadawari bull

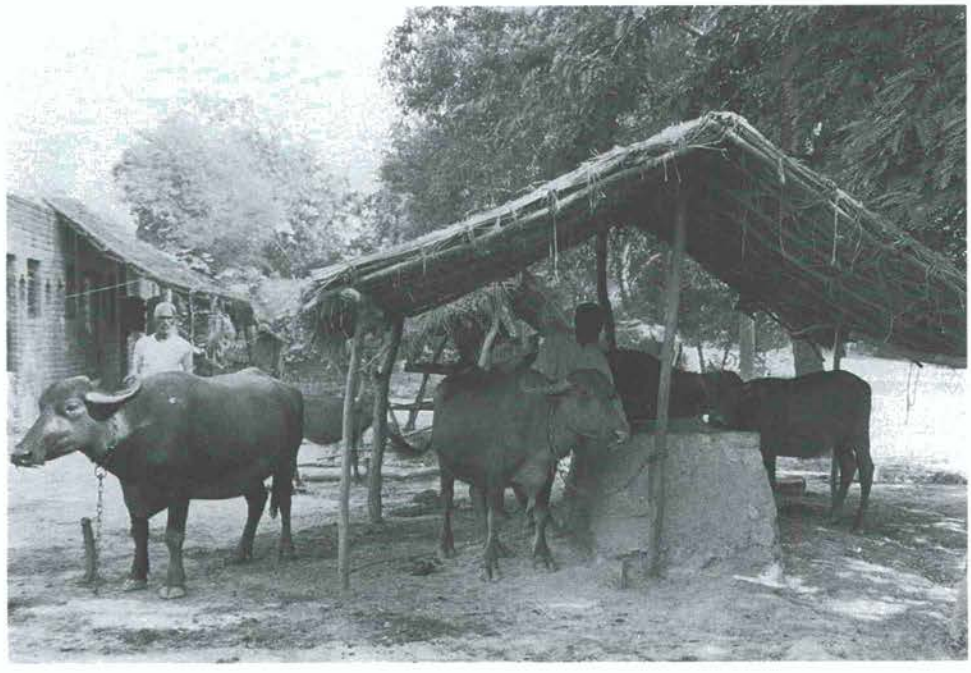
These results indicated a shift towards high milk production rather then high milk fat producing buffaloes in the native tract of Bhadawari breed - a trend which may be dangerous for the existence of this important germplasm.

3.0 PHYSICAL CHARACTERISTICS

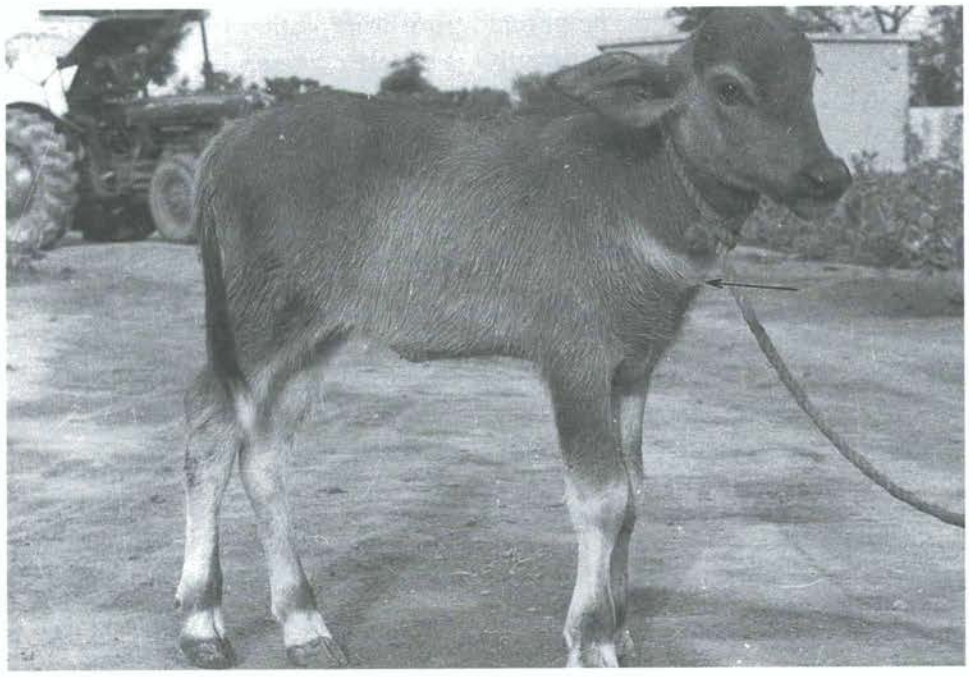
Bhadawari buffaloes are medium sized animals having usually a copper colour with scanty hair and pale legs. The skin colour is generally grey or greyish black. Presence of a white coloured ring on the lower side of neck is a typical characteristic of this breed. The head is comparatively small, bulging between the horns. In some cases the forehead has white markings on it. Horns are black in colour, curving slightly outward, downward before running backwards parallel and close to the neck and finally turning upwards. In case of slightly blackish coloured animals, the horns are turned inward at the end. The muzzle is black. Eyelids are copper in colour but some animals have light brown or black coloured eyelids. Ears are horizontal and medium in size. Hooves are black. The tail is thick and long sometimes touching the ground, ending in a brown or white coloured switch. The udder is small and not well developed, teats are cylindrical and centrally placed with pointed tips. The vulva is very close to the anus. Calves are generally lighter in colour than the adult animals.

4.0 BODY MEASUREMENTS

Body measurements on 69 animals of different ages were recorded at the Bhadawari buffalo farm, Etawah, Uttar Pradesh. The least square means, standard error and number of observations for different measurements are shown in table 2.



Housing under field conditions



Bhadawari calves

The estimates of body length, height and girth were within the range reported by Singh and Desai (1962). Females had significantly (Ps 0.05) longer bodies as compared to the males. However, the sample size was very small.

5.0 MANAGEMENT PRACTICES

A total of 81 farmers from three blocks of Agra were contacted to know the animal husbandry practices and feed and fodder availability in the area. The animal husbandry practices being followed to rear the Bhadawari breed of buffaloes in its breeding tract are given in table 3.

In the area, 70% farmers kept buffaloes for milk and 30% for draught. They are purchasing animals from farmers (30%) and businessman (30%) and 40% of the animals are farm born. Animals are sold to farmers (60%) and to businessmen (40%).

8.5% of farmers kept animals in the open, 8.4% in closed sheds and the remaining 83.1% in both types of houses. Two types of animal houses kachha (46.8%) and pacca (53.2%) were available. The majority of the farmers (96%) tied animals day and night. About 52% of the farmers had animal sheds as a part of their residence and rest of them had separate houses for animals. All the farmers reared the calves through milk suckling. In the case of colostrum feeding, 97.3% fed colostrum to new born after disposal of placenta. Only 41.3% farmers adopted the practice of cutting the naval by a new blade, the rest of them by other means like Khurpi, Daranti and knife etc. Dehorning was not practised. Only 17% of the farmers give wormicides to newborn calves.

The majority of the farmers (97%) practised cleaning of teats and udder prior to milking and 89% of the farmers adopted the practices of cleaning the milking utensils. Regarding milk disposal, 40% farmers sold whole milk, 17% in the form of ghee, 12% both milk and ghee while 31% utilized it for home consumption. All the farmers prepared ghee by the dahi method.

Among the farmers rearing buffaloes, only 11% had Bhadawari breed. All the farmers of the area adopted natural service, while very few (2.6%) adopted artificial insemination.

5.1 Feed & Fodder

In the area following feeds and fodders are available:

- **Dry feeds:** Wheat-bhusa (*Triticum aestivum*), karvi of Bajra (*Pennisetum typhoides*), Maize (*Zea mays*) and Jawar (*Sorghum vulgare*).
- **Green fodder:** Berseem (*Trifolium alexandrinum*), Lucerne (*Medicago sativa*), Bajra, Maize and Jawar.
- **Concentrate:** Mustard cake (*Brassica spp.*), meals of Bajra, Barley (*Hordeum vulgare*), oat (*Avena sativa*), gram (*Cicer arietinum*) and wheat grain.

Concentrates are fed prior to milking by mixing with fodder.

6.0 PERFORMANCE

6.1 Production and reproduction

Production and reproduction records pertaining to 491 lactation records of 108 Bhadawari buffaloes from 1976 to 1990, maintained at Chander Shekhar Azad University of Agriculture and Technology, Kanpur and Dalip Nagar farms were analyzed by the least square method to study the performance of this breed. Least square means of various economic traits are shown in table 4.5.

The least square means of first lactation milk yield, pooled lactation milk yield, and lactation length were 693.2+63.1 kg., 650.4+44.9 kg and 284.8+10.7 days respectively. Singh and Desai (1962) and Singh and Singh (1977) reported higher estimates of pooled lactation milk yield and first lactation milk yield respectively. Influence of period of calving was significant on all three traits.

The least square means of milk yield per day of lactation length and milk yield per day of calving interval were 2.45+0.12 kg. and 1.52+0.10 kg respectively. The estimate of milk yield per day of lactation length was higher than that reported by Singh and Singh (1977). Both traits were significantly affected by farm and period of calving.

The least square means of birth weight, age at first calving, gestation period and calving interval were 25.5+0.4 kg., 1 540.7+46.6 days, 308.9+1.8 days and 524.7+25.9 days respectively. The estimate reported by Singh and Desai (1962) for age at first calving was closer and for calving interval was lower than the present study. Parity and period of calving had significant ($P<0.01$) effects on birth weight.

6.2 Lifetime performance

Lifetime performance of the breed is shown in table 5. The herd life was considered from birth to disposal/death, Productive life as first calving to disposal/death and lifetime milk yield as sum of milk yield in different lactations. In Bhadawari buffalo lifetime milk yield was considerably lower than that of Surti (Biradar *et al.*,1991) and Murrah buffaloes (Pundir, 1993). Effect of period of calving was significant on lifetime milk yield and number of lactations completed.

It has been postulated that this breed is poorer in production, reproduction, lifetime performance and milk production efficiency traits than the other breeds of buffaloes.

6.3 Fat and solid non fat (SNF)

A total of 25 milk samples of Bhadawari buffalo (6 from morning and 19 from evening) were collected from Etawah farm to test fat and SNF percentage. The overall means of fat and SNF percentage were 7.53+0.94 and 9.55+0.35 respectively. The means of fat and SNF percentage from morning milk were 7.66+0.09 and 7.71+0.41 respectively and from evening milk were 7.41+1.09 and 9.39+0.41 respectively. Singh and Desai (1962) reported that the butter fat percentage of individual buffalo ranged from 6.1% to 12.5% and the mixed milk samples were found to contain 8.1% fat and 10.98% SNF.

7.0 ATTEMPTS FOR IMPROVEMENT

In 1985, the Indian Council of Agricultural Research (ICAR) started a Research project at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur for the improvement of Bhadawari buffaloes with the following objectives:

- to study production, reproduction, growth, heat tolerance and feed efficiency;
- to study the milk constituents fat and solid not fat (SNF).

They concluded that Bhadawari animals are economical as compared to Murrah. It does not need high care and can survive easily even on grazing. It is well suited to landless or marginal farmers. But it is not a commercial animal.

The project was started with 58 breedable females but in 1990 there were only 16 breedable females. The project was terminated in 1990.

Uttar Pradesh Government has also realized the need of conservation of this breed and has taken few steps.

a) A farm of Bhadawari buffaloes was established at Saidpur in 1971-72, which was later shifted to Etawah in 1988-89.

b) 63 Bhadawari bulls were selected on the basis of dam's milk yield. Of these, 58 are being used for natural services in villages of Agra, Allahabad, Jhansi and Kanpur divisions of Uttar Pradesh and 5 are being used for semen collection for freezing and artificial insemination. Simultaneously, a very large number of Murrah bulls (826) for natural service and frozen semen of 327 Murrah buffaloes for artificial insemination were distributed throughout the state covering even Bhadawari tract under the breed improvement programme (REPORT, 1991). This programme has diluted the efforts made for conservation of Bhadawari buffaloes by adopting selective breeding and genetic improvement as farmers in the breeding tract are using either Murrah bulls or their semen for breeding. To conserve the Bhadawari buffalo germplasm, large numbers of Bhadawari bulls should be selected and distributed and the Government should restrict the distribution of Murrah bulls/semen in its breeding tract.

National Bureau of Animal Genetic Resources (NBAGR) Karnal, has also initiated a research project entitled "Characterization of the Bhadawari breed" to study the population status, management practices and breed characteristics which includes morphological characteristics, production, reproduction and growth traits, cytogenetic profile, blood group and polymorphism under the field conditions existing in its breeding tract.

8.0 REFERENCES

Animal Husbandry Department. 1991. Report. Uttar Pradesh, Lucknow.

Biradar U.S., Harpanhalli M.D., Bhat A.R.S and Mallikarjunappa S. 1991. Lifetime production in Surti buffaloes. J. of Dairy Sci. 44:352-353.

Pundir R.K. 1993. Estimation of environmental effects on lifetime traits in Murrah buffaloes by maximum likelihood. J. of Dairying, Foods and Home Sci. 12:144-148.

Singh H.P. and Singh R. 1977. Statistical studies of some economic traits of Indian buffaloes Indian Vet. J. 54:823-833.

Singh R.V., Pundir R.K., Vij P.K., Nivsarkar A.E. and Sahai R. 1993. Need for conservation of Bhadawari buffaloes. Proc. of Nat. Sem. on Anim. Gen. Res. and their conservation, April 22-23,1993, held at National Institute of Animal Genetics and National Bureau of Animal Genetic Resources, Karnal.

Singh S.B. and Desai R.N. 1962. Production characters of Bhadawari buffalo cows. Indian Vet. J. 39:332-343.

Table 2: *Body measurements (cm) of Bhadawari buffalo*

Age	Sex	No.	Body length	Heart girth	Paunch girth	Hip width	Pin width	Face length	Face width	Height
Birth	F	1	54.0	62.0	61.0	13.0	6.0	22.0	26.0	60.0
6-12 months	M	9	80.0±3.7	103.1±13.6	119.4±7.5	22.0±1.7	9.3±1.4	31.4±0.9	36.0±1.2	85.8±2.5
12-24 months	F	8	88.6±3.9	110.8±14.4	117.0±8.0	25.1±1.8	11.3±1.5	33.1±1.0	38.5±1.3	88.3±2.7
	M	4	85.7±5.6	106.5±20.4	117.2±11.3	23.7±2.6	11.0±2.1	32.0±1.4	35.5±1.8	86.2±3.8
Adult	F	2	131.0±7.9	179.5±28.9	190.5±16.0	47.5±3.6	23.5±3.0	47.5±2.1	57.0±2.6	124.0±5.4
	M	44	142.6±1.6	198.0±6.1	211.6±3.4	51.7±0.7	26.8±0.6	49.9±0.4	53.1±0.5	127.3±1.1

M: Male, F: Female

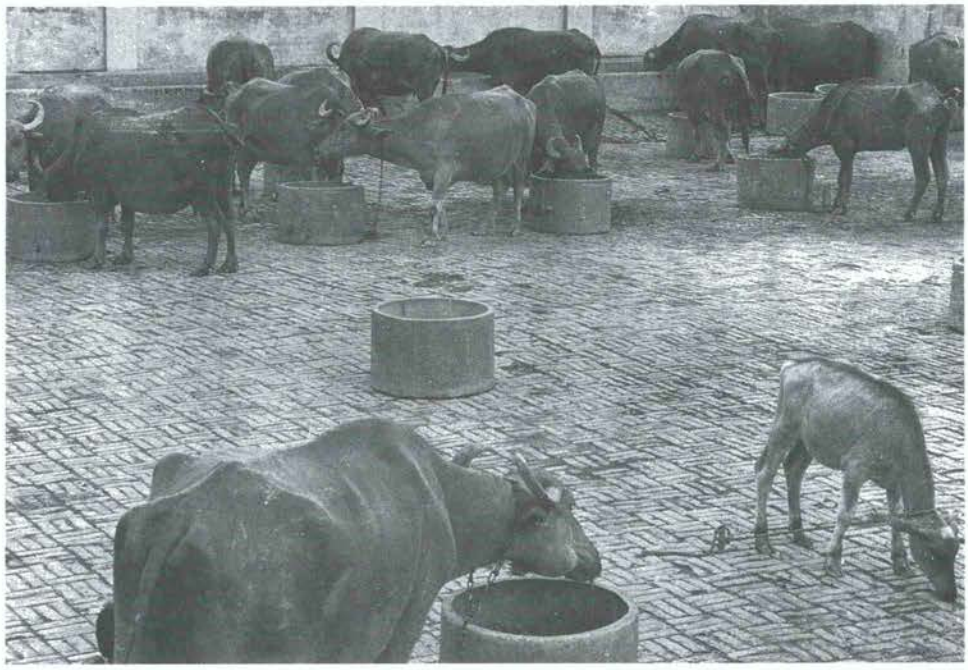
Table 3: *Animal husbandry practices in the breeding tract*

Parameter	% of respondents
1. Utility	
1.1 Milk	70.0
1.2 Draught	30.0
2. Sale of animals to	
2.1 Farmers	60.0
2.2 Businessmen	
3. Repurchase of animals from	
3.1 Farmbred	40.0
3.2 Purchase from farmers	30.0
3.3 Purchase from businessmen	30.0
4. Housing	
4.1 Type	
4.1.1 Open	8.5
4.1.2 Closed	8.4
4.1.3 Both	83.1
4.2 Shed	
4.2.1 Kachha	46.8
4.2.2 Packka	53.2
4.3 Confinement of animals	
4.3.1 Only for day	NIL
4.3.2 Only for night	3.9
4.3.3 Both day and night	96.1
4.4 Situation	
4.4.1 Part of residence	57.1
4.4.2 Away from residence	42.9
5. Calf management	
5.1 Type of rearing	
5.1.1 Suckling	100.0
5.1.2 Weaning	NIL
5.2 Colostrum feeding	
5.2.1 After parturition	2.7
5.2.2 After disposal of placenta	97.3
5.3 Cutting of navel cord	41.3
5.3.1 By new blade	58.7
5.3.2 Khurpi/Daranti etc.	NIL
5.4 Dehorning	
5.5 Wormicides	
5.5.1 Yes	17.3
5.5.2 No	82.7

Parameter	% of respondents
6. Clean milk production	
6.1 Cleaning animals before milking	97.1
6.1.1 Teat and udder	1.5
6.1.2 Whole animal	1.4
6.1.3 None	
6.2 Cleaning of milking utensils	89.2
6.2.1 Yes	10.8
6.2.2 No	
7. Milk utilization	
7.1 Sale of milk	40.4
7.2 Sale of ghee	17.0
7.3 Sale of milk and ghee	12.0
7.4 Family use	30.0
8. Method of ghee preparation	
8.1 Dahi	100.0
8.2 Cream	NIL
9. Breeds of buffaloes	
9.1 Badhawari	10.7
9.2 Murrah	89.3
10. Method of breeding	
10.1 AI	2.7
10.2 Natural	96.0
10.3 Both	1.3

Table 4: *Production and reproduction performance of Bhadawari buffaloes*

Traits	No.	Mean + S.E.
Birth weight (kg)	436	25.5±0.4
Age at first calving (days)	89	1 540.7±46.6
First lactation total milk yield (kg)	94	693.2±63.1
First lactation 300 days milk yield (kg)	93	678.2±53.9
Pooled lactation total milk yield (kg)	326	657.9±48.6
Pooled lactation 300 days milk yield (kg)	332	650.4±44.9
Lactation length (days)	332	284.8±10.7
Dry period (days)	255	213.1±22.7
Service period (days)	259	213.3±26.7
Gestation period (days)	409	308.9±1.8
Calving interval (days)	255	524.7±25.9
Milk yield per day of lactation length (kg)	332	2.5±0.12
Milk yield per day of calving interval (kg)	255	1.5±0.10



Bhadawari buffaloes at breeding farm

Table 5: *Lifetime performance of Bhadawari buffalo*

Traits	No.	Mean + S.E.
Herd life (days)	45	3 337±263
Productive life (days)	78	1 375±153
Lifetime milk yield (kg)	105	1 689±183
Total days in milk	105	719±68
Number of lactations completed	105	2.96±0.26
Lifetime milk yield per day of herd life (kg)	45	0.602±0.063
Lifetime milk yield per days of productive life (kg)	78	1.396±0.089
Lifetime milk yield per day of total days in milk (kg)	105	2.326±0.097
Lifetime milk yield up to 3rd lactation (kg)	74	1 904±122
Total days in milk up to 3rd lactation	74	782±41
Lifetime milk yield per day of total days in milk up to 3rd lactation (kg)	74	2.47±0.11
Lifetime milk yield up to 4th lactation (kg)	45	2 619±176
Total day in milk up to 4th lactation	45	1 051±6.5
Lifetime milk yield per day of total days in milk up to 4th lactation (kg)	45	2.52±0.13
Lifetime milk yield up to 5th lactation (kg)	34	3 038±329
Total days in milk up to 5th lactation	34	1 175±12.3
Lifetime milk yield per day of total days in milk up to 5th lactation (kg)	34	2.54±0.24

THE CRIOLLO SHEEP IN PERU

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SUMMARY

There are approximately fifteen million sheep in Peru, with more than 50% of this population being located in peasant communities and considered to be Criollo. Sheep were introduced by the Spanish, producing an almost complete displacement of the native camelid population. These animals were the foundation of the Criollo sheep presently found in the peasant communities of the Peruvian Andes. The Criollo sheep has a typically pear-shaped body, with a relatively small head, most often with horns. Productive characteristics among the Criollo sheep in the sierra are highly variable and depend mainly on the locations where they were raised. Criollo sheep and their crosses with improved breeds show a higher survival rate than crosses among the improved breeds of sheep in Peru. This indicates that although not as productive in conventional terms (weaning weight or fleece production) the criollo are well adapted to their environment.

RESUMEN

Existen aproximadamente 15 millones de ovinos en Perú y más del 50% del efectivo se considera Criollo y se encuentra en las comunidades rurales. Los ovinos fueron introducidos por los españoles, desplazando así la población local de camélidos. Para las comunidades campesinas peruanas de los Andes estos animales eran la base que representan ahora los ovinos de raza Criolla. La raza Criolla presenta un cuerpo típicamente en forma de pera, con una cabeza relativamente pequeña, a menudo con cuernos. Las características de producción de los ovinos Criollos de la sierra son altamente variables y dependen principalmente de las localidades donde se crían. Los ovinos Criollos y sus cruces con razas mejoradas muestran un mayor índice de supervivencia en comparación con los cruces obtenidos con las razas mejoradas del Perú. Esto indica que, a pesar de no ser muy productivas desde el punto de vista convencional (peso al destete y producción de lana), la raza Criollo está bien adaptada a su entorno.

1.0 INTRODUCTION

There are approximately fifteen million sheep in Peru, more than 50% of this population being located in peasant communities and considered to be Criollo sheep (Jamtgaard, 1989). Criollo sheep represent a very important part of the mixed livestock herds of the families in peasant communities in the highlands, and are also important for the small-scale farmers of the interandean valley. The proportion of different animals depends on the environmental conditions where the production system has developed (Martínez, 1985).

Although Criollo sheep represent the majority of the sheep population in Peru, they have received little attention from institutions entrusted with animal production research. As in other countries, there has been a growing tendency among sheep producers to introduce foreign breeds as alternatives to the Criollo. The disadvantage of foreign breeds is that they are often ill-adapted to the Peruvian environment (Burfening and Carpio, 1994).

The objective of this paper is to characterize Criollo sheep production in Peru and will focus on Criollo sheep in the sierra where most of the population is found.

2.0 HISTORY

The remarkable decline of the indigenous human population in Peru during the first fifty years of the Spanish conquest was accompanied by a similar decrease in the native camelid populations. Simultaneously, sheep were introduced, producing an almost complete displacement of the native camelids and, to a much lesser extent, cattle. Martínez (1985), reported that sheep existed in Peru prior to 1537 and their origin was from the Castille region of northern Spain. Apparently, the first sheep introduced were not Spanish Merino, but rather animals having coarse fibre, suggesting that the initial breeds could have been the Latxa and Churra (Chávez *et al.*, 1989). The Indian population adopted the sheep relatively rapidy, probably due to political and religious measures favouring the sheep over the native camelids (Martínez 1985).

Sheep were first introduced into valleys of the central coast especially in the Rimac valley where Lima is the capital. The Indians, subjected to slavery, worked as shepherds in the new property system established by the Spanish conquerors. Because seizure of their lands caused the destruction of the communities; especially along the coast, the indigenous people retreated to the foothills of the Andes, taking the sheep with them. The Criollo sheep started from these animals and are the ancestors of the present sheep which are located in the Peruvian Andes in peasant communities (Martínez 1985, Chávez *et al.*, 1989). Later hacienda owners allowed peasants to raise Criollo sheep along with the hacienda's animals as a compensation for unpaid labour. These sheep were often called "huaccha" animals (Calle, 1968; 1982).

Due to the environment and lack of planned production systems, genetic and phenotypic changes occurred gradually in the introduced sheep. These adaptive changes were frequently described as "degenerations". Likewise, the word "chusco" was also used. In Peru "chusco" is used to describe an animal which is ugly and with no value while in other Latin American countries as well as Spain, chusco has the opposite meaning (Chavéz *et al.*, 1989).

Typical Criollo ram

Criollo ram with bifuricated horns

3.0 POPULATION AND DISTRIBUTION

Of the approximately 15 million sheep in Peru, 99% are found in the sierra. Most are located in the South and Central regions (56.11 and 35.92 %, respectively) where the altitude, rough topography, and the low feeding quality of the native pasture make cultivation or raising bovine livestock impossible. Nearly all of the sheep in peasant communities can be grouped as "Criollo" or native sheep. Most of the Criollo sheep are distributed in the highlands of the Andes at 3 500 m above sea level, although some are found along the coast and a small number in the Amazon jungle.

The sierra of Peru represents an area of 335 million ha, which is one third of the land area of Peru. The productive base of the sierra has only 18 million ha of native pasture and 2.5 million ha of cropland. The human population of the sierra represents 44% of the national population and of this percentage, 55% depends primarily on agriculture and livestock activities to sustain a living. The large and medium-sized production units are of small numerical importance when compared to small-scale producers. Small scale production is dominant, with one million agricultural units with less than 10 ha of total land, and the small scale producers control more than 1.5 million ha of cultivated land (Franco, 1987). At the present time, sheep constitute the most typical animal husbandry among most peasants.

4.0 PHENOTYPIC AND PRODUCTIVE CHARACTERISTICS

The Criollo sheep has a typically pear-shaped body. The head is relatively small, most often with horns. It is possible to find individuals with bifurcated horns. The head colour and conformation are variable, although in general, brown spots are found on the face. In addition the neck is light, the body trim, the rump dropped, with long, thin legs (Calle, 1968).

The productive characteristics among the Criollo sheep in the sierra are highly variable, depending mainly on the locations where they are raised. In the interandean valleys, body weights are heavier than those found in the higher altitudes probably because of better pasture conditions and access to crop aftermath. Little information is available on body weights of rams and ewes; particularly mature animals. A summary of three studies is presented in table 1. Birth weights ranged between 2.5 and 3.5 kg with mature weights ranging between 20 and 33 kg.

Carcass dressing percents from Criollo in the Ayacucho area were reported to be 53.6% for males and 41.98% for females (Paquiyauri *et al.*, 1987). A total of 30 males, 18 months of age, raised in the Puno area, were slaughtered at an average weight of 33 kg and carcasses yielded 14.9 kg (45%). The carcasses were composed of 32, 20, 20, 18 and 10% leg, arm, rack, neck-shoulder and loin, respectively (Castelo, 1989). In interviews with members of the peasant communities it was reported that they prefer to eat the meat of Criollo sheep instead of that of improved sheep. However, no blind taste testing has been done.

In Criollo flocks, it has been found that animals produced an average fleece of 1.3 kg, and in some cases 2.3 kg (Reynoso, 1979). However, under these conditions the Criollo sheep are not shorn on a yearly basis but rather are shorn when wool is needed either for home processing into clothing or when income is needed. Shearing may be done with a variety of instruments including broken glass, sharp knives, scissors and occasionally hand shears. Rarely are Criollo sheep shorn with shearing machines. Cabrera and Chávez (1988) working in the community of Mantaro (3 750 m above sea level), reported fleece weights of 2.1 and

2.7 kg and staple lengths of 9.0 and 9.8 cm for ewes and rams, respectively. In Ancash, the diameter of the fibre reported in ewe lambs and ewes were 30 and 35 micrometers, respectively (Valenzuela, 1965). Aceituno (1989), compared productive characteristics between Criollo sheep raised at an experimental station *vs.* those raised in a peasant community. Both groups, were studied under the same conditions at 3 979 m above sea level, grazing natural pastures but differing in the management of the animals (table 2).

5.0 REPRODUCTIVE CHARACTERISTICS

Reproduction is not planned in the peasant communities and among small-scale producers. There is no separation by sex and ewes and rams remain together all year round. The proportion of males in the herd is about 8 to 10%. As a consequence of this, lambing does not have a defined season. The major lambing periods occur during two lambing seasons (most important November and December; May and June). However, it is common to observe young lambs all year round. The lambing season in November and December coincides with the start of the rainy season in which grasses grow and provide high quality forage for lactation. It is not uncommon to see many young lambs in peasant communities 5 to 6 months after the start of the rainy season and probably indicates that the improved nutrition associated with green grass induced the cycles of some ewes.

When this occurs the mortality of the lambs is very high because they are born during the dry season when nutrients are insufficient for lactation (Chávez *et al.*, 1989). The presence of oestrous in Criollo ewes is distributed all year around, and the ovulation frequency is higher than in Junín (a locally developed breed) and Corriedale breeds. The highest ovulation frequency (90%) for Criollo ewes is in March (Novoa, 1989). Ovarian activity is initiated 19 days post partum, four days earlier than Junín ewes. Huamán (1989) indicated that in spite of a shorter post-partum interval to first ovulation, Criollo ewes were less impacted by ram-stimulation than Corriedale ewes.

At puberty in males, the separation of the preputial attachments occurs when the animal reaches seven months of age. The first ejaculation is at eight months of age (57% of the adult weight). The Criollo rams are small animals with bigger scrotal circumference (during the liberation of the penis) than Corriedale and Junín rams. In adult Criollo rams, the size of the scrotal circumference is still large with respect to the size of the animal (table 3). The semen volume and the sperm concentration in Criollo rams tend to be less than Junín and Corriedale, although, the motility was highest in Criollos (table 4) (Novoa, 1989).

6.0 CROSSING WITH IMPROVED BREEDS

Although much crossing with improved breeds of sheep has been done in Peru, few results have been reported in the literature. Junin (an improved breed developed in Peru), Targhee, 1/2-Finn (Finn x Targhee), both imported from the United States, and Criollo rams, were mated to Criollo and Junin ewes. The number of lambs born per ewe exposed for breeding was affected by the breed of sire, the imported sires having a lower percentage of lambs born compared to Junin and Criollo sires (74.9 vs 81.9%; $P<0.05$). Lambs born to Criollo dams had much higher survival rates to weaning compared to lambs born to Junin dams (91% and 71%, respectively, $P<0.05$). As a result of the high capacity to survival of lambs from Criollo dams, the number of lambs weaned per ewe exposed for breeding was higher ($P<0.01$) in the Criollo ewes (69.6%) than the Junin ewes (55.2). Lambs born to Junin

dams were heavier (P<0.05) at birth, weaning, and shearing than lambs born to Criollo dams. Lambs sired by Junin, Targhee and Finn rams and raised on Criollo dams were lighter than those raised on Junin dams but heavier than straightbred Criollo lambs (P<0.05). Straightbred Criollo lambs had lighter (P<0.05) fleeces than those of other breed crosses.

No differences were observed in kilograms of lamb weaned per ewe exposed for breeding. However, Criollo ewes raising lambs sired by either Junin, Targhee or Finn cross rams had more (P<0.05) kilograms of lamb weaned per ewe lambing compared to the other crosses. There is no question that the Criollo sheep which adapted to the high altitude environment offer better survival to their lambs under the conditions that exist in the highland of the Andes.

7.0 SOCIO-ECONOMIC IMPLICATIONS

Approximately 99% of the peasant communities recognized in Peru use agropastoral production systems. The agropastoral and pastoral communities contain 45.1% and 44%, respectively of the sheep flocks (table 6; Jamtgaard, 1989).

Within these communities communal herds exist that belong to all members of the community as well as herds that belong to each family of the peasant community. In the Mantaro valley, the sheep communal production is 7% compared with family sheep production of 93% (Torres, 1985).

Particularly in the agropastoral communities, the livestock production represents a great diversity of animal species, and each one has a specific function within the system. These species are divided in two groups: one, called "hato" which are composed of cattle, sheep, horses, camelids, swine and goats; the second group raised consists of small animals such as guinea pigs, hens, ducks and rabbits. This latter group of animals are generally managed inside the house. Within each of these two groups, each specie plays a specific role and competes for the same natural resources (Fernández *et al.*, 1986).

Women and children are in charge of grazing and moving the animals daily, avoiding scattering of animals or mingling with the neighbour's flocks. Women have most of the responsibility for the flocks and small animals raised at home. Management and production decisions are also made by women, while men are in charge of crop production (Chávez *et al.*, 1989; Jamtgaard, 1989).

Within the community, most of the peasants are small-holders with herds ranging from 20 to 30 animals while some peasants have up to 400 animals. In general, the small-holders utilize overgrazed lands near the villages and the larger group takes advantage of better quality range, situated further away (several hours of travel) (Jamtgaard, 1986). In the highland agropastoral communities, of Cuzco, Puno and Ayacucho, a family has an average of 3.5 cattle, 20 sheep, 1 horse or mule, 1 llama or alpaca, 2.3 pigs, 11 guinea pigs and 3 hens.

Málaga (1986) affirmed that sheep, cattle and small animals represent their main source of protein, as well as the income from the sale of their products for peasants. Sheep and small animals constitute a renewable source of capital that is kept to use as money to purchase inputs on certain occasions (Gonzáles de Olarte, 1986). The production is used as raw material for artisan manufacture of textiles, ropes and leather. Manure is used as a organic fertilizer for agriculture and fuel for homes. Generally, sheep consumption and sales take

place on important dates or when an animal is sick or has died by accident. The wool is sold after shearing or as a pelt with fleece. Part of this wool production is utilized for manufacturing clothing for the family. The annual percentage of culled Criollo sheep in the communities of Mantaro valley is approximately 20%. Out of this percentage, 33% is used for consumption *vs.* 77% for sale (Torres, 1985).

All the products are sold in fairs that take place on specific days near towns. In the communities in Ancash during the rainy season (March, April and May), animals are sold to middlemen or butchers. The most valued animals are males with 6 to 8 teeth and of 3 to 4 years of age with good conformation and good muscling. Females are zealously guarded by the peasants (Valenzuela, 1965).

In the agropastoral communities in the southern sierra of Peru, three quarters of the peasant family's income is divided from crops, livestock and family labour. The family income generally comes from cultivation (14%), livestock (23%), non-agricultural activities (24%), including commerce, salaries from local labour (22%) and salaries from non-local labour (17%). Of their monetary expenses, only 5% goes toward input acquisition and less than 2% for procuring productive services. An additional 4% is destined for the purchase of capital goods which means that 90% is destined for consumable goods (Figueroa, 1987; Martínez and Barrera, 1989).

Sheep manure is highly valued as a fertilizer. Each peasant household requires from 1.5 to 2 tons of fertilizer annually (principally from sheep) to provide adequate fertilization for the land. Criollo sheep serve as gatherers of nutrients from distant and less productive areas to be concentrated on peasant land, thereby increasing the land production potential (Jamtgaard, 1989). The use of sheep manure as a currency in the agropastoral communities is an indicator of its productive utility. For example, salaries for agricultural labour, land and corral rents; even fines are frequently paid with manure. Criollo sheep manure constitutes a basic product in the peasant economy, since commercial fertilizers are beyond the peasants' economic reach. The "irrational" tendency for keeping mature or less productive animals in the peasants' flocks, could be explained by the basic importance of animal manure (Jamtgaard, 1989).

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9.0 BIBLIOGRAPHY

Aceituno J. 1989. Algunas características físicas en la lana de ovinos Criollos "UNA-Paylla". Tesis Médico Veterinario y Zootecnista. Universidad Nacional del Altiplano. Puno, Peru.

Burfening P.J. and Caprio M. 1994. Improving Criollo sheep in Peru through crossbreeding. Small Rumin. Res. (In Press).

Cabrera P. and Chavez J. 1988. Algunos índices productivos en ovinos Criollos de comunidades de la zona alta del valle del Mantaro. XI Reunión Científica Anual de la Asociación Peruana de Producción Animal. Piura, Peru.

Calle R. 1982. El huacchillaje es el cáncer que roe a la ganadería andina. Agronoticias 37:35.

Calle R. 1968. Producción de Ovinos. Facultad de Zootecnia. Universidad Nacional Agraria La Molina. Lima, Peru.

Castelo H. 1989. Algunas características de la canal del ovino Criollo macho de dieciocho meses. Tesis Médico Veterinario y Zootecnista. Universidad Nacional del Altiplano. Puno, Peru.

Chávez J.F., Cabrera P. and Olivera E. 1989. El ovino Criollo y su sistema de crianza. En: J. Gamarra y J.F. Chavez (Ed). Sistemas Propios de Manejo de Tierras y Animales en Comunidades Campesinas. pp.54-68. Lluvia Editores. Lima, Peru.

Fernández E. 1986. Potencial del ovino Criollo de una comunidad campesina en Puno. V Congreso Internacional de Sistemas agropecuarios Andinos. Universidad Nacional Técnica del Altiplano. Puno, Peru.

Fernández M. and Huaylinos A. 1986. Sistemas de producción agropecuarios y zonas agroecológicas del valle del Mantaro. Betaprint (Ed.). Lima, Peru.

Figueroa A. 1987. La economía campesina de la sierra del Perú. Fondo Editorial. Pontificia Universidad Católica del Perú. Editorial 1987. pp.146.

Franco E. 1987. El cambio tecnológico en la sierra del Perú. En: Agricultura Andina y Tecnología, unos factores condicionantes pp.26. Cuadernos de Debate y Reflexion. CCTA, Lima, Peru.

Gonzáles de Olarte E. 1986. Economía de la Comunidad Campesina. Instituto de Estudios Peruanos (IEP). 2da. Edición. Lima, Peru.

Huamán J. 1989. Estudio de "efecto macho" y lactación sobre la ovulación post-parto en borregas Corriedale y Criollas. Tesis Médico Veterinario y Zootecnista. Universidad Nacional del Altiplano. Puno, Peru.

Jamtgaard K. 1989. Aspectos sociológicos sobre la producción de rumiantes menores. En: Arturo Florez (Ed.) Resultados de Investigacion en Rumiantes Menores en el Perú (1980-1989) p.223-228. Riobamba, Ecuador.

Jamtgaard K. 1986. Agropastoral production systems in Peruvian peasant communities. In: Selected Proceedings of Kansas State University Farming System Research Symposium. Kansas State University. Manhatan, Kansas.

Málaga S. 1986. Caracterización de los sistemas de producción agropecuaria en la comunidad campesina de Tarmatambo (Junín). Tesis Ingeniero Zootecnista. Universidad Nacional Agraria La Molina. Lima, Peru.

Martínez D. 1985. Producción de ovinos en el Perú : Problemas estructurales. En: Asociación Peruana de Producción Animal (Ed). II Curso Internacional de Producción Ovina pp.B1-B12. Huancayo, Peru.

Martínez D. and Barrera M. 1989. Uso del trabajo familiar en comunidades. En: M. Fernandez (Ed.). El Trabajo Multifamiliar y el Rol de la Mujer en la Ganadería en Comunidades Alto-andinas de Producción Mixta. p.24-48. Lluvia Editores, Lima, Peru.

Novoa C. 1989. Reproducción de rumiantes menores. En: Arturo Flórez (Ed). Resultados de Investigación del Programa de Rumiantes Menores (SR-CRSP) en el Perú. p.138-149. Riobamba, Ecuador.

Paquiyauri T., Jeri L. and Cook D. 1987. Evaluación de algunos parámetros productivos en ovinos Criollos beneficiados en el canal de Ayacucho. X Reunión Científica Anual de la Asociación Peruana de Producción Animal pp.109. Puno, Peru.

Reynoso V. 1979. Peso de vellón y acresiones endógenas de la lana de ovinos no mejorados de la provincia de Puno. Tesis Médico Veterinario y Zootecnista. Universidad Nacional del Altiplano. Puno, Peru.

Torres O. 1985. Mercantilismo en Comunidades Campesinas del valle del Mantaro. Documento de trabajo Atención Primaria y Servicios Básicos de Salud. Huancayo, Peru.

Valenzuela O.J. 1965. Estudio de la crianza y características zoométricas de ovinos nativos de una comunidad campesina del Departamento de Ancash. Tesis Ing. Zootecnista, Universidad Nacional Agraria La Molina. Lima, Peru.

Children herding a small flock of Criollo sheep

Table 1: *Body weights (kg) of Criollo sheep in Peru from three study locations*

Reference	**Velenzuela (1985)**		**Lencinas *et al.* (1985)**		**Caprio and Burfening (1988)**	
Sex	♀	♂	♀	♂	♀	♂
Birth			2.5	3.5	2.5	3.4
Weaning	19	20	15.0	15.4	16.8	19.4
8 months			16.2	16.7	20.0	19.6
1 year	25	30				
2 years	28	33	20.0	23.0	28.8	24.7
3 years	30	40				
4 years	32					
Location	Ancash		Puno		Cerro de Pasco	
Elevation (m)	3 000		3 800		3 900	

Table 2: *Fleece characteristics in Criollo sheep raised under two management systems in the Puno area of Southern Peru*

	Production system	
Characteristics	**Experiment Station**	**Community**
Fleece wt. (kg)	1.58 ± 0.06	1.73 ± 0.02
Staple length (cm)	6.42 ± 0.13	9.50 ± 0.02
Fibre diameter (μ)	27.09 ± 0.12	26.97 ± 0.04
Medullated Fibre (%)	11.20 ± 0.27	9.42 ± 0.09
Clean yield (%)	60.01	57.33

Table 3: *Body weight and scrotal circumference in Criollo, Corriedale and Junin rams in the Central Sierra of Peru (Novona, 1989)*

	Body wt. (kg)		Scrotal circumference (cm)	
Breed	**n**	**mean ± S.E.**	**n**	**mean ± S.E.**
Criollo	165	41.7 ± 0.5	251	29.4 ± 0.2
Corriedale	145	50.6 ± 0.8	243	31.1 ± 0.2
Junin	177	64.7 ± 0.7	270	59.9 ± 0.1

Table 4: *Semen characteristics in Criollo, Corriedale and Junin rams in the Central Sierra in Peru*

	Volume (ml)		Concentration n x 10^9/ml		Motility (%)	
Breed	**n**	**mean ± S.E.**	**n**	**mean ± S.E.**	**n**	**mean ± S.E.**
Criollo	351	1.1 ± 0.03	338	2.2 ± 0.1	348	56.4 ± 1.1
Corriedale	296	1.2 ± 0.04	284	2.1 ± 0.1	295	54.8 ± 1.2
Junin	381	1.2 ± 0.03	368	1.9 ± 0.1	379	51.9 ± 1.0

Table 5: *Reproductive performance of Junin and Criollo ewes mated to Junin (J), Targhee (T), one half 1/2-Finn (F) or Criollo (C) rams (Burfening and Carpio, 1994)*

Sire breed x Dam breed	Number of ewes lambing (%)[a]	Number of lambs weaned (%)[a]	Weaned per ewe exposed (%)	Ewe Productivity, wt. weaned per ewe (kg)	
				Lambing	Exposed
JxJ	494(82)[b]	353(71)[b]	59.0[b]	15.2[b]	12.6[b]
TxJ	427(78)[b]	297(69)[b]	54.2[b]	15.3[b]	12.1[b]
FxJ	402(72)[c]	287(71)[b]	52.0[b]	15.9[b]	11.6[b]
JxC	77(74)[c]	71(92)[c]	68.9[c]	18.6[c]	14.0[b]
TxC	75(70)[c]	67(89)[c]	63.2[c]	17.8[c]	12.6[b]
FxC	70(74)[c]	66(94)[c]	69.4[c]	18.3[c]	13.5[b]
CxC	118(84)[b]	105(89)[c]	75.0[c]	14.5[b]	12.3[b]
Junin dams	1 323(78)[d]	937(71)[d]	55.2[d]	15.6[d]	12.7[d]
Criollo dams	340(77)[d]	309(91)[e]	69.6[c]	17.0[e]	13.0[d]

[a] Ewes with multiple births deleted from data set.

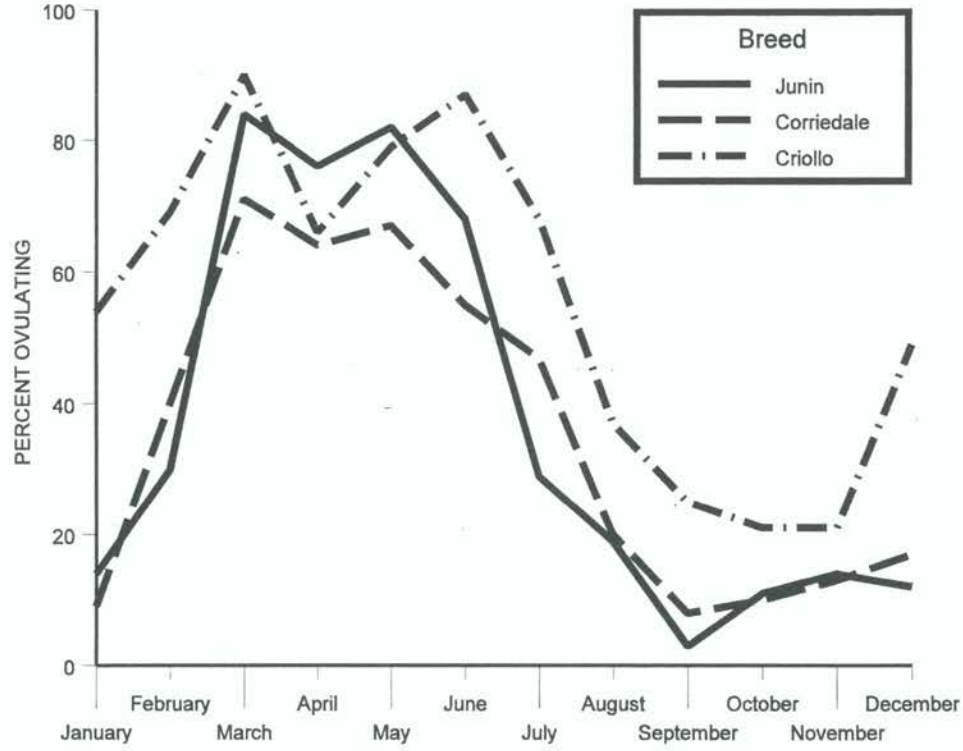
[b,c] Means within a column in the breed cross comparisons without lacking a common superscript differ (P<0 05).

[d,e] Means within a column in the dam breed comparisons without lacking a common superscript differ (P<0.05).

Table 6: *Sheep and camelid numbers in peasant communities by type of production system (Jamtgaard, 1986)*

Production system	Sheep	
	Number	%
Agropastoral	3 502 251	45.2
Pastoral	3 416 596	44.0
Others	838 404	10.8
Total	7 757 251	100.0

Figure 1: *Percent of ewes ovulating by month of the year (Novoa, 1989)*



Women shearing a Criollo ewe with knives

WHITE FULANI CATTLE OF WEST AND CENTRAL AFRICA

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SUMMARY

The paper reviews information on the White Fulani cattle under the headings: origin, classification, distribution, population statistics, ecological settings, utility, husbandry practices, physical characteristics, special genetic characteristics, adaptive attributes and performance characteristics. It was concluded that the breed is economically important for several local communities in many West and Central African countries. The population of the breed is substantial. However, introgression from exotic cattle breeds as well as interbreeding with local breeds represent the major threat to the breed. The review identified a lack of programmes to develop the breed as being inimical to its long-term existence.

RESUME

L'article repasse l'information sur la race White Fulani du point de vue: origine, classement, distribution, statistique de population, contexte écologique, utilité, pratiques de conduites, caractéristiques physiques, caractéristiques génétiques spéciales, adaptabilité, et performances. On conclu que la race est importante du point de vue économique pour diverses communautés rurales dans la plupart des régions orientales et centrale de l'Afrique. Le nombre total de cette race est important; cependant, l'introduction de races exotiques, ainsi que le croisement avec des races locales représente le risque le plus important pour cette race. Cet article souligne également le fait que le manque de programmes de développement à long terme représente un risque important pour la conservation de cette race.

1.0 INTRODUCTION

The White Fulani are the most numerous of the Nigerian cattle breeds and have socio-economic importance and wide distribution in several West African countries. This breed is currently threatened by persistent interbreeding with other cattle breeds (e.g. Muturu, Gudali). At the same time, very little effort has been made to ensure that they are characterized and documented, despite their invaluable qualities.

The Fulani cattle are mainly owned by the nomadic Fulani people who occupy the belt between the Sahara and the Rainforest from the west of the River Senegal to the east of Lake Chad, including parts of western Senegal, southern Mauritania, in and around the flood plains of Niger, Chad, northern Nigeria and Cameroon.

2.0 ORIGIN AND CLASSIFICATION

The origin of the Fulani cattle, is quite controversial. Loftus *et al.* (1994) have observed that the origins and history of African cattle are complex because of the often emerging varieties due to the intricate web of nomadic movements and pastoralist migrations. Moreover, the introduction of exotic genes into these populations may have changed their constitution over time this making it difficult to trace their time origins. Several theories have been postulated to trace the origin of the White Fulani.

One school of thought is of the opinion that the Fulani cattle are truly longhorned zebus that first arrived into the East African coast between the neolithic era of the Duccan and the latest pre-historic (2500-1500 BC) period (Fricke, 1979). The longhorned zebus are believed to have been introduced into West Africa by the Arab invaders during the seventh century, AD (Joshi *et al.*, 1957), roughly about the same time that the shorthorned zebus arrived into East Africa. The appearance of a distinct hump in a newborn calf, especially in the bull calf, and the characteristic nature of the skull and thoracic vertebrae (Olaloku, 1972) point to the Fulani as a longhorned zebu.

Another school of thought (e.g. Curson and Thornton, 1936; Stewart, 1937; Gates, 1952; Faulkner and Epstein, 1957; Joshi *et al.*, 1957; Epstein, 1971; Mason, 1987) contends that these cattle originated from the Horn of Africa, present-day Ethiopia and Somalia, and that interbreeding between the shorthorned zebu (which arrived in the Horn around the first millennium BC) and the ancient Hamitic Longhorn and/or Brachyceros Shorthorn (which had arrived much earlier) occurred in the Horn about 2000-1500 BC. The subsequent successive introductions of zebu cattle (the shorthorned zebu) are believed to have displaced most of these sanga cattle into Southern Africa (Mason, 1987). During this period, which was characterized by constant movements of people and animals within Africa, some of these sanga cattle probably intermixed with the shorthorned thoracic-humped cattle to produce the so-called thoracic-humped sanga. The latter may have migrated, most probably along with the spread of Islam, westerly to constitute what is today the lyre-horned cattle of West and Central Africa, including the Fulani cattle.

The characteristic cranial (primigenius) character (Faulkner and Epstein, 1957) and the giant lyre-horns (Curson and Thornton, 1936), coupled with the apparent tolerance of this breed to trypanosomiasis (Stewart, 1937), have lent support to the thesis that the Fulani has *Bos taurus* breeding. These large horns were, most probably, derived from an intermingling of the thoracic-humped shorthorned zebu (on its westerly passage) with either the humpless

Longhorn x cervico-thoracic-humped zebu or the humpless Longhorn x thoracic-humped zebu. The latter sanga types were probably bred in either Darfur and Wadai in the Sudan or Lake Chad region. Payne (1964, 1970) has also described the westerly passage of a zebu breed similar to the White Fulani from Darfur and Wadai in Sudan to Lake Chad, Bornu and Kano in West Africa in the fifteenth century. This is supported by the presence today of some Fellata and Habani cattle in Sudan, considered similar to the Fulani cattle of West Africa. These animals were introduced by Arab traders, who apparently encountered, on arrival, the taurine Kuri and N'Dama cattle (Payne, 1970). Kennedy (1958) has reported evidence of the passage of the Hamitic Longhorns on rock paintings in Birnin Kudu on the Bauchi Plateau in Nigeria, areas where only zebu or sanga cattle are present today. None of these authors has, however, explicitly referred to the White Fulani as a sanga.

Evidence supporting the contention that the Fulani cattle have taurine genes has come from studies of allele frequencies controlling adult haemoglobin in cattle which have suggested that the White Fulani has allele frequencies which are intermediate between that of the Ankole (sanga) and the Nganda (zebu x sanga) types (Epstein, 1971). Additionally, an analysis of the haemoglobin gene frequencies (Petit, 1968; Queval *et al.*, 1971) has shown that Hb^A is more abundant (0.62-0.70 vs 0.38-0.58) in the Fulani cattle (the Gobra, Red Fulani and Sudanese Fulani) than in the typical zebu cattle (Brahman, Madagascar Zebu and Arab Zebu). Conversely, Hb^B is more abundant (0.42-0.62 vs 0.30-0.38) in the latter than in the former group. The low frequency of Hb^B in both Fulani and taurine breeds (Petit, 1968) is indicative of probable common heritage in evolutionary history.

The Fulani cattle form a group of their own. They are different from the typical zebu of Western and Eastern Africa by the presence of long horns. They differ from the cervico-thoracic-humped sanga of Eastern and Southern Africa by the presence of a thoracic or sometimes intermediate hump. The Fulani cattle have been classified into two subgroups. The lyre-horned subgroup is comprised of the Senegalese Fulani (or the Gobra), the Sudanese Fulani and the White Fulani (Doutressoulle, 1947; Payne, 1970; Mason, 1988). The long lyre-horned subgroup is represented mainly by the Red Fulani or Rahaji (Payne, 1970; Mason, 1988). The Senegalese and White Fulani are much larger than the Sudanese Fulani. The coat of the Senegalese and White Fulani is predominantly white whereas that of the Sudanese Fulani is quite variable, usually with a spotted light grey (Mason, 1951; Payne, 1970).

3.0 POPULATION STATISTICS AND DISTRIBUTION

Estimates of the population of White Fulani (table 1) clearly show that this breed is not in any danger of disappearing. The White Fulani are the most numerous and widespread of all the Nigerian cattle breeds; representing about 37.2% of the national cattle population (RIM, 1992). In Cameroon, they represent approximately 33% of the national cattle population and are only second to the Rahaji population. Population statistics of the White Fulani are not available in the ILCA data base (ILCA, 1992) for Ghana, Sudan and Niger. Lamorde and Franti (1975) have presented approximate distributions of the White Fulani herds in northern Nigeria as follows: Benue Plateau (247 herds), Kano (241), North Western (71), North Central (45) and North Eastern (223). Despite the relatively large populations of the White Fulani in the region, introgression of other cattle breeds into this breed (e.g. Muturu or Gudali) should be cause for concern. A recent survey in the Adamawa region of the Cameroon has shown

that most White Fulani breeders tend to cross their animals with the Gudali in order to readily sell them (IRZ/GTZ, 1989).

4.0 ECOLOGICAL SETTINGS

The climatic environment in the areas in which the White Fulani are predominantly found is tropical and characterized by two well-defined seasons - the wet and dry seasons and two prevailing wind systems - the south-west rain-bearing wind from the Gulf of Guinea and the dry north-easterly dust-laden wind (the harmattan).

The vegetation varies from closed forest in Derived savannah to light forest and open woodlands in the Guinea savannah. Most trees in the Guinea savannah are fire-tolerant and include *Daniellia oliveri* and *Isoberlinia spp.* The major grass species have been described by Tawah and Rege (1994), with *Hyparrhenia spp.* being the most common. Luxuriant growth of many tall grasses, such as Gamba grass (*Andropogon tectorum* and *A. gayanus*) and Guinea grass (*Panicum maximum*), is characteristic of the Derived and Guinea savannah zones.

The distribution of the tsetse fly is quite variable. *Glossina longipalpis* is found mainly in the heavy woodlands of the southern Guinea savannah, while the riverine species of *Glossina tachinoides* is found along the riverbanks, especially during the wet season. The semi-arid zones and the Adamawa and Bauchi Plateaux are permanently free of tsetse flies. Thus, some of these cattle are located in tsetse-free areas, while others are in tsetse-infested areas. This factor has significant influence on both the distribution pattern of the White Fulani in the region and the management practices adopted by their owners.

5.0 UTILITY, HUSBANDRY PRACTICES AND PRODUCTION SYSTEMS

White Fulani cattle are triple-purposed - milk, meat and draught - animals, but are kept mainly for milk by their traditional owners (Payne, 1970; Olutogun, 1976). Its dairy potential is better than that of most zebus in the region (Oyenuga, 1967), but is comparable to that of the Kenana in the Sudan (Osman, 1984). The White Fulani is also a good draught animal by virtue of its docility, tractability, conformation and body size (Mason, 1951; Gates, 1952; Faulkner and Epstein, 1957; Payne, 1970). However, it is slow and sluggish. It is a good beef animal which fattens quite well in feedlots (Olayiwole *et al.*, 1981) and on natural pastures (Faulkner and Epstein, 1957).

Herd sizes and herd structures of the White Fulani vary considerably (Otchere, 1986a; IRZ/GTZ, 1989; Rege *et al.*, 1993a). Herd sizes have ranged from 13 to 135 head per owner and herd composition has averaged 54.6% adult females, 13.5% adult males, 8.0% young bulls, 13.0% heifers and 11.1% calves (Rege *et al.*, 1993a) in the subhumid zone of Nigeria. Breeding is usually not controlled - thus cows are bred throughout the year. Moreover, unwanted bulls are generally not castrated - unless they are troublesome - and, in any case, castration is only done when bulls are at least two years of age.

6.0 PHYSICAL CHARACTERISTICS

6.1 Body size and conformation

Estimates of mature (adult) live weights and body measurements are presented in table 3. There was complete lack of information in the literature reviewed on bulls in village herds. Available figures indicate substantial variations in mature live weight and body measurements in the male and female populations.

The White Fulani is generally taller and narrower-bodied than most European cattle breeds (Hall, 1991). They are fairly medium to large size, with a well-balanced body of good depth and width. The barrel is well sprung and of good capacity. The topline is strong but slopes gently from the hump to a somewhat high sacrum. The back is generally of good width with reasonably satisfactory muscular development. The rump is of good length but has a marked slope from hook to pinbones, which tend to be narrow in some animals. The general shallowness of the body and lack of width give the animal a "leggy" appearance. This characteristic of the breed has been described as an adaptation to long distance trekking (Oyenuga, 1967; Capitaine, 1972). The tail is thin and long, the brush (tail switch) almost reaching the ground. The limbs are of moderate length; the front limbs being well placed with the shoulders which are smoothly covered but not unduly prominent. The hindlimbs are reasonably well-developed, with upper thighs being of fair breadth and fullness. Its bones are clean, light but hard and of good quality.

The hump is well developed, moreso in the males than in the females. It sometimes tends to hang over at the back in the males like in the Gudali. The hump is musculo-fatty (Mason, 1951; Gates, 1992; Ogunsiji, 1974). As alluded to, its placement on the vertebral column is either thoracic or cervico-thoracic. The dewlap is well-developed and fairly large, especially in the bulls. It commences at the throat and is carried well between the front legs. Folding of the dewlap is commonly seen. Umbilical (navel flap) and sheath folds are well-developed.

The head is long and of good proportion, being wide across the forehead and having fairly prominent orbital arches, unlike in the shorthorned zebus (Payne, 1970). In profile, the head is straight or slightly dished (concave). The neck is strong and deep, providing an upright carriage for the head. The horns are medium to long in length in contrast to the very long horns of the Red Fulani. The horns are slender, well proportioned and carried high on the head. They are also round in cross-section and curve outwards and upwards soon after leaving the head. Most animals have horns with an outward twist at the tips, giving the characteristic lyre shape. The horns vary in length from about 81 to 107 cm, with pointed tips (Faulkner and Epstein, 1957). The ears are of medium size, erect and set horizontally, showing the inner parts with the black points to the front. The udder of the White Fulani is fairly well-developed, is of good shape and is strongly attached. The teats are well positioned and are of medium to reasonably large size.

6.2 Coat and skin colour

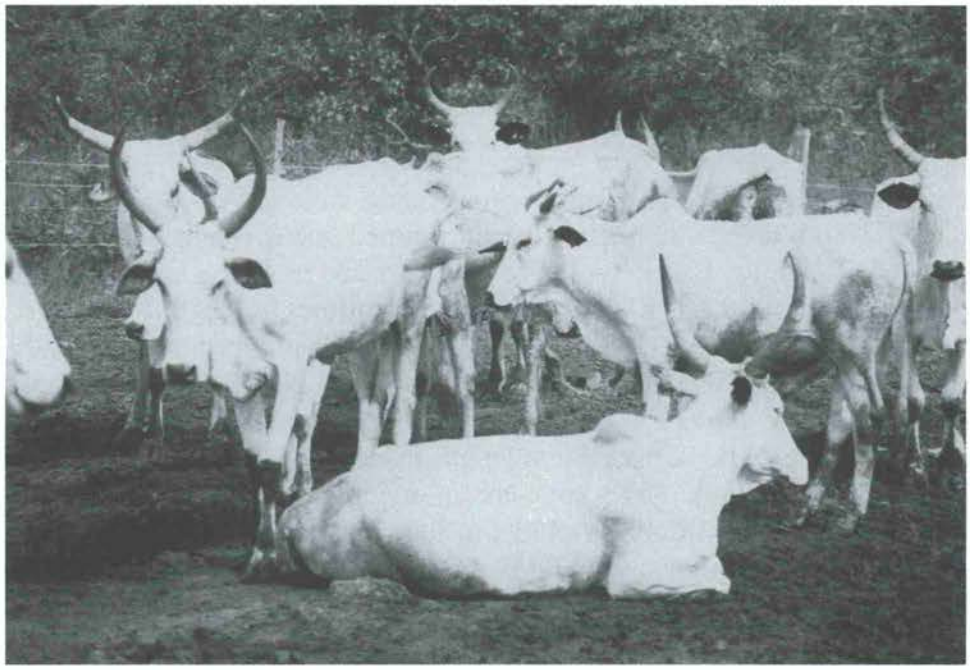
The coat of the White Fulani is commonly white on a black skin with black ears, eyes, muzzle, hooves, horn tips and tip of tail. There are a few cases with black coats mixed with dark fleckings, or red-and-white coats (Payne, 1970). Black fleckings on the sides and limbs are fairly common and red markings are frequent. Where variations exist in coat colour, there

are many possible combinations of black and white on a black skin or red and white on a white skin (Mason, 1951; Gates, 1952; Faulkner and Epstein, 1957; Ogunsiji, 1974). The skin is loose and pigmented and the hair is soft (Payne, 1970).

7.0 ADAPTIVE CHARACTERISTICS

Estimates of cumulative mortality rate of White Fulani cattle at one year of age, both on-farm and on-station, are presented in table 4. The White Fulani is less tolerant to trypanosomiasis than the N'Dama (Roberts and Gray, 1973b; Hill and Esuruoso, 1976) but is more tolerant than the Gudali and other zebu types (Faulkner and Brown, 1953; Faulkner and Epstein, 1957). Ross *et al.* (1959) have suggested the existence of a genetic basis for the resistance of White Fulani cattle to intestinal helminths as well. The White Fulani cattle have also been reported to be more resistant to dermatophilosis than the Muturu and N'Dama breeds (Amakiri, 1974; Nwufoh and Amakiri, 1981).

Studies of anatomical and physiological features related to heat tolerance mechanisms (table 5) show that the White Fulani is more heat tolerant than the N'Dama and the Gudali in Nigeria (e.g. Amakiri and Mordi, 1975). This is reflected in their low respiration rate and heat tolerance index. The White Fulani also exhibited less panting and salivation under heat stress (Buvanendran *et al.*, 1992). The White Fulani have a tendency to sweat much more profusely than the Gudali, N'Dama, the Muturu and Holstein Friesians when exposed to similar high ambient temperatures (e.g. Amakiri and Mordi, 1975; Amakiri and Onwuka, 1980). Indeed, the White Fulani has been reported to be the least stressed breed in the hot climates of Nigeria (Igono and Aliu, 1982).



White Fulani herd

8.0 PRODUCTION CHARACTERISTICS

8.1 Growth and liveweights

Estimates of liveweights from birth to weaning (table 6) and postweaning (table 7) suggest substantial variation in the growth of the White Fulani. Feedlot studies have shown that the White Fulani cattle are able to achieve growth performance of up to 1 kg per day (Harbers *et al.*, 1972; Olaloku, 1980; Olayiwole and Fulani, 1979; Olayiwole *et al.*, 1975, 1981, 1986; Ngere, 1985a).

8.2 Carcass characteristics

Several studies have reported on carcass weight of the White Fulani (Clotte, 1972; Harbers *et al.*, 1972; Johnson and Bell, 1978; Olaloku, 1980; Buvanendran *et al.*, 1983; Ngere, 1985a) but hardly any reports were available on carcass quality. Harbers *et al.* (1972), Buvanendran *et al.* (1983) and Ngere (1985a) have reported a range of 310-445 kg for slaughter weight and of 165-250 kg for carcass weight in well finished young bulls. Johnson and Bell (1978) have reported slaughter weights of 325 kg and carcass weights of 166 kg in well finished steers. Carcasses have yielded dressing-out percentages of between 50 and 60% (Gates, 1952; Payne, 1970; Olayiwole and Fulani, 1979; Buvanendran *et al.*, 1983; Ngere, 1985a).

8.3 Reproductive characteristics

8.3.1 *Male reproduction*

Puberty, defined as the age at which ejaculated semen contains at least 5×10^7 spermatozoa with a minimum of 10% motility (Rekwot *et al.*, 1987), is a major determinant of optimum reproductive efficiency. Age at puberty has ranged from as early as 15 months under a high protein diet (Rekwot *et al.*, 1987) to as late as 17 months under range conditions (Oyedipe *et al.*, 1981). Age at first service in the White Fulani bulls has ranged from 36 to 54 months under station conditions in Nigeria (Faulkner and Epstein, 1957; Foster, 1960; Oyenuga, 1967).

8.3.2 *Female reproduction*

The reproductive performance of White Fulani females is presented in table 8. Age at first calving as low as 25.4 months (e.g. Knudsen and Sohael, 1970; Roberts and Gray, 1973a) and calving interval as short as 360 days (e.g. Knudsen and Sohael, 1970; Pullan, 1979) have been reported on station. In contrast, extreme figures of 73 months and 810 days, respectively, have been reported by Pullan (1979, 1980), among others, under traditional management. Supplementation has been shown to reduce age at first calving from 73 months to about 40 months in village herds (Pullan, 1979; Synge, 1980; Otchere, 1986a). Calving rate, which has been defined as a percentage of the number of calves dropped to the number of cows mated in a year, ranged from 53% to 90% under station conditions. In contrast, calving rate which was much lower in village herds ranged from 38% in unsupplemented traditional systems to 72% in supplemented village systems (e.g. Synge, 1980; Otchere, 1986a).

8.4 Milk production characteristics

Estimates of lactation milk yield of the White Fulani cows maintained under various management systems are presented in table 9. Few studies have reported on the constituents of the White Fulani milk. Some of these studies (table 2) point to a wide range in milk butterfat percent and solids-not-fat (SNF).

9.0 REFERENCES

Adamu A.M., Eduvie L.O., Lufadeju E.A., Ehoche W.O., Okaiyeto P.O., Olorunju S.A.S., Hena S.W. and Tanko R.J. 1990a. Wet season nitrogen, phosphorus and sodium supplementation of Bunaji heifers grazing native pastures. NAPRI Annual Report, 1990, Shika-Zaria, Nigeria. p.107-111.

Adamu A.M., Eduvie L.O., Lufadeju E.A., Ehoche W.O., Okaiyeto P.O., Olorunju S.A.S., Hena S.W. and Tanko R.J. 1990b. Urea/molasses supplementation of Bunaji heifers grazing cereal residues and native pastures. NAPRI Annual Report, 1990, Shika-Zaria, Nigeria. p.102-106.

Adeyemo O. 1986. Serum progesterone levels in monitoring ovarian activity in White Fulani (Zebu) dairy cattle after parturition. Proceedings of a symposium, jointly organized by IAEA and FAO in Vienna, Austria, 17-21 March. In: Nuclear and related Techniques in Animal Production and Health. p.597-601

Aganga A.A., Oyejola B.A., Aganga A.O. and Yaakugh I.D.I. 1986. Reproductive performance of White Fulani cows. Thai J. Agric. Sci. 19:225-229.

Amakiri S.F. 1974. Sweat gland measurements in some tropical and temperate breeds of cattle in Nigeria. Anim. Prod. 18:285-291.

Amakiri S.F. and Funsho O.N. 1979. Studies of rectal temperature, respiratory rates and heat tolerance in cattle in the humid tropics. Anim. Prod. 28:329-335.

Amakiri S.F. and Mordi R. 1975. The rate of cutaneous evaporation in some tropical and temperate breeds of cattle in Nigeria. Anim. Prod. 20:63-68.

Amakiri S.F. and Onwuka S.K. 1980. Quantitative studies of sweating rate in some cattle breeds in a humid tropical environment. Anim. Prod. 30:383-388.

Buvanendran V., Adamu A.M. and Abubakar B.Y. 1992. Heat tolerance of Zebu and Friesian-Zebu crosses in the Guinea Savanna Zone of Nigeria. Trop. Agric. (Trinidad) 69(4):394-396.

Buvanendran V., Ikhatua U.J., Abubakar B.Y. and Olayiwole M.B. 1983. Carcass characteristics of indigenous breeds of cattle in Nigeria. J. Agric. Sci. (Cambridge) 100:407-411.

Capitaine P. 1972. Projet de Développement de l'Elevage au Ghana. Etudes de factibilité de quatre ranches. Etude Zootechnique, IEMVT, France, 103pp.

Clotte St. J. 1972. Comparative evaluation of carcass and offal traits of tropical and temperate cattle. Trop. Agric. (Trinidad) 49:9-13.

Curson H.H. and Thornton R.W. 1936. A contribution to the study of African Native cattle. Onderstepoort J. Vet. Sci. Anim. Industry 7(2):613-739.

Dawuda P.M., Eduvie L.O., Esievo K.A.N. and Molokwu E.C.I. 1988a. Interval between calving and first observable oestrus in postpartum Bunaji cows. Br. Vet. J. 144:258-261.

Dawuda P.M., Oyedipe E.O., Pathiraja N. and Voh A.A. Jr. 1988b. Serum progesterone concentrations during the postpartum period of indigenous Nigerian Zebu cows. Br. Vet. J. 144:253-257.

Dawuda P.M., Eduvie L.O., Esievo K.A.N. and Molokwu E.C.I. 1987. Factors affecting the intervals between calving and resumption of ovarian activities in indigenous cattle: interval between calving and first observable oestrus in postpartum Bunaji cows. NAPRI Annual Report, 1987 Shika-Zaria, Nigeria. p.93-95.

Dettmers A. and Williams T.A. 1978. Some genetic parameters in White Fulani (Bunaji) cows. Nigerian J. Genetics 2:45-52.

Doutressoulle G. 1947. L'Elevage en Afrique Occidentale Française. Paris, Editions Larousse, 298pp.

Eduvie L.O. 1985. Factors affecting postpartum ovarian activity and uterine involution in Zebu cattle indigenous to Nigeria. Anim. Reprod. Sci. (The Netherlands) 8:123-128.

Eduvie L.O. and Dawuda P.M. 1986. Effect of suckling on reproductive activities of Bunaji cows during the postpartum period. J. Agric. Sci. (Cambridge) 107:235-238.

Eduvie L.O., Njoku C.O., Addo P.B., Molokwu E.C.I. and Osori D.I.K. 1984. Gross and histological changes in the reproductive tract of suckled and non-suckled postpartum cows. J. Anim. Prod. Res. (Nigeria) 4(1):21-41.

Epstein H. 1971. The Origin of the Domestic Animals of Africa. Volume I. Africana Publishing Corporation, London. p.498-505.

Falua E.K. 1976. A study of reproductive efficiency of White Fulani cows as observed in Old Dairy of Teaching and Research Farm, Univ. Ibadan. DVM Dissertation, Univ. Ibadan, Nigeria, 19pp.

Faulkner D.E. and Brown J.D. 1953. The improvement of cattle in British Colonial Territories in Africa. Colonial Advisory Council of Agriculture, Animal Health and Forestry. HMSO, London. Publication No. 3, 144pp.

Faulkner D.E. and Epstein H. 1957. The indigenous cattle of British dependent territories in Africa. Colonial Advisory Council of Agriculture, Animal Health and Forestry. HMSO, London. Publication No. 5, 186pp.

Foster W.H. 1960. The breeding of White Fulani cattle at Shika, Nigeria. Institute for Agricultural Research, Ahmadu Bello Univ., Samaru, Zaria, Nigeria. Samaru Res. Bull. No. 2, 31pp.

Fricke W. 1979. Cattle Husbandry in Nigeria: A study of its ecological conditions and social-geographical differentiations. Heidelberger Geographische Arbeiten, Germany, 330pp.

Gates G.M. 1952. Breeds of cattle found in Nigeria. Farm and Forest (Nigeria) 11:19-43.

Hall S.J.G. 1991. Body dimensions of Nigerian cattle, sheep and goats. Anim. Prod. 53:61-69.

Harbers L.H., Schalles R.R., Okoye B.I.C. and Zemmelink G. 1972. Comparative study of White Fulani, Friesian and White Fulani-Friesian bulls for meat production. Trop. Agric. (Trinidad) 49:1-8.

Hartley K. and Baker D.W.H. 1935. An unsual variation in the butterfat content of milk. J. Dairy Res. 6:353.

Hill D.H. 1956. Observations on the performance of a dairy herd of White Fulani (Bunaji) cattle at University College, Ibadan, under conditions of moderate exposure to infection from trypanosomes. Inter-African Bureau for Epizootic Diseases Technical Report No. 12, 25pp.

Hill D.H. and Esuruoso G.O. 1976. Trypanosomiasis in N'Dama and White Fulani heifers exposed to natural infection on a ranch in Western Nigeria. Bull. Anim. Hlth Prod. Afr. 24(2):117-124.

IAR. 1976. Report to the Board of Governors on the Institute's work in 1974-1975, Livestock Improvement Programme. Ahmadu Bello University, Zaria, Nigeria, 54pp.

Igono M.O. and Aliu Y.O. 1982. Adaptive thermal responses of the Zebu, half and three-quarter Friesian-Zebu crosses to the hot-dry and hot-humid seasons. Bull. Anim. Hlth Prod. Afr. 30(4):329-333.

ILCA. 1992. Livestock Population Statistics for Sub-Saharan Africa: A Computerized Data Base. International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia.

Irfam M. 1967. Improvement of cattle in Ghana. The Ghana Farmer 11(2):53-57.

IRZ/GTZ. 1989. Livestock Farming Systems in Adamawa. Research Report N° 1. Institute of Animal Research (IRZ), Wakwa, Cameroon.

Jagun A.G. 1980. Calf mortality in Shika farm during 1975-1979. NAPRI Seminars 2:100-110.

Johnson A.O. and Bell T.D. 1978. Comparative performance of calves from Bunaji (White Fulani) dams and Charolais, three-quarter Friesian and Bunaji sires. J. Agric. Sci. (Cambridge) 91:305-308.

Johnson A.O. and Gambo A. 1979. Oestrus behaviour in Bunaji (White Fulani) heifers. J. Agric. Sci. (Cambridge) 92:689-694.

Joshi N.R., McLaughlin E.A. and Phillips R.W. 1957. Types and breeds of African cattle. FAO Agric. Studies No. 37, Rome, Italy.

Kennedy R.A. 1958. History Today 8:646.

Knudsen P.B. and Sohael A.S. 1970. The Vom herd: A study of the performance of mixed Friesian/Zebu herds in a tropical environment. Trop. Agric. (Trinidad) 47:189-203.

Kumaresan A., Naharajan G. and Singh A. 1983. Serum thyroxine and triiodothyronine concentrations in three breeds of cattle in Nigeria. J. Anim. Prod. Res. (Nigeria) 3(1):57-62.

Lamorde A.G. and Franti C.E. 1975. Nomadism and cattle production in Nigeria. Proceed. Ist Annual Conf. Nigerian Soc. Anim. Prod., Enugu, 14-17 July. p.14-17.

Loftus R.T., MacHugh D.E., Bradley D.G., Sharp P.M. and Cunningham E.P. 1994. Evidence for two independent domestications of cattle. Proc. Natl. Acad. Sci (USA) 91:2757-2761.

Mason, I.L. 1988. A World Dictionary of Livestock Breeds, Types and Varieties. (3rd edition). CAB International, The Cambrian News Ltd (UK), 348pp.

Mason, I.L. 1987. Domestication and breed formation in cattle. Wld Rev. Anim. Prod. 23(3):71-76.

Mason I.L. 1951. The Classification of West African Livestock. Commonwealth Bureau of Animal Breeding and Genetics. Commonwealth Agric. Bureau, Farnham Royal, England. Tech. Comm. No. 7, p.1-10.

Maximuangu J.C. and Chaloux L. 1978. Extension programme of the Bambui dairy project. IRZ Bambui Station, 14pp.

Miller T.B. 1961. Studies on the nutrition of Zebu cattle in N. Nigeria. I. Energy intake and milk production. Emp. J. Exper. Agric. 29:230-242.

Miller T.B. and Thorpe R.J. 1962. Potential production of White Fulani cattle under Shika System of Management. Samaru Agric. Newsletter No. 49, Samaru, Nigeria.

Mrode R.A. 1988. Lactation performance of the White Fulani cattle in Southern Nigeria. Trop. Anim. Hlth Prod. 20:149-154.

Ngere L.O. 1985a. The White Fulani (Bunaji) of Nigeria. In: Animal Genetic Resources in Africa: High Potential and Endangered Livestock Proceed. 2nd OAU Expert Committee Meeting oNovember 24-28, 1983, Bulawayo, Zimbabwe. p.67-77.

Ngere L.O. 1985b. The Gudali of Nigeria - Review. In: Animal Genetic Resources in Africa: High Potential and Endangered Livestock Proceed. 2nd OAU Expert Committee Meeting November 24-28, 1983, Bulawayo, Zimbabwe. p.77-81.

Ngere L.O. 1975. The improvement of livestock production in Nigeria through breeding. Nigerian J. Anim. Prod. 2(1):36-43.

Nwufoh K.J. and Amakiri S.K. 1981. The normal skin bacterial flora of some cattle breeds in Nigeria. Bull. Anim. Hlth Prod. Afr. 29:103-105.

Ogunsiji O. 1974. Length and level of preparum feeding on the milk of W. Fulani cows in Ibadan. Ph.D. Thesis, Univ. Ibadan, Nigeria, 356pp.

Olaloku E.A. 1980. Problems of intensive beef production in the derived and Southern Guinea vegetation zones of Nigeria. Premier Colloque International: Recherches sur l'Elevage Bovin en Zone Tropicale Humide, 18-22 avril, Bouaké, Côte d'Ivoire. p.671-682.

Olaloku E.A. 1972. The effect of the level of feed, nutrient intake and stage of lactation on the milk of White Fulani cows at Ibadan. Ph.D. Thesis, Univ. Ibadan, Nigeria.

Olaloku E.A., Hill D.H. and Oyenuga V.A. 1971. Observations on the White Fulani (Bunaji) Zebu cattle of Northern Nigeria in a Southern Nigeria environment. I. Factors influencing the birth weight of calves at Ibadan. Trop. Agric. (Trinidad) 48:209-216.

Olaloku E.A. and Oyenuga V.A. 1979. Observations on the White Fulani (Bunaji) Zebu cattle of Northern Nigeria in a Southern environment. VII. Dietary energy and protein utilization during lactation at Ibadan. East African Agric. Forestry J. 42:296-303.

Olaloku E.A. and Oyenuga V.A. 1976. Feed intake and milk yield of White Fulani (Bunaji) Zebu cattle as influenced by the stage of lactation. J. Assoc. Adv. Agric. Sci. Afr. 3(1):20-26.

Olaloku E.A. and Oyenuga V.A. 1974. Feed intake, yield and composition of milk of cows fed supplementary concentrate at pasture. East African Agric. Forestry J. 40:103-110.

Olaloku E.A. and Oyenuga V.A. 1973. Studies on the White Fulani (Bunaji) Zebu cattle: The effect of stage of lactation, age of cow and seasons of the year on milk yield, butterfat and solids-not-fat content of White Fulani cattle at Ibadan. J. Assoc. Adv. Agric. Sci. Afr. (Suppl.1):20-31.

Olayiwole M.B., Ahmed M.B. and Bell T.D. 1975. Feedlot performance and carcass characteristics of steers fed high energy rations. Nigerian J. Anim. Prod. 2(2):270-276.

Olayiwole M.B., Buvanendran V. Fulani I.J. and Ikhatua J.U. 1981. Intensive fattening of indigenous breeds of cattle in Nigeria. Wld Rev. Anim. Prod. 17(2):71-77.

Olayiwole M.B. and Fulani I.J. 1979. Economics of commercial beef production under feedlot system of management. NAPRI Seminars, Zaria. 1:167-177.

Olayiwole M.B., Olorunju S.A.S., Kera B.S., Agishi E.C., and Adesipe Y.M. 1986. Economics of feedlot technology. NAPRI Annual Report, 1986. Shika, Nigeria. p.131-132.

Olutogun O. 1976. Reproductive performance and growth of N'Dama and Keteku cattle under ranching conditions in the Guinea Savannah of Nigeria. Ph.D. Thesis, Univ. Ibadan, Nigeria, 126pp.

Osman A.H. 1984. Sudanese indigenous cattle breeds and the strategy for their conservation and improvement. FAO Anim. Prod. Hlth Paper 44(1):58-66.

Otchere E.O. 1986a. Traditional cattle production in the subhumid zone of Nigeria. In: von Kaufmann, R., S. Chater and R. Bench (eds). Livestock Systems Research in Nigeria's Subhumid Zone. Proceed. 2nd ILCA/NAPRI Symposium, Kaduna, Nigeria, October 29-November 2, 1984. International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia, p.110-140.

Otchere E.O. 1983. The productivity of Bunaji (White Fulnai) cattle in pastoralist herds on the Kaduna plains of Nigeria. International Livestock Centre for Africa (ILCA) Subhumid Programme Kaduna. Internal Comm. No. 46. 27pp.

Oyedipe E.O., Kumi-Diaka J. and Osori D.I.K. 1981. Determination of onset of puberty in Zebu bulls under tropical conditions of Northern Nigeria. Theriogenology 16:419-431.

Oyedipe E.O., Pathiraja N., Voh Jr. A.A., Eduvie L.O. and Marire B.N. 1987. The effect of Human Chorionic Gonadotrophin (HCG) on corpus luteum function in Zebu cattle. NAPRI Annual Report, Shika-Zaria, Nigeria, p.91-92.

Oyenuga V.A. 1967. Agriculture in Nigeria: An Introduction. FAO, Rome, Italy, p.240-253.

Payne W.J.A. 1970. Cattle Production in the Tropics. Volume I. Tropical Agricultural Series, Longman Group Ltd, Western Printing Services Ltd, Bristol, Great Britain, 336pp.

Payne W.J.A. 1964. The origin of domestic cattle in Africa. Empire J. Exp. Agric. 32:97-113.

Petit J.P. 1968. Détermination de nature des hémoglobines chez 982 bovins africains et malgaches (taurins et zébus) par électrophorèse sur acétate de cellulose. Rev. Elev. Méd. vét. Pays trop. 21(3):405-413.

Pullan N.B. 1980. Productivity of White Fulani cattle on the Jos Plateau, Nigeria. II. Nutritional factors. Trop. Anim. Hlth Prod. 12:17-24.

Pullan N.B. 1979. Productivity of White Fulani cattle on the Jos Plateau, Nigeria. I. Herd structures and reproductive performance. Trop. Anim. Hlth Prod. 11:231-238.

Pullan N.B. and Grindle R.J. 1980. Productivity of White Fulani cattle on the Jos Plateau. Nigeria. IV. Economic factors. Trop. Anim. Hlth Prod. 12:161-170.

Queval R., Petit J.P. and Hascoet M.C. 1971. Analyse des hémoglobines du Zébu arabe (*Bos indicus*). Rev. Elev. Méd. vét. Pays trop. 24 (1):47-51.

Rekwot P.I., Oyedipe E.O., Akerejola O.O., Kumi-Diaka J. and Umoh J.E. 1987. The effect of protein intake on the onset of puberty in Bunaji and Friesian x Bunaji crossbred bulls in Nigeria. Theriogenology 28(4):427-434.

Rege J.E.O., von Kaufmann R.R. and Mani R.I. 1993a. On-farm performance of Bunaji (White Fulani) cattle 1. Herd structures and cattle disposal. Anim. Prod. 57:199-209.

Rege J.E.O., von Kaufmann R.R., Mwenya W.N.M., Otchere E.O. and Mani R.I. 1993b. On-farm performance of Bunaji (White Fulani) cattle 2. Growth, reproductive performance, milk offtake and mortality. Anim. Prod. 57:211-220.

RIM. 1992. Nigerian Livestock Resources (6 vols). Report by Resource Inventory and Management Limited (RIM) to FDLPCS, Abuja, Nigeria.

Roberts G.J. and Gray A.R. 1973a. Studies on Trypanosome-resistant cattle. I. The breeding and growth performance of N'Dama, Muturu and Zebu cattle maintained under the same conditions of husbandry. Trop. Anim. Hlth Prod. 5:211-219.

Roberts G.J. and Gray A.R. 1973b. Studies on Trypanosome-resistant cattle. II. The effect of trypanosomiasis on N'Dama, Muturu and Zebu cattle. Trop. Anim. Hlth Prod. 5:220-233.

Ross J.G., Lee R.P. and Armour J. 1959. Haemonchosis in Nigerian Zebu cattle. The influence of genetic factors in resistance. Vet. Rec. 71:27-31.

Ruthenberg H. 1974. Artificial pastures and their utilization in the Southern Guinea Savannah and the Derived Savannah of West Africa. Tour d'horizon of an agricultural economist. Beef production on artificial pastures. Handbuch der Landwirtschaft u. Ernährung. In: den W. Entwicklungslä'ndem 13:312-330.

SARS. 1972. Shika Agricultural Research Station Annual Report (1971). Institute for Agricultural Research, Samaru, Ahmadu Bello Univ., Zaria, Nigeria, 39pp.

Stewart J.L. 1937. The cattle of the Gold Coast. Vet. Rec. 49(41):1289-1297.

Synge B.A. 1980. Factors limiting cattle productivity in highland areas of Nigeria II. Centre for Tropical Veterinary Medicine, Easter Bush, Roslin, Midlothian, Scotland, 50pp.

Tawah C.L. and Mbah D.A. 1989. Cattle Breed Evaluation and Improvement in Cameroon: A review of the situation. Institute of Animal Research (IRZ), Wakwa, Cameroon, 29pp.

Tawah, C.L. and Rege, J.E.O. 1994. Gudali cattle of West and Central Africa. Animal Genetic Resources Information, No. 17, FAO, Rome, Italy.

Umoh J.U. 1982. Relative survival of calves in a University herd in Zaria, Nigeria. Br. Vet. J. 138:507-514.

Umoh J.E. and Koch B.A. 1971. Consumption of salt and mineral mixtures, Shika Agricultural Research Station Annual Report, Zaria, Nigeria, p.21-22.

Umoh J.U. and Jagun A.G. 1981. A case-control study of calf mortality in Zaria. Nigerian Vet. J. 10:31-39.

van Raay J.G.T. 1975. Rural Planning in a Savannah Region (northern Nigeria). Rotterdam University Press, Rotterdam (The Netherlands), 183pp.

Wheat J.D. and Broadhurst J. 1968. Analysis of data on Bunaji cattle in Birnin Kudu and Kabomo, Northern Nigeria. Institute for Agricultural Research, Ahmadu Bello Univ., Samaru, Zaria, Nigeria. Samaru Miscellaneous Paper No. 25, 13pp.

Wheat J.D., de Leeuw P.N. and Koch B.A. 1972. Bunaji cattle at the Shika Research Station, North Central State, Nigeria. Institute for Agricultural Research, Ahmadu Bello Univ., Samaru, Zaria, Nigeria. Samaru Miscellaneous Paper No. 41, 12pp.

Zakari A.Y., Molokwu E.C.I. and Osori D.I.K. 1981. Effect of season on the oestrous cycle of cows (*Bos indicus*) indigenous to Northern Nigeria. Vet. Rec. 12:213-215.

Table 1: *Distribution and population statistics of the White Fulani cattle*

Country	Synonym	Number	Year	Source	Habitat
Nigeria	Bunaji (Hausa)[a], Yakanaji (Fulani), White Kano	4 335 000 7 670 850 5 118 547	1985 1992 1992	Ngere, (1985b) ILCA (1992) RIM (1992)	Northern Nigeria: Kano, Katsino, Bauchi, Sokoto, Zaria, Bornu Plateau, Adamawa, Benue Southern Nigeria: (recent introduction) Ibadan, Lagos
Cameroon	Aku (Fulani), Akou (French), White Fulani, White M'Bororo	845 688 1 373 615	1989 1992	Tawah & Mbah (1989) ILCA (1992)	North West (Bamenda Highlands) Adamawa North Far North
Central African Republic	Akou	600 000	1992	ILCA (1992)	North, Northwest and Central Regions
Sudan	Fulbe, Tulus, Umbororo, White Fellata	250 000	1994	Mohammed (unpub.)	Southern Sudan
Ghana	White Fulani	NA[b]			NA

[a]Names in parentheses refer to the origin of the synonym
[b]NA = not available

Table 2: *Composition of White Fulani milk (%)*

Milk constituents	Mean	Standard deviation
Butterfat	4.10-7.50	0.28
Solids-not-fat (SNF)	8.39-9.12	0.13-0.15
Proteins	3.73-3.99	0.09-0.14
Lactose	4.24-4.24	0.09-0.11
Minerals	0.67-0.68	0.02-0.05
Total Solids	12.51	0.38

Adapted from: Hartley & Baker, 1935; Hill, 1956; Miller, 1961; Irfam, 1967; Oyenuga, 1967; Payne, 1970; Ogunsiji, 1974; Ngere, 1975; Olaloku and Oyenuga, 1973, 1974, 1976

Table 3: *Mature weight and adult linear body measurements in the White Fulani*

	Husbandry system		
	"Improved"		Village
Trait	**Bull**	**Cow**	**Cow**
Mature weight, kg	425-665 (14)[a]	250-380 (191)	270-310 (50-395)
Height at withers, cm	130-152	118-137	-
Body length, cm	152	117-137	-
Heart girth, cm	193 (7)	145-161 (141)	155 (50)
Width at hips, cm	45	40-41 (27)	-
Hip height, cm	-	122 (110)	-
Rump length, cm		39-42 (27-110)	

[a]Number of animals sampled

Adapted from:

Mason, 1951; Gates, 1952; Faulkner & Epstein, 1957; Joshi et al., 1957; Foster, 1960; Oyenuga, 1967; Wheat & Broadhurst, 1968; Payne, 1970; Olaloku et al., 1971; Capitaine, 1972; Wheat et al., 1972; Roberts & Gray, 1973a; Ogunsiji, 1974; Ruthenberg, 1974; Olutogun, 1976; Buvanendran et al., 1980; Synge, 1980; Hall, 1991

Table 4: *Mortality rates in the White Fulani by location and management system*

Station/Country	Management System	Mortality (%)		Perinatal mortality rate (%)		Source
		Calf (≤1 yr.)	Adult	Abortion	Stillbirth	
Shika, Nigeria	Station	3.0-11.2	-	4.2	2.6	Jagun (1980); Umoh & Jagun (1981); Umoh (1982); Aganga *et al.* (1986)
Ibadan, Nigeria	Station	12.4	-	8.0	-	Falua (1976)
Bambui, Cameroon	Station	15.4	0.9	-	-	Tawah & Mbah (1989)
Jos Plateau, Nigeria	Village (supplemented)	2.9-3.3	-	-	-	Synge (1980)
Jos Plateau, Nigeria	Village	10.7-11.7	4.1	-	-	Pullan (1980); Synge (1980)
Kaduna, Nigeria	Village	12.5-22.4	-	-	-	Otchere (1986a); Rege *et al.* (1993b)

Table 5: *Heat tolerance characteristics of White Fulani cattle*

Trait	Mean ± se[a]	Source
Sweat gland measurements:		
Length, μm	354.0 ± 32.00	Amakiri (1974);
Diameter, μm	105.0 ± 3.00	Amakiri & Mordi (1975);
Shape (length/diameter), units	3.2 ± 0.34	Igono & Aliu (1982)
Volume, $\mu m^3 \times 10^6$	3.1 ± 0.45	Amakiri (1974);
Density, number/cm^2	1 584.0 ± 336.0	Amakiri & Mordi (1975);
	1 520.0 ± 212.0	Igono & Aliu (1982)
Sweating rate, gm/m^2/hr	1 209.6 ± 180	Amakiri & Onwuka (1980);
	105.8-161.3 ± 18.8	Igono & Aliu, 1982;
	77.5 - 172.0	Buvanendran *et al.* (1992)
Moisture loss/gland, $x10^{-6}$ g/hr	7.0 - 10.6	Igono & Aliu (1982)
Rectal temperature (RT),°C	38.3 - 38.9	Amakiri & Funsho (1979); Igono & Aliu (1982);
Respiratory rate (RR), flank movements/minute	15-30	Buvanendran *et al.* (1992)
Coefficient of adaptability[b] (CA, heat tolerance index)	2.0 - 2.3	Amakiri & Funsho (1979); Igono & Aliu (1982);
Heat tolerance coefficient (HTC)[c]	90.7	Buvanendran *et al.* (1992)

[a]Standard error
[b]CA = RT/38.33 + RR/23.0
[c]HTC = 100 - 10[RT_1 - RT_2], where RT_1 = rectal temperature at 16.00 hr and RT_2 = rectal temperature at 07.00 hr

Table 6: *Pre-weaning weights (±standard deviations) of White Fulani cattle by location and management system*

		Birth weight (kg)		3 mo. weight (kg)		6 mo. weight (kg)		9 mo. weight (kg)		
Location/Country	Management system	n[a]	Mean ± sd	n	Mean ± sd	n	Mean ± sd	n	Mean ± sd	Source
Shika, Nigeria	Station	3464	22.3 ± 1.1 (21.7-27.0)[b]	732	63.2±1.6 (62.5-66.9)	918	101.7 ± 13.4 (77.0-132.6)	580	126.5 ± 24.1	Faulkner & Epstein (1957); Foster (1960); Miller & Thorpe (1962); Oyenuga (1967); Umoh & Koch (1971); Wheat *et al.* (1972); IAR (1976); Johnson & Bell (1978); Oni *et al.* (1988).
Kabomo, Nigeria	Station	84	23.0 ± 4.6	70	81.5 ± 11.7	44	130.2 ± 23.2		-	Wheat & Broadhurst (1968)
Birnin Kudu, Nigeria	Station	118	21.7 ± 4.3	77	64.7 ± 13.2	77	130.8 ± 24.6		-	Wheat & Broadhurst (1968)
Vom, Nigeria	Station		24.2		-		129.4		-	Roberts & Gray (1973a)
Bambui, Cameroon	Station	120	23.1 ± 1.8	24	60.2 ± 3.6	19	88.7 ± 6.1	4	98.5 ± 9.8	Tawah & Mbah (1989)
Idon, Nigeria	Ranching	128	19.8		-	20	76.3 ± 15.2	3	99.7 ± 11.2	Otchere (1983)
Mando, Nigeria	Ranching	148	20.1		-	50	97.8 ± 25.5	51	128.7 ± 27.8	Otchere (1983)
Abet, Nigeria	Village	389	20.2 ± 8.3		-	250	61.6 ± 14.3	244	76.9 ± 23.4	Otchere (1986a); Rege *et al.* (1993b)
Kurmin Biri, Nigeria	Village	731	20.0 ± 11.1		-	163	74.1 ± 14.4	387	77.9 ± 33.4	Otchere (1983); Rege *et al.* (1993b)
Ganawuri, Nigeria	Village	277	19.9 ± 7.5		-		-	129	85.3 ± 26.1	Rege *et al.* (1993b)
Madauchi, Nigeria	Village	399	18.2 ± 9.4		-		-	129	67.0 ± 29.5	Rege *et al.* (1993b)

[a]Number of observations
[b]Figures in parentheses are ranges

Table 7: *Post-weaning weights (±standard errors) of White Fulani cattle by location and management system*

Location/Country	Management system	12mo. weight (kg)		18mo. weight (kg)		24mo. weight (kg)		30mo. weight (kg)		36mo. weight (kg)		48mo. weight (kg)		Source
		n[a]	Mean ± se	n	Mean ± se	n	Mean ± se	n	Mean ± se	n	Mean ± se	n	Mean ± se	
Shika, Nigeria	Station	658	145.1±0.4	392	188.8±0.9	345	226.8±1.5	313	267.0±2.2	256	302.4±2.2	138	336.5±4.1	Wheat *et al.* (1972); Oni *et al.* (1988)
Kabomo, Nigeria	Station	22	214.2±6.2	9	255.6±8.0	8	333.9±8.1		-		-		-	Wheat & Broadhurst (1968)
Birnin Kudu, Nigeria	Station	69	180.5±3.2	62	236.5±4.1	42	278.1±5.3	30	300.0±9.4	26	322.0±9.4	11	335.2±12.9	Wheat & Broadhurst (1968)
Abet, Nigeria	Village	213	92.5±1.9	213	113.4±1.6		-		-		-		-	Otchere (1983); Rege *et al.* (1993b)
Kurmin Biri, Nigeria	Village	317	96.5±2.2	317	114.3±1.6		-		-		-		-	Otchere (1983); Rege *et al.* (1993b)
Ganawuri, Nigeria	Village	98	97.5±2.8		-		-		-		-		-	Rege *et al.* (1993b)
Madauchi, Nigeria	Village	109	82.1±3.4		-		-		-		-		-	Rege *et al.* (1993b)
Mando, Nigeria	Ranching	53	136.0±4.2	53	174.8±5.6		-		-		-		-	Otchere (1983)

[a]Number of observations

Table 8: *Reproductive characteristics (±standard deviations) of White Fulani females*

Traits	n[a]	Mean ± sd	Source
Age at first service, months		26.2 ± 4.9	Aganga *et al.* (1986)
Length of productive life, no. of lactations (no. of years)		5.0 - 5.8 (9-10 yrs)	Payne (1970); Ngere (1975)
Length of oestrous cycle, days	130	20.8 ± 2.0 (18.0 -22.9)[b]	Johnson & Gambo (1979); Zakari *et al.* (1981); Oyedipe *et al.* (1987); Adamu *et al.* (1990a, b).
Duration of oestrous, hours	3	8.3 ± 4.6 (3.1 - 12.0)	Payne (1970); Johnson & Gambo (1979); Zakari *et al.* (1981)
Intensity of oestrous		4.12 ± 0.03	Zakari *et al.* (1981)
Interval from parturition to first oestrous, days	148	74.0 ± 51.3 (15.0 - 137.6)	Adeyemo (1986); Dawuda *et al.* (1987); Dawuda *et al.* (1988a,b); Adamu *et al.* (1990a,b).
Interval from parturition to conception, days		43.8 ± 15.2 (146.7 ± 80.7)	Adeyemo (1986); Eduvie & Dawuda (1986)
Interval from parturition to complete uterine involution, days	74	26.0 ± 1.1 (25.9 - 35.5)	Eduvie (1985); Dawuda *et al.* (1988b)
Interval postpartum to detection of first follicles, days	38	44.9	Eduvie (1985)
Interval postpartum to first ovulation, days	68	65.8	Eduvie (1985)
Interval from first follicle to first ovulation, days	36	43.3	Eduvie (1985)
Number of ovulations	82	1.7 ± 0.5	Adamu *et al.* (1990a,b).
Conception rate between 60 and 90 days postpartum, %	41	48.8 ± 26.1	Eduvie & Dawuda (1986)
Interval from parturition to first elevation of serum progesterone, days	6	37.0 ± 8.7	Adeyemo (1986)
Initiation and completion of caruncular re-epithelialization postpartum, days		10-21	Eduvie *et al.* (1984)

[a]Number of observations
[b]Figures in parentheses are ranges

Table 9: *Lactation milk performance (±standard deviation) of White Fulani cattle*

Location/Country	Management system	Milking system	Lactation yield (kg)		Lactation length (days)		Butterfat percent	Daily milk yield (kg)	Source
			n[a]	Mean ± sd	n	Mean ± sd			
Shika, Nigeria	Station	Hand & Machine	3704	992.6 ± 118.3 (720-2240)[b]	3203	249.5 ± 9.2 (196-365)	7.5	4.2±0.07	Faulkner & Brown (1953); Faulkner & Epstein (1957); Foster (1960); Miller (1961); Oyenuga (1967); SARS (1972); IAR (1976)
Vom, Nigeria	Station	Machine	389	835 ± 343 (635-1130)	347	246.0 (241-246)	-	3.4	Knudsen & Sohael (1970)
Ibadan, Nigeria	Station	Hand	1085	932.5 ± 115.9 (855-2950)	1085	244.7 ± 10.0 (239-427)	4.5	3.8	Hill (1956); Joshi *et al.* (1957); Dettmers & Williams (1978); Ngere (1985a); Mrode (1988)
Ibadan, Nigeria	Station	Hand	94	1328.3 ± 16.8[c] (1310-1345)	38	240.0	5.6	5.5	Olaloku & Oyenuga (1973)
Accra, Ghana	Station	Most probably milked	498	623.2 ± 10.5	440	194 ± 64 (240-300)	-	3.7±0.5 (2.3-3.7)	Faulkner & Epstein (1957); Ngere (1985a)
Bambui, Cameroon	Station (supplemented)	Hand	-	465-555	-	173-200	-	-	Maximuangu & Chaloux (1978)
Bambui, Cameroon	Station	Hand	8	536.5 ± 114.3	8	175.5 ± 38.6	-	3.2±0.13	Tawah & Mbah (1989)
Jos Plateau, Nigeria	Village	Hand	-	-	-	-	4.5-5.9	0.27-0.87	Pullan (1979); Pullan & Grindle (1980); Synge (1980)
Jos Plateau, Nigeria	Village (supplemented)	Hand	-	-	-	-	-	0.87-1.06	Pullan (1979); Pullan & Grindle (1980); Synge (1980)
Kaduna, Nigeria	Village	Hand	-	-	-	-	-	0.34-0.42	Otchere (1983)
Kaduna, Nigeria	Village (supplemented)	Hand	-	-	-	-	-	0.54-0.75	Otchere (1983)
Zaria, Nigeria	Village (supplemented)	Hand	-	-	-	-	-	0.50-1.07	van Raay (1975)

[a]Number of observations
[b]Figures in parentheses are ranges
[c]Fat-corrected milk yield

GUDALI CATTLE OF WEST AND CENTRAL AFRICA

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SUMMARY

The objective of this paper was to compile the available information in the conventional and non-conventional literature on the origin, distribution, ecological settings, utility, husbandry practices and production systems of the Gudali, a West and Central African shorthorned zebu which is similar in conformation, size and origin to the East African shorthorned zebu. These animals are reputed not only for their beef and dairy qualities but also for their hardiness to the harsh northerly environments. Under the prevailing circumstances in the pastoral systems, natural selection is the primary force affecting any genetic change and, as a result, animals tend to perform relatively poorly. Most of the documented studies have been limited in scope and applicability. Therefore, further studies are needed to adequately characterize these animals under their different production systems.

RESUME

L'objectif de cet article est de recueillir l'information disponible dans la littérature conventionnelle et non-conventionnelle au sujet de l'origine, la distribution, le contexte écologique, l'utilité, les pratiques de conduites et les systèmes de production de la race Gudali, zébu à courtes cornes de l'Afrique orientale et centrale, semblable du point de vue de la conformation, l'origine et la taille au zébu à courtes cornes de l'Afrique de l'est. Ces animaux sont réputés non seulement pour leur viande et leur qualité laitière, mais aussi pour leur résistance aux dures conditions environnementales du nord. Dans les conditions de systèmes pastoraux, la sélection naturelle est la force principale qui influence n'importe quel changement génétique et les animaux présentent des performances très limitées. La plupart des études réalisées ont eu un objectif très limité et peu d'applicabilité. Il est donc nécessaire de réaliser d'autres études afin de caractériser ces animaux sous les différents systèmes de production.

1.0 INTRODUCTION

The African indigenous livestock populations are not only in danger of complete dilution by imported exotics or complete extinction, they are also poorly characterized and not systematically classified. Halting the persistent decimation of potentially invaluable indigenous African animal germplasm and standardizing their classifications will require a "comprehensive" knowledge of not only their physical, biological and adaptive characteristics but also of the ecoclimatic environments in which they have survived and reproduced for several millennia. This is necessary to facilitate the development of strategies for the conservation and improvement of those breeds with high genetic potentials. In addition, it will facilitate the identification of genetic markers of adaptive traits for incorporation into breed improvement schemes. The objective of this paper is to compile available information in the conventional and non-conventional literature with the aim of identifying information gaps that will need to be filled to adequately characterize these populations.

2.0 ORIGIN AND CLASSIFICATION

Three ancestral bovine types which migrated into Africa from western Asia several centuries ago (Curson and Thorntorn, 1936; Faulkner and Epstein, 1957; Williamson and Payne, 1974; Payne, 1990) are believed to have contributed significantly to the present-day cattle types in the continent (Stewart, 1937; Williamson and Payne, 1974). These are the Hamitic or Egyptian Longhorns (*Bos taurus longifrons*) and the Brachyceros Shorthorns (*Bos taurus brachyceros*) which are both considered as the ancestral *Bos taurus* types, and the humped (*Bos indicus*) or zebu type (Payne, 1964). The latter have two recognized sub-types, namely, the lateral-horned cervico-thoracic-humped (the first humped type to arrive into Africa) and the thoracic-humped. The thoracic-humped (or zebu) sub-type is a comparative newcomer which is believed to have entered into Africa only about 1500 (Epstein and Mason, 1984) to 2500 years ago from India.

The precise centre of domestication of the zebu is unknown. However, it is believed that humped cattle, like their humpless counterparts, were first domesticated in western Asia, about 5000-6000 years ago (Payne, 1970) and that they migrated with Arab and Indian traders from the Indian sub-Continent in successive waves (Payne, 1964) into Africa via the Horn of Africa, i.e., present-day Ethiopia and Somalia (Epstein and Mason, 1984; Mason, 1987). From the Horn these animals subsequently dispersed northward into lower Egypt (Faulkner and Epstein, 1957) and, comparatively recently, westward into the West and Central African region (Curson and Thornton, 1936; Epstein, 1971; Payne, 1990). The zebu probably reached the semi-arid West Africa before 1000 AD (Epstein, 1971). The westerly migration followed the route south of the Sahara and north of the great rainforest belt (Payne, 1964) in an attempt to avoid tsetse-infested humid coastal zones. Another wave of migration into western Asia probably took place and might account for the presence of zebu cattle in Iraq and Iran (Payne, 1990).

The two major cattle groups in West and Central Africa today are the "humpless" (*Bos taurus*) or taurine and "humped" (*Bos indicus*) or zebu cattle, including their derivatives. Mason (1951) has classified the zebu into short- and lyre-horned sub-groups. Whereas the former have similar origin, physical appearance and conformation to the East African and Indo-Pakistan shorthorned zebus (Irfam, 1967; Payne, 1970), the latter apparently have evolved from an intermixture of the shorthorned zebu and the Hamitic longhorned cattle. Amongst the

shorthorned zebus of West and Central Africa are the Gudali which are found mainly in Nigeria and Cameroon. Also included are the Maure of Senegal, Mali and Mauritania, the Tuareg of Mali, the Djelli of Niger, the Azawak of Mali, Niger and Nigeria and the Shuwa of Nigeria, Chad and Cameroon (Epstein, 1971; ILCA, 1992a). They probably have a common ancestry (Gates, 1952).

Gudali is a Hausa word which means for shorthorned and short-legged cattle. It is generally used to embrace a large group of shorthorned zebus which is collectively known as the Fulbe or Peuhl zebu in West and Central Africa. There are two major sub-types of the Gudali. These are the Sokoto and the Adamawa Gudali. The latter is comprised of three strains, namely, the Ngaundere, Banyo and Yola Gudali. Whereas all three strains have been found in Cameroon, only the latter two exist in Nigeria (RIM, 1992).

The Adamawa Gudali has inhabited the Adamawa mountain ranges stretching from Nigeria to Cameroon, hence its name. Indeed, the various names (Mason, 1988) used to designate these cattle populations are primarily based either on place of origin (e.g. Sokoto Gudali, Adamawa Gudali, Ngaundere Gudali, Banyo Gudali, Yola Gudali), or name of owning tribe (e.g. Fulbe Gudali, Peul, Poulfoulo, Fulani Gudali), or, in some cases, predominant colour markings (e.g. Tattabareji, which is a Fulani word for speckled coat colour, is used as synonym for Yola Gudali).

3.0 POPULATION STATISTICS AND DISTRIBUTION

Accurate estimates of the Gudali population are not available, mainly because of the constant movement of these animals with their pastoral owners inside and outside their ecological zones and the overlap in the distribution of the different sub-types. In view of the overlap in breed boundaries, available figures (table 1) are likely to be overestimates of the Gudali population.

4.0 ECOLOGICAL SETTINGS

The climate in the zone occupied by the Gudali is marked by a dry and a wet season. The north-south rainfall gradient is considerable, with the northern region receiving substantially less rainfall and having a much shorter wet season compared to the forest belt and coastal area in the south.

The rainfall gradient, the relative humidity and the length of the dry season tend to influence the vegetation of the zone. The natural vegetation is dry grassland in the north interspersed with montane grasslands on the Jos and Mambila Plateaux and open woodland on the Adamawa Plateau. The common grasses are *Pennisetum spp.*, *Paspalum spp.*, *Hyparrhenia spp.*, *Brachiaria spp.*, *Panicum phragmitoides*, *Loudetia arundinacea* and *Andropogon gayanus*.

The Plateaux are relatively free of major animal diseases (Faulkner and Epstein, 1957), although blackquarter and foot-and-mouth diseases are still endemic. Tsetse are not found in the northern arid zone and have been eradicated from most of northeastern Nigeria (RIM, 1992). However, savannah tsetse like *Glossina morsitans* and the riverine species like *G. tachinoides* and *G. palpalis* are found in the subhumid zone. Indeed, the pattern of cattle distribution in the region is mainly determined by the tsetse distribution (Rege *et al.*, 1994). Dermatophilosis which is a skin disease caused by *Dermatophila congolense* is also common

in the zone. Tick-borne diseases such as cowdriosis and babesiosis are equally widely spread (Tawah and Mbah, 1989), as are endoparasites.

5.0 UTILITY, HUSBANDRY PRACTICES AND PRODUCTION SYSTEMS

Gudali cattle are primarily used for milk and meat. However, they are also exploited for draft purposes, particularly ploughing and, to a lesser extent, carting in some areas, for the Gudali is a sturdy and docile animal (Gates, 1952; Oyenuga, 1967; Payne, 1970; Domingo, 1976). Despite their sturdy and docile nature, characteristics which make the Gudali suitable for draught, they are slow and sluggish. The bullocks are usually put to work at about three to four years of age (Payne, 1970). Gudali cattle respond reasonably to intensive feeding (Lhoste and Dumas, 1972; Olayiwole *et al.*, 1981) and are believed to be amongst the most promising beef breeds in the region (Leclercq, 1976; Olutogun, 1976; Pagot, 1985).

About 90% of Gudali cattle are traditionally kept by Fulani and Hausa pastoralists (Ngere, 1985a). The most significant feature of the traditional husbandry system is the communal ownership and use of grazing lands. At the approach of the dry season herders undertake a short distance transhumance, particularly into the flood valleys (*yaérés*) of the tributaries of river Benoue (Pagot, 1992) in northern Nigeria and Cameroon. The dry season movements involve long treks from the homestead usually southwards. When the rains return, there is a reverse movement, with cautious efforts to avoid tsetse-infested and flooded areas. During transhumance, suckling or lactating cows stay in the village (Faulkner and Epstein, 1957). However, most herds tend to be sedentary most of the year. The Sokoto Gudali is reputed to be specialized in eating browse and the herders are commonly seen lopping trees towards the end of every dry season (RIM, 1992). Breeding is not controlled, although castration of unwanted bulls is often practised.

6.0 PHYSICAL CHARACTERISTICS

6.1 Body size

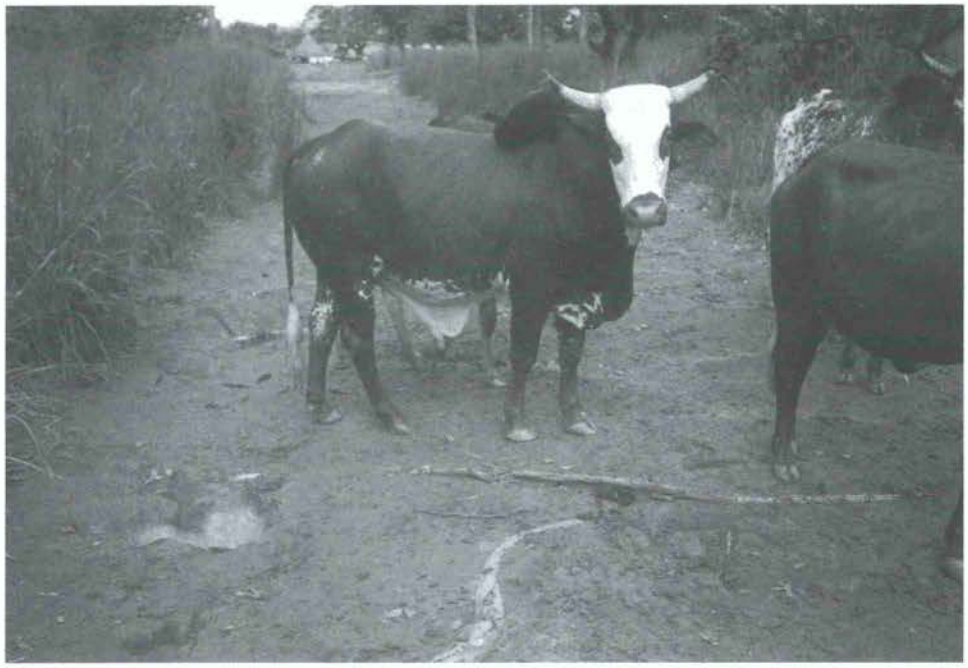
The substantial variation as reflected in the range in mature (adult) body measurements (table 2), especially in the mature weight of the Gudali, is most probably associated with the wide range in "mature age" arising partly from the differences in the definition of maturity at farm level.

6.2 Conformation

Despite differences in conformation and other physical features (table 3), the Gudali is generally a long, well balanced and relatively compactly built animal, with a deep and wide body and well-sprung ribs. They are deeper-bodied than the White Fulani (Faulkner and Epstein, 1957; Oyenuga, 1967), with a close-to-the-ground appearance. They closely resemble the East African Boran in conformation, size and type (Payne, 1970; Domingo, 1976), to a large extent, and the Sudanese Kenana (Faulkner and Epstein, 1957), to a lesser extent.

6.3 Coat colour

Gudali cattle have multiple coat colour markings (table 3).



Banyo Gudali bull

Ngaundere Gudali cow

7.0 ADAPTIVE CHARACTERISTICS

Rectal temperatures (RT) of 38.0-39.0 and 38.5-39.1°C and respiration rates (RR) of 19.9-38.3 and 24.9-42.6 flank movements per minute, respectively in the cool and hot seasons in Nigeria have been reported for Sokoto Gudali (Buvanendran *et al.*, 1992). Based on these values, corresponding coefficients of adaptability (CA) for the breed of 1.77-2.69 and 2.09-2.87 have been estimated using the formula: (RT/38.33) + (RR/23.0) - a higher value of which indicates poor adaptability. A corresponding sweating rate of 54.7-93.3 and 170.8-224.1 $g/m^2/hr$ has also been recorded. These results suggest that the Sokoto Gudali compared to the White Fulani are less adapted to the Guinea savannah (e.g. Ngere, 1985a; Buvanendran *et al.*, 1992). This may partly account for their limited dispersion beyond their present habitat. It has also been suggested that the Sokoto Gudali have relatively less tolerance to trypanosomiasis than the White Fulani (Stewart, 1937; Faulkner and Epstein, 1957) and the "humpless" Shorthorns and Longhorns in the region.

Cumulative mortality rates at one year of age in Ngaundere Gudali have ranged from 3.5% at Wakwa station to 10.9% at Bambui station in Cameroon (Tawah and Mbah, 1989). In Sokoto Gudali, they have varied from 6.2% at the research station in Ghana (ILCA, 1992b) to 24.6% at Obudu ranch in Nigeria (Iloeje, 1985). The figures indicate substantial variation most probably due to between-environment differences. The differences in calf mortality rates point to the inability of the Gudali to survive outside their traditional niches. Adult mortality rate has ranged from 1.6 to 3.6% for Ngaundere Gudali on-station in Cameroon (Tawah and Mbah, 1989).

8.0 PERFORMANCE CHARACTERISTICS

8.1 Growth and live weights

The growth performance of the Gudali is presented in table 4. These results point to the possible superior mothering ability of Banyo Gudali cows as compared to Ngaundere Gudali cows. The growth performance of Gudali seems to be inferior to that of most European beef cattle breeds and their crosses with zebus under similar management conditions in the tropics.

8.2 Carcass characteristics

Carcass performance under different feeding regimes for the Gudali are presented in table 5. The increase in carcass weights under improved conditions has not been translated into improved dressing-out percentages in the Gudali. A similar trend has been observed with the White Fulani in the region (Tawah and Rege, 1994). Carcass yields of the Gudali are lower than those of the White Fulani (Buvanendran *et al.*, 1983), but the hides of the Gudali are much heavier than those of the White Fulani.

8.3 Reproductive characteristics

The reproductive performance of the Gudali is presented in table 6. Age at first calving and calving interval have manifested substantial variations both within and across breed types. It was evident that Gudali cattle attain sexual maturity at a much later age than the "humpless" West African Shorthorns under similar conditions (Rege *et al.*, 1994). The long calving interval may be attributed to the postpartum period of ovarian inactivity

(anoestrus) in the Gudali (Eduvie, 1985). The length of the interval between successive calvings indicates that, on average, Gudali cows calve every other year.

Perinatal mortality, including abortions and stillbirths, in Ngaundere Gudali has ranged from 4.7 to 5.9% under station conditions (Tawah and Mbah, 1989; Mbah *et al.*, 1991). These figures may partly account for the low fertility rate obtained for the Gudali. Annual weaning rate - percentage calf crop weaned to number of calves born per year - has ranged from 49 to 53% in Ngaundere Gudali (Lhoste, 1980; Tawah and Mbah, 1989) and 55% in Sokoto Gudali (Osmanu, 1979) under station conditions, a reflection of high calf losses from birth to weaning in the Gudali. Such losses tend to slow down efforts at genetic improvement of the breed (Tawah *et al.*, 1994). RIM (1992) has reported a 32% mortality rate in less-than-ten-months-old Gudali calves under traditional pastoral management. No recent estimates of length of productive life of Sokoto Gudali exist. However, available figures have averaged about 10 years (Faulkner and Epstein, 1957; Irfam, 1967; Oyenuga, 1967).

There was a general absence of information in the literature reviewed on male reproductive performance. However, age at first service in Sokoto Gudali bulls has been estimated at 36 months under improved grazing in Ghana (Irfam, 1967).

8.4 Milk production

The range in milk yield and lactation length of the Gudali (table 7) indicates substantial variation in these traits. These figures point to the opportunity for genetic improvement of milk traits through stringent selection. It is apparent from the limited data that the dairy qualities of Adamawa Gudali are inferior to those of Sokoto Gudali and that, in general, the Gudali is a relatively poor milker compared to the White Fulani and the other important zebu breeds in the region.

Information was generally lacking on the milk composition of the Gudali. The only available figures for milk butterfat for the Sokoto Gudali was in the range of 5.4 to 6.5% (Faulkner and Epstein, 1957; Payne, 1970; Epstein, 1971; Ngere, 1985a).

9.0 SPECIAL GENETIC CHARACTERISTICS

Studies by Braend and Khanna (1968), Braend (1971) and Queval (1982) on haemoglobin and transferrin polymorphisms of zebu and taurine cattle of Western and Eastern Africa have pointed to the possibility that the Gudali may share the same evolutionary path with the zebus of India, Pakistan and Eastern Africa. There is also evidence that zebu cattle are distinct from the "humpless" Shorthorns and Longhorns of West and Central Africa. For example, haemoglobin (Hb) gene frequencies are similar in the zebus, with a substantial presence of both Hb^A (0.52-0.60) and Hb^B (0.32-0.44) compared to the taurine with a predominance of Hb^A (0.72-0.99). There is a complete absence of Hb^D in the zebu and of Hb^B and Hb^C in the Muturu, a taurine breed.

Transferrin (Tf) allele frequencies are similar in the zebus, with Tf^A (at a frequency of 0.17-0.24), Tf^B (0.03-0.21), Tf^D (0.14-0.23), Tf^E (0.23-0.25) and Tf^F (0.25) alleles being present in the Gudali. Alleles Tf^B and Tf^F are completely absent in the Muturu, N'Dama and the European taurine breeds (Queval, 1982). Whereas the Y chromosomes are acrocentric in the zebus, they are sub-metacentric in the West African taurine breeds Baoulé and N'Dama as well as the European taurine breeds (Popescu, 1980). The blood factor Z' is common in

the Gudali and Fulani zebus but absent in the Muturu and N'Dama (Braend and Khanna, 1968).

The aforementioned polymorphic systems may be useful as markers in the investigation of genetic relationships amongst these populations and for studying the purity of these breeds. They may also contribute in the tracing of the micro-evolutionary histories of the Gudali populations. Thus, they may be useful in the development of strategies for the enhancement, utilization and conservation of the Gudali. There is hardly any DNA work published on these breeds. So, as part of breed characterization, there is a need for genetic distance studies to determine the relationships between the various breeds, strains or populations of the Gudali.

10.0 REFERENCES

Braend M. 1971. Haemoglobin variants in cattle. Anim. Blood Groups and Biochem. Genetics 2:15-21.

Braend M. and Khanna N.D. 1968. Haemoglobin and transferrin types of some West African cattle. Anim. Prod. 10(2):129-134.

Buvanendran V., Adamu A.M. and Abubakar B.Y. 1992. Heat tolerance of Zebu and Friesian-Zebu crosses in the Guinea Savanna Zone of Nigeria. Trop. Agric. (Trinidad) 69(4):394-396.

Buvanendran V., Ikhatua U.J., Abubakar B.Y. and Olayiwole M.B. 1983. Carcass characteristics of indigenous breeds of cattle in Nigeria. J. Agric. Sci. (Cambridge) 100:407-411.

Buvanendran V., Umoh J.E. and Abubakar B.Y. 1980. An evaluation of body size as related to weight of three West African breeds of cattle in Nigeria. J. Agric. Sci. (Cambridge) 95:219-224.

Capitaine P. 1972. Projet de Développement de l'Elevage au Ghana. Etudes de factibilité de quatre ranches. Etude Zootechnique, IEMVT, France, 103pp.

CRZW. 1974. Rapport d'activités trimestrielles, 1973/74. Centre de Recherches Zootechniques de Wakwa, Cameroon.

Curson H.H. and Thornton R.W. 1936. A contribution to the study of African native cattle. Onderstepoort J. Vet. Sci. Anim. Industry 7(2):613-739.

Domingo, M.A. 1976. Contribution à l'Etude de la Population Bovine des Etats du Golfe du Bénin. Agence de Coopération Culturelle et Technique, France, 143pp.

Dumas R. and Lhoste P. 1966. Variations du poids vifs et du rendement en viande de boeufs Zébus de l'Adamaoua au cours de la saison séche. Rev. Elev. Méd. vét. Pays trop. 19(4):573-579.

Eduvie L.O. 1985. Factors affecting postpartum ovarian activity and uterine involution in Zebu cattle indigenous to Nigeria. Anim. Reprod. Sci. (The Netherlands) 8:123-128.

Epstein H. 1971. The Origin of the Domestic Animals of Africa. Volume I. Africana Publishing Corporation, New York (USA), p.327-556.

Epstein H. and Mason I.L. 1984. Cattle. p. 6-27. In: Evolution of domesticated animals. Mason, I.L. (ed.). Longman Group Ltd, New York (USA), 452pp.

Faulkner D.E. and Epstein H. 1957. The indigenous Cattle of the British Dependent Territories in Africa. Colonial Advisory Council of Agriculture, Animal Health and Forestry. HMSO Publication No. 5, 186pp.

Gates G.M. 1952. Breeds of cattle found in Nigeria. Farm and Forest 11:19-43

Hall S.J.G. 1991. Body dimensions of Nigerian cattle, sheep and goats. Anim. Prod. 53:61-69.

Huebl K. 1973. L'embouche intensive des Zébus Gudali à Mokwa (Nigéria). Actes du Colloque sur l'Embouche intensive des Bovins en Pays Tropicaux, 4-8 décembre, Dakar, Sénégal, p.295-296.

ILCA. 1992a. Livestock Population Statistics for Sub-Saharan Africa: A Computerized Data Base. International Livestock Centre for Africa, Addis Ababa, Ethiopia.

ILCA. 1992b. Trypanotolerant Livestock in West and Central Africa Volume 3 - A Decade's Results. ILCA Monograph 2, 116pp.

Iloeje M.U. 1985. Heterosis from crosses among Zebu and South Devon beef cattle in South Eastern Nigeria. 1. Fertility and calf performance to weaning. J. Anim. Prod. Res. (Nigeria) 5 (2):151-158.

Irfam M. 1967. Improvement of cattle in Ghana. The Ghana Farmer 11(2):53-57.

Johnson A.O., Buvanendran V. and Dim N.I. 1986. Evaluation of dairy potential of Bunaji and Sokoto Gudali breeds. National Animal Production Research Institute (NAPRI), Shika-Zaria, Nigeria, Annual Report, 1986, p.23-28.

Johnson A.O., Buvanendran V. and Oyejola B.A. 1984. Dairy potential of Bunaji (White Fulani) and Bokoloji (Sokoto Gudali) breeds. Trop. Agric. (Trinidad) 61 (4):267-268.

Joshi N.R., McLaughlin E.A. and Phillips R.W. 1957. Types and breeds of African cattle. FAO Agricultural Studies No. 37. Rome, Italy.

Lamorde A.G. and Franti C.E. 1975. Nomadism and cattle production in Nigeria. Proceed. 1st Annual Conf. Nigerian Soc. Anim. Prod., Enugu, 14-17 July, p.14-17.

Leclercq P. 1976. Principales races d'animaux domestiques des zones tropicales. Institut d'Elevage et de Médecine vetérinaire des Pays tropicaux (IEMVT), France, ENS/II-35, p.35-36.

Lhoste P. 1980. L'amélioration génétique des Zébus de l'Adamaoua (Cameroun) pour la production de la viande. Premier Colloague International: Recherches sur l'Elevage Bovin en Zone Tropicale Humide, 18-22 Avril, Bouaké, Côte d'Ivoire, p.761-769.

Lhoste P. 1973. Essai de finition de boeufs Zébus avec utilisation maximale de mélasse. Acts du Colloque sur l'Embouche Intensive des Bovins en Pays Tropicaux, 4-8 décembre, Dakar, Sénégal, p.139-147.

Lhoste P. 1968. Comportement saisonnier du bétail Zébu en Adamaoua Camerounais. II. La croissance avant sevrage pour les veaux de race locale et les métis demi-sang Brahma. Rev. Elev. Méd. vét. Pays trop. 21(4):499-517.

Lhoste P. 1967. Comportement saisonnier du bétail Zébu en Adamaoua Camerounais. I Etude des femelles adultes: Comparaison de la race locale aux métis demi-sang Brahma. Rev. Elev. Méd. vét. Pays trop. 20(2):329-342.

Lhoste P. and Dumas R. 1972. Embouche intensive des Zébus de l'Adamaoua. I. Comparaisons de différents systémes d'alimentation (1970). Rev. Elev. Méd. vét. Pays trop. 25(2):259-280.

Lhoste P., Dumas R. and Haon P. 1972. Embouche intensive des Zébus de l'Adamaoua, II. Influence de la durée de la période d'embouche (1971). Rev. Elev. Méd. vét. Pays trop. 25 (2):281-293.

Lhoste P. and Pierson J. 1973. Embouche intensive de jeunes mâles: Comparaison de taurillons et bouvillons de trois races. Actes du Colloque sur l'Embouche Intensive des Bovins en Pays Tropicaux, 4-8 décembre, Dakar, Sénégal, p.233-236.

Lhoste P., Pierson J., Atekwana J. and Munji M. 1976. Expérimentation de l'alimentation intensive des bovins au Cameroun. Rapport de Synthèse. Centres de Recherches Zootechniques de Wakwa et de Bambui, Cameroun, 21pp.

Mandon A. 1957. Le Zébu Brahma au Cameroun: Premiers résultats de son introduction en Adamaoua. Rev. Elev. Méd. vét. Pays trop. 10:129-145.

Mason I.L. 1987. Domestication and breed formation in cattle. Wld Rev. Anim. Prod. 23(3):71-76.

Mason I.L. 1988. A World Dictionary of Livestock Breeds, Types and Varieties. (3rd ed.) CAB International, The Cambrian News Ltd, United Kingdom, 348pp.

Mason I.L. 1951. The Classification of West African Livestock. Commonwealth Bureau of Animal Breeding and Genetics. Commonwealth Agricultural Bureau, Farnham Royal, England, Technical Communication No.7, p.1-10.

Mbah D.A., Abassa P.K., Zamba P., Tawah C.L., Messine O. and Oumate H. 1991. Factors affecting the reproductive performance of Zebu cattle on the Adamawa Plateau. Proceed. 2nd Annual Conf. Cameroon Biosci. Soc., 22-29 November, 1990, Dschang University Centre, Cameroon 2:217-225.

McCulloch J. 1951. Livestock Breeding Policy at Jakiri Livestock Breeding Investigation Centre, Nigeria (Unpublished).

Millar D. 1979. Relationships between inbreeding levels and some reproductive performance traits in West African Shorthorn and Sokoto Gudali cows at Agricultural Research Station, Legon, Ghana. BSc Dissertation, University of Ghana, Legon, 52pp.

Miller T.B. 1961. Study on the nutrition of Zebu cattle in northern Nigeria. I. Energy intake and milk production. Emp. J. Exp. Agric. 29:230-240.

Ngere L.O. 1985a. The Gudali of Nigeria - Review. In: Animal Genetic Resources in Africa - High Potential and Endangered Livestock. Proceed. 2nd OAU Expert Committee Meeting, 24-28 November, 1983, Bulawayo, Zimbabwe, p.77-81.

Ngere L.O. 1985b. The White Fulani (Bunaji) of Nigeria. In: Animal Genetic Resources in Africa -High Potential and Endangered Livestock. Proceed. 2nd OAU Expert Committee Meeting, 24-28 November, 1983, Bulawayo, Zimbabwe, p.67-77.

Olayiwole M.B., Buvanendran V., Fulani J.I. and Ikhatua J.U. 1981. Intensive fattening of indigenous breeds of cattle in Nigeria. Wld Rev. Anim. Prod. 17(2):71-77.

Olayiwole M.B., Olorunju S.A.S., Kera B.S., Agishi E.C. and Adesipe Y.M. 1986. Economics of feedlot technology. NAPRI, Shika-Zaria Annual Report, 1986, p.131-132.

Olutogun O. 1976. Reproductive performance and growth of N'Dama and Keteku cattle under ranching conditions in the Guinea savannah of Nigeria. Ph.D. Thesis, University of Ibadan, Nigeria, 126pp.

Oni O.O., Buvanendran V. and Dim N.I. 1988. The influence of some environmental factors on growth rate of two Nigerian cattle breeds and the hybrid with the Charolais. J. Anim. Prod. Res. (Nigeria) 8(2):121-131.

Osmanu S.T. 1979. Studies on bovine infertility at the Agricultural Research Station (Legon) over half a decade (1972-1977). BSc. Dissertation. University of Ghana, Legon, 82pp.

Oyenuga V.A. 1967. Agriculture in Nigeria: An Introduction. FAO, Rome, Italy, p.240-253.

Pagot J. 1992. Animal Production in the tropics and subtropics (translated by Wilding, J.). The MacMillan Press Ltd, London, p.351-358.

Pagot J. 1985. L'Elevage en Pays Tropicaux. Editions G.P. Maisonneuve et Larousse, Paris, France, p.380-383.

Payne W.J.A. 1990. An Introduction to Animal Husbandry in the Tropics. 4th edition. Tropical Agricultural Series, Longman Group Ltd, New York (USA), 881pp.

Payne W.J.A. 1970. Cattle Production in the Tropics. Volume I. Tropical Agricultural Series, Longman Group Ltd, New York (USA), 336pp.

Payne W.J.A. 1964. The origin of domestic cattle in Africa. Emp. J. Exp. Agric. 32:97-113.

Pierson J.N. 1980. Bilan succinct d'un essai de contrôle de lactation sur des vaches de trois groupes génétiques différents. Premier Colloque International: Recherches sur l'Elevage Bovin en Zone Tropicale Humide, 18-22 Avril, Bouaké, Côte d'Ivoire, p.771-776.

Popescu C.P. 1980. Etude cytogénétique d'un lot de bovins Africains. Résultats préliminaires. Premier Colloque International: Recherches sur l'Elevage Bovin en Zone Tropicale Humide, 18-22 Avril, Bouaké, Côte d'Ivoire, p.821-822.

Queval R. 1982. Polymorphismes de la transferrine chez les bovins trypanosensibles et trypanotolérants de l'Afrique de l'Ouest. Répartition et fréquence de leurs allèles. Rev. Elev. Méd. vét. Pays trop. 35 (4):373-380.

Rege J.E.O., Aboagye G.S. and Tawah C.L. 1994. Shorthorn cattle of West and Central Africa II. Ecological settings, utility, management and production systems. World Anim. Rev. 78:14-21.

RIM. 1992. Nigerian Livestock Resources (6 vols). Report by Resource Inventory and Management Limited (RIM) to FDLPCS, Abuja, Nigeria.

Sada I. 1968. The length of the gestation period, calving interval and service period in indigenous West African cattle: N'Dama, West African Shorthorn and Sokoto Gudale. Ghana J. Agr. Sci. 1:91-97.

Stewart J.L. 1937. The cattle of the Gold Coast. Vet. Rec. 49(41):1289-1297.

Tawah C.L. 1992. Genetic evaluation of growth performance of Gudali and two-breed synthetic Wakwa beef cattle populations under selection in Cameroon. A Research Fellowship Report. ILCA, Addis Ababa, Ethiopia, 105pp.

Tawah C.L. and Mbah D.A. 1989. Cattle breed evaluation and improvement in Cameroon: A review of the situation. Institute of Animal Research (IRZ), Wakwa, Cameroon, 29pp.

Tawah C.L. and Rege J.E.O. 1994. White Fulani cattle of West and Central Africa. Animal Genetic Resources Information, No. 17, FAO, Rome, Italy.

Tawah C.L., Rege J.E.O., Mbah D.A. and Oumate H. 1994. Genetic evaluation of birth and weaning weight of Gudali and two-breed synthetic Wakwa beef cattle populations under selection in Cameroon: genetic and phenotypic trends. Anim. Prod. 58:25-34.

Wheat J.D. and Broadhurst J. 1972. An analysis of data on Sokoto Gudali cattle at Bulassa and Dogondaji, North Western State, Nigeria. Institute for Agricultural Research, Samaru, Ahmadu Bello University, Zaria, Nigeria. Samaru Miscellaneous Paper 39, 11pp.

Williamson G. and Payne W.J.A. 1974. An Introduction to Animal Husbandry in the Tropics. Tropic Agricultural Series, Longman Group Ltd, 447pp.

Table 1: *Distribution and population figures of Gudali cattle in West and Central Africa*

Breed type	Synonym	Number	Country	Year	Source	Habitat
Sokoto Gudali	Bokoloji, Sokoto	1 000 000	Nigeria	1985	Ngere (1985a)	Found mainly in Nigeria: Sokoto, Mambila and Adamawa regions; Northwestern Nigeria, Northeastern Nigeria, Northcentral Nigeria and Benue Plateau
		1 743 375	Nigeria	1992	ILCA (1992a)	
		4 351 523	Nigeria	1992	RIM (1992)	
		NA	Northern Benin			Northern Benin
		NA	Ghana			Ghana
		NA	Mali			Mali
Adamawa Gudali[1]		1 000 000	Nigeria	1985	Ngere (1985a)	Northeastern Nigeria; Adamawa and Sardauna regions of Nigeria and Gongola State
		1 603 905	Nigeria	1992	ILCA (1992a)	
		263 019	Nigeria	1992	RIM (1992)	
		2 942 000	Nigeria & Cameroon	1985	Pagot (1985)	
Banyo Gudali		NA	Nigeria			Mambila Highlands in the southern fringe of Nigeria
		140 420	Cameroon	1992	ILCA (1992a)	Banyo and Bamenda Highlands of Cameroon
Yola Gudali	Tattabareji	NA	Nigeria			Central and Muri Emirates of Nigeria Tignere of Cameroon
		NA	Cameroon			
Ngaundere Gudali	Peuhl, Fulbe, Poulfoulo, Fulani Gudali, Goudali	550 000	Cameroon	1957	Mandon (1957)	Ngaundere and Bamenda Highlands of Cameroon
		598 980	Cameroon	1992	ILCA (1992a)	
		400 000	Central African Republic	1992	ILCA (1992a)	Central African Republic
		NA	Congo			Congo

NA indicates that population figures are not available

[1]Adamawa Gudali is generally used in Cameroon to refer to the Banyo, Yola and Ngaundere Gudali

Table 2: *Mean ranges of mature weight and body measurements of Gudali cattle*

Trait	Sex/category	Adamawa Gudali			Sokoto Gudali
		Ngaundere	Banyo	Yola	
Mature weight, kg					
	Bulls	400-563	400-408	350-352	499-660
	Cows	330-408	360-363	335-336	241-353
	Oxen	350-499	453	-	509-662
Height at withers, cm					
	Bulls	133-136	-	122	130-137
	Cows	123	-	120	117-131
	Oxen	122-131	-	-	-
Heart (chest) girth, cm					
	Bulls	190-194	-	-	190
	Cows	170	-	-	144-166
	Oxen	170-184	-	-	-
Body length, cm					
	Bulls	158-179	-	88	154
	Cows	145	-	76	124-145
Width at hips, cm					
	Bulls	42-55	-	41	46
	Cows	44	-	40	42-44

Adapted from: McCulloch, 1951; Gates, 1952; Faulkner & Epstein, 1957; Joshi *et al.*, 1957; Dumas & Lhoste, 1966; Lhoste, 1967; Oyenuga, 1967; Payne, 1970; Epstein, 1971; Captaine, 1972; Lhoste *et al.*, 1972; CRZW, 1974; Domingo, 1976; Leclercq, 1976; Olutogun, 1976; Buvanendran *et al.*, 1980; Lhoste, 1980; Ngere, 1985a; Pagot, 1985; Hall, 1991

Table 3: *Physical characteristics of Gudali cattle*

Attribute	Sokoto Gudali	Ngaundere Gudali	Banyo Gudali	Yola Gudali
Conformation	Topline slopes slightly from hump to sacrum; rump is somewhat shorter than that of White Fulani and sloping; body is generally of good capacity, thus, an excellent beef type; head is long and wide between the eyes and across the forehead, with a straight or slightly convex facial profile; head is generally carried very low on a narrow, short and solidly muscled neck, particularly in the bulls; muzzle is of good width.	Rump is less sloping and very well fleshed; flat and broad back, especially over the loins; head is well proportioned and long, averaging 50-62 cm, and narrow below eyes, averaging 21-25 cm in width, with a similar facial profile as in Sokoto Gudali; head is somewhat bigger than that of Banyo Gudali and carried on a narrow, short and solidly muscled neck, particularly in the bulls as in Sokoto Gudali.	Shoulders blend smoothly with the body; topline slopes slightly from hump to sacrum as in Sokoto Gudali; rump is of fair length and sloping; body is of uniform width throughout, with a well developed musculature; head is well proportioned as in Ngaundere Gudali, with a good width between the eyes and at the muzzle.	Considerable variation in body conformation, more closely resembling Banyo type than the other types in their constitutional make-up; they are shorter and smaller-bodied than the other subtypes.
Appendages (limbs, tails, ears)	Upper thighs are of fair width, but tend to narrow somewhat lower down; tail is long and well developed, terminating with a switch almost touching the ground; ears are long, large and convex, sometimes pendulous, although not to the same degree as in some of the Indo-Pakistan zebus.	Upper thighs are broad, fairly full and thick; they are well let down to the lower thighs; legs are shorter than those of the White Fulani but well set, with less fine but clean and strong bones.	Upper thighs are broad, fairly full and thick as in Ngaundere Gudali but narrow and lean as they descend; limbs are of moderate length with little impression of leggedness; bone quality is good but tends to be a little too fine for size and weight of body; prominent tail end, with a high setting.	Limbs are much shorter than in the other subtypes.
Hump	Hump is rounded from front to back with a slight fall at the back, firmly placed over the withers (thoracic in position) and musculo-fatty in structure, especially in the bulls.	Hump is very large and pendulous, generally hanging over on one side and having the appearance of being broken; it is thoracic in position and musculo-fatty in structure as in Sokoto and Banyo Gudali; it is shaped like a conical hat (phrygian shaped) in the bulls.	Hump is well developed in both sexes, more so in the males; as in Sokoto & Ngaundere Gudali, it is thoracic in position; it is firm, pyramidal in shape and tending to be upright.	Hump is moderately large and tends to be upright as in Banyo Gudali but smaller than in Ngaundere Gudali; it may be cervico-thoracic in position

Table 3 (continued)

Attribute	Sokoto Gudali	Ngaundere Gudali	Banyo Gudali	Yola Gudali
Horns	Horns are shorter than in Ngaundere Gudali; they are especially shorter in the bulls than in the cows; they are sometimes extremely short, with little curvature; generally, horns project in a lateral and upward direction from the head; they may be totally absent or polled; they are round but can sometimes be flattish or oval in cross-section, with blunt rather than sharp pointed tips	Horns are short to medium in length and crescent-shaped; they are not thick; they project outwards, upwards and slightly forwards; some animals have downward hanging horns; horns can be short and massive in the bulls but fine and less developed in the cows	Horns are short to medium in length as in Ngaundere Gudali; they may be thin or moderately thick; they project outwards and upwards and slightly forwards, with the tips sometimes curving backwards, they may at times have only a slight curvature; they are more developed than in Ngaundere Gudali and similar in cross-section to that of Sokoto Gudali	Similar to those of Banyo & Ngaundere Gudali, being short to medium in length, moderate in size or thickness and projecting outwards, upwards and slightly forwards as in Banyo & Ngaundere Gudali
Skin folds	Dewlap, sheath (prepuce) and umbilical folds are prominent; dewlap is very well developed and large, averaging 35-40 cm in length, with pendulous neck folds often running into the large umbilical and sheath folds in the bulls	Dewlap, sheath and umbilical folds are poorly to moderately well developed and not unduly pendulous; they are little more developed than in Banyo Gudali	Dewlap is moderately developed but not unduly pendulous; umbilical and sheath folds are usually obvious but not pendulous	Dewlap, sheath and umbilical folds vary from being small & poorly developed to moderately well developed
Coat colour	Pure forms have white, grey-white, cream or fawn colours, with dark grey areas over the shoulders and hump extending forward to the neck in the bulls; they are often white or cream in the females and light grey or cream with a light grey, light blue tinge or dark grey patches over the head, neck, shoulders, hump and tail in the males; the different shades of colour vary in intensity; occasionally, dark patches are seen around the eyes, often with minute dark spots on the legs, just above the hooves and blue-grey shaded dun coats; the skin, hooves, muzzle and tail-switch are generally black, but red skin is sometimes seen under the tail and in the ears; hair is short and loose; skin is medium-thick and pigmented	Mainly red, white-and-red, reddish brown or solid white; they are far more whitish and broken than Banyo Gudali; brindle and roan animals are also frequent as are spotted red animals in white-and-brown coats	White and deep bright red; usual colour pattern consists of a white face similar to that of the Hereford, except that there is always colour around the eyes and muzzle, with white running down the dewlap, along the abdomen up between the thighs and on the legs; rest of body is red; there are cases where red may extend over the entire face while white may be present in splashes over the back or on the flanks; the two colours are clearly demarcated though the division may take the form of a broken or a clean line	Mixtures of red, black, blue, dun, brown, blue-roan and white are seen, with the white either in patches or speckles; it is this speckled pattern that has given rise to its Fulani name Tattabareji (or speckled cattle)

Table 4: *Means (± standard error) of pre- and post-weaning liveweights of Gudali cattle*

Station	Country	Breed[a]	Birth weight (kg)	3mo. weight (kg)	6mo. weight (kg)	8mo. weight (kg)	12mo. weight (kg)	18mo. weight (kg)	24mo. weight	30mo. weight (kg)	36mo. weight (kg)	Source
Wakwa & Bambui	Cameroon	NG	24.2±0.03 (1263)[b]	72.9±0.35 (561)	123.3±0.16 (566)	140.1±0.64 (199)	162.2±0.70 (132)	194.4±0.93 (129)	228.6±1.59 (71)	-	307.4±2.64 (21)	Tawah & Mbah (1989)
Wakwa	Cameroon	NG	24.2±0.06 (2211)	79.7±0.06 (211)	124.2±0.38 (202)	148.7±0.80 (1413)	-	-	-	-	-	Lhoste (1968); Tawah (1992)
Bambui	Cameroon	MBG	24.5±0.05 (399)	55.6±0.57 (303)	80.7 ± 0.96 (251)	203.0 (12)	153.7±2.00 (32)	183.2±2.30 (26)	218.2±4.79 (17)	-	-	Faulkner & Epstein (1957); Tawah & Mbah (1989)
Dogondaji	Nigeria	SG	22.0±0.30 (171)	76.0±2.00 (94)	114.0±2.70 (57)		144.0±2.70 (57)	199.0±5.20 (49)	241.0±4.30 (5)	301.0±10.1 (7)	358.0±4.60 (11)	Wheat & Broadhurst (1972)
Shika	Nigeria	SG	23.7 (92)	74.0 (67)	87.4 (90)	-	120.5 (68)	-	-	-	-	Oni *et al.* (1988)

[a]NG = Ngaundere Gudali; MBG = Mixed Banyo Gudali (i.e. a mixed population of pure Banyo Gudali and crosses between Banyo Gudali, Sokoto Gudali and White Fulani); SG = Sokoto Gudali
[b]Figures in parentheses are number of observations

Table 5: *Feedlot performance and carcass characteristics of Gudali cattle under different feeding regimes*

			Weight gain (kg)		Daily gain (g/d)		Slaughter weight (kg)				Carcass weight (kg)				Dressing percentage			
							Before fasting		After fasting		Hot		Chilled		Gross		Net[c]	
Sex	Age (mo.)	Feeding regime	n[a]	mean±sd[b]	n	mean±sd	n	mean±sd	n	mean±sd	n	mean±sd	n	mean±sd	n	mean±sd	n	mean±sd
Ngaundere Gudali																		
Bull	12-24	Intensive	5	130.1	25	901.7±117.3 (778-1084.4)	10	417.5		-	20	190.2±40.2 (151.0-229.4)		-	38	54.1±1.1 (52.4-55.0)		-
Steer	36-48	Intensive	82	42.6±15.1 (17.2-64.2)[d]	132	719.2±325.3 (147.0-1270.0)	70	411.0±23.0 (381.0-441.3)	60	387.1±23.0 (360.4-420.9)	70	219.9±13.2 (203.2-247.0)	65	214.8±11.1 (200.7-229.3)	120	52.6±1.7 (51.0-56.6)	60	59.8±2.0 (55.8-62.0)
Steer	36-48	Semi-intensive	15	29.7±13.3 (20.6-47.9)	15	333.3±149.8 (231.0-538.0)	7	414.7±7.5 (410.3-425.7)	7	388.1±4.3 (385.6-394.5)	7	222.0±8.9 (216.8-235.0)	7	219.0±8.2 (214.2-231.0)	7	53.5±1.2 (52.8-55.2)	7	57.2±1.7 (56.2-59.6)
Steer	36-48	Extensive	8	-27.6±10.6	8	-310.0±120.0	8	363.9±21.8 (348.1-390.3)	8	344.1±19.2 (330.2-367.3)	8	187.1±7.4 (181.7-196.0)	8	184.6±7.8 (178.9-194.0)	8	51.4±1.1 (50.1-52.2)	8	54.4±0.9 (53.3-55.0)
Sokoto Gudali																		
Bull	-	Intensive	-	29.5-93.5	-	300.0-920.0	-	295.0-353.0	11	308.9±14.7	-	156.0-317.0	-	-	-	44.8-54.4	-	-

[a]Nnumber of animals

[b]Standard deviation

[c]Net dressing percentage = gross dressing percentage adjusted for weight of digestive content

[d]Figures in parentheses are ranges

Adapted from: Lhoste *et al.*, 1972; Lhoste and Dumas, 1972; Lhoste and Pierson, 1973; Lhoste, 1973; Lhoste *et al.*, 1976; Lhoste, 1980 Huebl, 1973; Domingo, 1976; Olayiwole *et al.*, 1981, 1986; Buvanendran *et al.*, 1983

Table 6: *Means (± standard deviations) of reproductive parameters of Gudali cattle*

			Age at first calving (months)		Calving interval (days)		Calving rate (%)	
Station	Country	Breed[a]	n[b]	Mean±sd	n	Mean±sd	Mean±sd	Source
Bambui	Cameroon	NG	-	48.0	-	511.5±101.2	54.0±3.6	Tawah & Mbah (1989)
Wakwa	Cameroon	NG	-	53.0±8.5	-	536.0±14.7	57-63	Lhoste (1980); Tawah & Mbah (1989)
Wakwa	Cameroon	NG	-	49.5±0.6	-	536.9±17.3	-	Mbah *et al.* (1991)
Bambui	Cameroon	MBG	-	48.0	-	511.6±123.5	75.0±6.0	Tawah & Mbah (1989)
Bambui	Cameroon	MBG	-	-	122	424.5±41.5 (340-483)[c]	-	Faulkner & Epstein (1957)
Bambui	Cameroon	PBG	-	-	-	602 (402-728)	-	Faulkner & Epstein (1957)
Kofare	Nigeria	YG	-	-	-	431	-	Faulkner & Epstein (1957)
Bulassa	Nigeria	SG	34	43.4±7.7	85	496.0±147.5 (442-510)	-	Wheat & Broadhurst (1972)
Dogondaji	Nigeria	SG	75	40.8±9.8	132	439.0±126.4 (378-458)	74.2±1.5[d]	Wheat & Broadhurst (1972); Iloeje (1985)
Shika	Nigeria	SG	11	40-47.0	270	378.4±23.6 (366-423)	-	Faulkner & Epstein (1957); Johnson *et al.* (1984)
Legon	Ghana	SG	24	43.0±7.9	24	459.0±84.0	33-76	Millar (1979); Osmanu (1979); ILCA (1992b)
Nungua	Ghana	SG	23	38.6±26.4	60	465.2±17.0	-	Sada (1968)

[a]NG = Ngaundere Gudali; MBG = Mixed Banyo Gudali (i.e. mixed herd of pure Banyo Gudali and crosses between Banyo Gudali Sokoto Gudali and White Fulani); PBG = Pure Banyo Gudali; YG = Yola Gudali; SG = Sokoto Gudali

[b]Number of observations

[c]Figures in parentheses are ranges

[d]Estimate from Obudu ranch with a standard error

Table 7: *Means (± standard deviations) of lactation milk performance of Gudali cattle*

				Lactation yield (kg)		Lactation length (days)		
Station	Country	Breed[a]	Milking system	n[b]	Mean±sd	n	Mean±sd	Source
Shika	Nigeria	SG	Hand & Machine	1 319	1 101.3±104.9 (1 055-i 526)[c]	1394	244.8±14.1 (236-279)	Faulkner & Epstein (1957); Miller (1961); Johnson *et al.* (1984, 1986)
Wakwa	Cameroon	NG	Hand, restricted suckling	14	374±183.3 (374-1 047)	14	140±48.6 (140-270)	CRZW (1974); Leclercq (1976); Pierson (1980); Pagot (1985); Tawah & Mbah (1989)
Bambui	Cameroon	MBG	Hand	122	619±63 (549-834)	122	221±21 (204-242)	Faulkner & Epsein (1957)
Jakiri	Cameroon	PBG	Hand	23	1249±370 (423-1 818)	217	-	Faulkner & Epstein (1957)
Bambui	Cameroon	PBG	Hand	3[d]	1322 (1 174-1 614)	-	-	Faulkner & Epstein (1957)
Yola,	Nigeria	YG	Most probably hand	14[d]	884-1247	-	-	Faulkner & Epstein (1957)
Kofare	Nigeria	YG	Most probably hand		964-1227		216-305	Gates (1952); Faulkner & Epstein (1957)

[a]SG = Sokoto Gudali; NG = Ngaundere Gudali; MBG = Mixed Banyo Gudali (i.e. a mixed population of pure Banyo Gudali and crosses between Banyo Gudali, Sokoto Gudali and White Fulani); PBG = Pure Banyo Gudali; YG = Yola Gudali

[b]n = number of observations

[c]Figures in parentheses are ranges

[d]Number of lactations

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