PRINCIPLES FOR INDIGENOUS ANIMAL IMPROVEMENT IN THE TROPICS - AFRICAN EXPERIENCES WITH SHEEP AND GOATS

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1. INTRODUCTION

The Inter African Bureau for Animal Resources (IBAR) estimated the cattle, sheep and goat population in Africa in 1981 as follows:

	(in thousands)
Cattle	161 267
Sheep	166 684
Goats	142 665

These represent about 13% of total world cattle and about 25% each of its sheep and goat populations. Phenotypically, the African sheep and goats exhibit great variation in conformation, coat colour, size, height, length and size of tail, presence or absence of horns and their shape, and behaviour patterns, among others. The different breeds of sheep and goats appear well adapted to the various ecozones found in Africa within which they are widely distributed. The management system in most of Africa is extensive with most of the animals having the natural grasslands and browse, as available, to sustain themselves. The small ruminants also have a variety of use for the indigenous populations. The more conventional includes their utilization as a source of milk, meat, skin, wool; but there are also less conventional socio-economic uses: dowry, cash, sacrifices etc., especially in the rural communities.

2. IMPROVEMENT OF AFRICAN SHEEP AND GOATS

The numbers of African sheep and goats are considerable and a first step in the rational use of such a large collection of animals would be to organize them into smaller manageable groups. This need has been recognized and attempts have been made (Epstein, 1953; Mason, 1951; Mason and Maule, 1960) using easily distinguishable phenotypes of body size and height as well as ear shape and length. Thus, with information from their works, Tables 1 and 2 have been built up showing over 48 breeds of sheep and 22 breeds of goat in Africa. Although the classifications were on a phenotypic basis, simplification of the African sheep and goat fauna was achieved and future studies may reveal even more important underlying genetic differences between the breeds.

In discussing any animal improvement scheme, the environment is important. Africa is a large continent and although the bulk of its area lies within the tropics, the southern and northern tips are within subtropical, and Mediterranean climates, respectively. And the tropics are not one uniform environment - though characterized by high ambient temperatures, trade winds and other geophysical factors influencing rainfall which in turn, being seasonal, affects vegetative cover on which the ruminant stock of sheep and goats largely subsist. This is particularly important in extensive systems under which most of the small ruminants are kept in Africa. The ecozones can be grouped into: Arid, Semi-arid, Sub-humid, Humid, Highlands, and Mediterranean. These zones offer differing opportunity for grazing/browse, can influence parasites which cause disease of the animals, and also affect the comfort of the animals themselves - all these are factors which influence animal productivity and so merit consideration.

Table 1 AFRICAN BREEDS OF SHEEP

Land Area	Main Breed Types		Varieties	Special Character	Country
North Africa	Algerian Arab		Ouled Jellal	Coarse wooled, thin tailed	Algeria
	Atlantic coast:				
		Beni Ahsen		Coarse wooled, medium fibre	Morocco
		Doukkala		Coarse wooled, thin tailed	
		Zemmour		Coarse wooled	
	Beni Guil/Petit Oranais, Hamyan		Harcha	Coarse wooled, thin tailed	Plateau of E. Moroccc and W. Algeria
			Tounsint		
			Zoulay		
	Berber/Chleuh, Kabyle		Ait Barka	Coarse wooled, thin tailed earless	Mountains of Morocco
			Ait Haddidou		
			Ait Monad		
			Aknoul	Dwarf,	
			Mannoucha		
			Tounfite		
			South Moroccan		
			Zanan		
	Ausimi/Meraisi, Awsemy, Osemi, Ossimi, Ousimi			Coarse wooled, fat-tailed	Lower Egypt
	North African Barbary:			Corse wooled, fat-tailed	N.W. Egypt
		Barki/Arab, Bedouin, Dermawi, Libyan b.			
North Africa	Tunisian b./Tunisienne				
	North East fat-tailed:				

		Barki			
		Fellahi			
		Rahmani	Jhalawani, Sarawani	Fat-tailed	Egypt
		Ibeidi			Morocco
		Saidi			
		Kurassi			
	Middle Atlas:				
		Azrou		Mixed types with	
		Bekrit		Berber and Tadla blood	
		El Hammam		Coarse wooled	
		Timhadit			
		South Moroccan	Rehamma-Srarhna,		
			Zembrane		
		Tadla Beni Meskine	Tadla Beni Meskine	Mixed: Berber x South Moroccan x Zaian. Coarsed wooled	Morocco - Plateau of west
			Tadmit	Mixed (?) Algerian Arab x Merino	Algeria
				Medium fibre wool	Tunisia
			Tunisian milk		
			sheep/ Sardinian	Coarse wooled, milked	Tunisia
West Africa	Macina		Goundoun	Coarse wooled, long tailed	Mali
	West African Long-legged/				Niger
		Guinea Long-legged,		haired	North of West Africa
		Sahel:			

		Fulani				
		Maure				
		Tuareg				
	West African Dwarf/				haired	
		Cameroon Dwarf, Djallonke,				
		Fouta Jallon, Kirdi,				South of West
		Kirdimi/Lakka,				
		Nigerian Dwarf, Southern				
		West African maned				
Eastern and Southern Africa	Northern Sudan Sheep:					Areas in north of
						Sudan
			Sudanese Desert		Thin-tailed	East of Nile,
				Gezira		Eritrea
				Baraka		Northern riverine
				Wellega		Eritrea
						West Ethiopia
	West African:			Zaghawa	Thin-tailed	North-west Sudan
		Angola Thin-tailed		Fellata	Thin-tailed	West Sudan
		Dongola				Sudan
		Arrit				North Eritrea
		Southern Sudan Sheep				South Sudan
		Congo long-legged			Thin-tailed	East Congo
		Congo Dwarf			Thin-tailed	Katanga, Congo
		Angola Thin-tailed				Angola
		Myasinian	Akele Guaai		Fat-tailed	Eritrea

Eastern and Southern Africa				
		Tucur	Fat-tailed	Ethiopia
		Mens	Fat-tailed	Ethiopia
		Arusi-Bale		Ethiopia
		Rashaidi		Eritrea
Arab			Fat-tailed	Somalia
	Masai	Nandi, Samburu		
		E. Uganda		Kenya
	East African Blackhead		Fat-tailed	Karamoja, Uganda
	East African Long-tailed	Tanzania Long-tailed	Fat-tailed	W. Uganda
		Raunda - Uruadi		Uganda
	Rhodesian	North Rhodesian	Fat-tailed	Kenya and Tanzania
		South Rhodesian		Burundi
	Bo Tswana			Zambia, Zimbabwe
	Mondombes			Malawi
	Nguni			
		Swazi	Fat-tailed	Mozambique
		Zulu		Swaziland
		Landin		
		Bapedi		Bolswap
	Africander	Namagua	Fat-tailed	South Africa
		Ronderib		
		Transwaal		
		Damara		
	Madagascar		Fat-tailed	
	Somali		Fat rumped	Ogaden, Somalia
		Adali		North-east Ethiopia
		Topesa		South-east Sudan

		Kenya		Kenya
	Blackhead Persian			
	Derivatives	Dorper	Fat-rumped	South Africa
		Van Rooy	Fat-rumped	
		Bezuidenhet		
		Africander		
		Wiltiper		South Africa

Sources: Mason,1951; Mason and Maule 1960.

Table 2 AFRICAN GOAT BREEDS

Land Area	Main Breed Types	Varieties	Special Character	Country
North Africa	Baladi/Bedouin, Egyptian	Sharkawi	Mohair, dairy	Lower Egypt
	Berber			Maghreb,
	Libyan		Meat, dairy	North Africa
	Nubian		Dairy, Roman nose	North-east Africa
	Mzabite/Algerian Red		Long ears, short hair	
	Touggourt			South Algeria
	Zaraibi			Upper Egypt
	Saidi		Bigger form of Baladi	
West Africa	West African Dwarf/:		Short-legged, haired	South of West Africa
	Cameroon Dwarf			
	Fouta Djalien			
	Kirdi/Kirdin (Chad)			
	Nigerian Dwarf			

	Guinea			
	West African Long-legged/		Long-legged, haired	North of West Africa
	Sahel			
	Arab (Chad)			
	Maure (Mauritania)			
	Nigerian	Red Sokoto (Maradi)		Noth-west Nigeria
East and Southern Africa	Sudenese Nubian		Long-eared	
	Sudanese Desert		Long-eared	
	Benadir	Bimal	Long-eared	
		Garre		
		Tuni		
	Southern Africa	Boer		
		Zambia		
		Zimbabwe		
		Botswana		
		Mozambique		
East and Southern Africa		Swazi		

		Zulu		
		Angola		
		South-west Africa		
	Madagascar		Long-eared	
	Southern Sudan		Short-eared	
	Eritrean and Abyssinian		Short-eared	
		Galla - Sidama		
		Arusi - Bale		
		Danakil		
	Somali	Abgal	Short-eared	
		Ogaden	Short-eared	
		Somali Land		
		Kenya		
	Arab		Short-eared	
	East African		Short-eared	
		Small East African		
		Mubende		
		Kigezi		
		Boran		
	Congo		Short-eared	
	Angola		Short-eared	
	Southern Africa	Zimbabwe	Short-eared	

		Malawi		
		Mozambique		
	Madagascar		Short-eared	Malagasy

Source: Mason, 1951; Mason and Maule, 1960.

From the foregoing, animal productivity can be improved either by ameliorating adverse environment, for example, through better nutrition (improving browse/grazing), shelter, health care management of these resources or through genetics. It is only the last mode of improvement that will be considered, in the context of course, of the African environment.

The general principles of animal improvement are well known and there is no reason why it should be different for the African continent. There are, however, some peculiarities of sheep and goat production circumstances in Africa that should be noted:

1. Large numbers of stock (or genetic material) and paucity of information.
2. Generally non-specialized/multiple use of these stock, i.e. for meat, milk, hides and skins.
3. Great range of the environment with the breeds appearing to be well adapted to their particular econiche.
4. Dominance of the extensive system of husbandry in which the animal feeds on whatever the environment provides, and when it can.
5. Poor control of the breeding animals.
6. Systems of flock rearing which may constrain the use of particular breeding plans.

Given such circumstances, plans for genetic improvement of sheep and goats should involve the following:

a. Characterization/documentation of existing sheep and goat resources in Africa, as well as their econiche and management system.
b. Selective breeding or within-breed selection.
c. Crossbreeding of suitable breeds to optimize production.
d. New breed development.

These are not new techniques, but the opportunities they hold for African sheep and goats and examples of their application as well as the problems of their use will be discussed further.

As regards information on sheep and goat resources, work has already begun. FAO and UNEP are collaborating with OAU/IBAR in the establishment of Regional Data Banks and lists of descriptors have been prepared and their methodology and problems discussed at an Expert Consultation meeting in Rome in June 1985. In supporting the establishment of such banks the OUA/IBAR Expert Committe group emphasized, among others:

- the need to identify and characterize breeds throughout the continent;
- identify these with high potential;
- help to encourage the development of good record keeping and centres for breed development;
- assemble performance data on prolific sheep and goats of Africa.

There are of course some problems with developing data banks not least of which are what information to record, and how to record so as to optimize usage. In Africa the situation is further complicated by the low literacy rates of the livestock farmers, the majority of whom cannot read or write, and the way the sheep and goats are more often left to fend for themselves or are bush grazed. Most of the information will, therefore, come from research scientists, and from fewer animals maintained under systems considerably different from what obtains for the bulk of the population.

Good records of performance form the bases of selective breeding since selection by sight will result in slow, if any, genetic progress. In recording performance, the economic traits need to be focussed upon. For the sheep and goats, these include:

a. Measures of reproductive efficiency, including number of and weight of lambs/kids weaned per ewe/doe joined per year.
b. Mortality at all ages especially from birth to weaning.
c. Measures of growth: birth, weaning and later period weights.
d. Milk yield, where appropriate.
e. Wool quality and quantity, where applicable.
f. Carcass quality.
g. Disease data.

Mason and Buvanendran (1982) have detailed procedures and data that can give information on these economic traits for sheep and goats in the tropics. The close adaptation of African sheep and goats to their habitats would suggest that until more is known of their characteristics much emphasis should be placed on this avenue, i.e. within-breed selection for genetic improvement. Unfortunately, records of performance which form the basis of this technique are still not much developed in most African countries. However, there is an acute awareness of this deficiency and most countries have embarked on development of sheep and goat performance recording schemes at local and national levels, and are collaborating at international levels. Those records when analysed should help herd management, identify superior stock and generally lead to improvements in sheep and goat production in the African region. The data so far available show that African sheep and goats are valuable genetic resources. Thus:

a. The West African dwarf (Mason, 1980) and the D'Man of Morocco (Lahlu-Kassi, 1983) have been identified as highly prolific breeds of sheep.
b. The dwarf breed of sheep and goats of West and Central Africa have been noted to be trypanotolerant (FAO/ILCA/UNEP, 1980).
c. Some goat breeds are reputed to be good producers (Devendra and Burns, 1970).

Milk - the Nubian

Meat - the Blackhead Persian derivatives (Boer)

Skin - Red Sokote (Maradi); Mubende

and more valuable breeds will be identified in the future. In addition records of performance can help identify constraints to productivity and suggest appropriate modes of intervention. But recording performance under the prevailing extensive management of large flocks or in small household flocks will not be easy. Therefore, cooperation between small herds or organization of larger herds probably by governments will enhance the use of this technique. Alternatively, improved breeds (e.g. males developed at breeding stations) can be used on traditional local flocks. The observation by Van Vlaenderen (1985) in northern Togo regarding improvements in productivity in traditional herds using selected rams supports this view. Some improvement programmes in North Africa (Lahlu-Kassi, 1983) of sheep have been planned along such lines.

Crossbreeding is a valuable tool for livestock improvement when properly used. The present knowledge of African sheep and goats as well as the level of husbandry does not permit a general adoption of this technique at this time. When more is known about our breeds one can foresee the use of crossbreeding for systematic exploitation of heterosis in 2, 3 or 4 breed combinations or as a foundation for new breed development incorporating valuable genes from identified superior breeds.

South Africa, though subtropical, has evolved new breeds to meet specific needs:

Sheep: Dorper: (1942 - 50) Dorset Horn x Blackhead Persian Van Rooy: in 19th century
(Rambouillet x Ronderib Africander x Blackhead Persian)
Bezuidenhet Africander: (1918) Wooled Persian x Blackhead Persian
Wiltiper: (1946) Wiltshire Horn x Blackhead Persian

Goats: Boer; from local goats x European, Angora and Indian types. Inasmuch as all these new breeds were evolved from inputs of indigenous African breeds, repeat of similar schemes is possible. Infact, Ngere (1973) and Ngere and Abeagye (1981) have described the Numgua Blackhead evolved from the West African dwarf x Blackhead Persian in Ghana.'

In conclusion, there is need for more detailed and extensive documentation on performance characteristics of African sheep and goats. Selective breeding (within breeds) would seem to be the most favourable method for the moment.

Any scheme to improve the small ruminants should take into account the habitat and flock sire. Crossbreeding and breed development also have a place under improved husbandry conditions and in the more developed countries of Africa.

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IMPROVEMENT OF ANDEAN CAMELIDS

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In the last two decades, research has produced much knowledge about the biology of camelids and how to make better use of this resource.

Some erroneous concepts have been modified but many gaps in knowledge need further study. This paper contains a brief description of environment, farm characteristics and a summary of management practices recommended for increased production.

1. ENVIRONMENTAL CHARACTERISTICS OF PASTURE GRAZING LAND

The central Andes "Puna" a natural zone for rearing camelids is composed of a series of mountain valleys and plateaux situated between 3600 to 5000 metres altitude. The area commences in the "Pampa de Junin" in the central region of Peru (latitude 11 south) and finishes in the south of Bolivia (latitude 21 south). Due to its diversity, the Puna is divided into three zones: humid, dry and arid.

The humid Puna is close to the eastern Cordillera and the dry Puna is close to the western Cordi Llera, both starting in the central region of Peru and extending as far as central Bolivia. The arid Puna is close to the Atacama desert in Chile and reaches as far south as Bolivia.

The typical climate of the Puna is characterized by low temperatures, frequent night frost and variability in rainfall. These characteristics are related to the altitude. The annual mean temperature is 8 C but improves from October to April, the rainy months. The greatest differences in temperature are during the day with a range of 20 C in the dry season, due to night frost. At 4500 metres night frost occurs throughout the year. To the north rainfall is about 500-850 mm decreasing to the south to 100-400 mm, being very irregular in the arid Puna. In general the soils are poor.

Owing to the factors described above, the main vegetation consists of graminea and herbaceous plants, with only a few trees found in specific microenvironments. However this geographical area has been of great importance to the local inhabitants. Alpacas and llamas were originally domesticated in this area creating a pastoral/agricultural economy (potatoes, quinua (Chenopodium guinea) canihua (Chenspodium pallidicaule), etc., cultivation of the latter always being subject to the hazards of the environment. This "agro-pastoral" system is now used with sheep and cattle, introduced after the Spanish conquest.

2. CAMELID FARM CHARACTERISTICS

Of the total world camelids Peru has 3.02 million, 90 percent alpacas, and Bolivia 2.5 million, 70 percent llamas (Table 1). In Peru farmers who are organized in "Ayullus" (communities) own 75 percent of the alpacas. They are small farmers with low production and management levels. The remainder (25 percent) are associated with large farm enterprises created by agrarian reform (Table 2). There is also a limited amount of middle-level farmers who were not affected by agrarian reform. It must be pointed out that within the communities, some farmers are prosperous while others have no land and few animals.

Table 1 ESTIMATED POPULATION OF SOUTH AMERICAN CAMELIDS ('000)

Country	Domestic		Wild	
	Llamas	Alpacas	Vicuñas	Guanacos
Peru	900	3 020	50	5
Bolivia	2 500	300	2	0.2
Argentina	75	0.2	2	100.2
Chile	85	0.5	1	10.0
Colombia	0.2	-	-	-
Ecuador	2.0	-	-	-
USA	2.5	-	-	-
	3 564.7	3 320.7	55	115.2

Table 2 ALPACA POPULATION IN PUNO STATE ACCORDING TO TYPE OF PRODUCTION

(Village)	Production Type				Total
	Big associated farmers	(%)	Small individual farmers	(%)	
Puno	35 509	(39.3)	54 923	(60.7)	90 432
Azangaro	49 442	(50.0)	49 456	(50.0)	98 898
Carabaya	24 106	(16.2)	124 675	(83.8)	148 781
Chucuito	15 077	(6.5)	215 587	(93.5)	230 664
Huancane	41 496	(33.5)	82 315	(66.5)	123 811
Lamp a	81 179	(41.0)	117 201	(59.0)	198 200
Melgar	58 230	(37.4)	97 344	(62.6)	155 574
Sandia	_		43 995	(100.0)	43 995
San Roman	130	(2.4)	5 205	(97.6)	5 335
Total	305 169	(28.0)	790 521	(72.0)	1 095 690

Source: Anuario estadistico 1979, ORDEPUNO, Dirección Regional de Agricultura y Alimentación, Puno.

Both in Peru and Bolivia, llamas are in the hands of the community farmers. A distinction must be made between the large enterprise and the small community farmer, particularly as agrarian reform has not largely changed social relationships and production techniques even where land has changed ownership.

The big associated farmers in general have better soils, better pastures and are situated close to good roads. They also benefit from investment facilities. On the other hand, the small farmers with limited basic resources, overexploit and destroy the environment for themselves as well as for future generations.

It has been possible from various studies made of the Puna, one of the most important areas of camelid husbandry, to evaluate the main characteristics of raising these animals as well as their management (see appendix). There are different levels of organization. Sometimes all animals are put together with no distinction by age, sex or colour and no timetable is set for field operations. Other animals are classified according to age and sex and a timetable exists. In this case husbandry practices are the same as for sheep. In general, castrated males are kept for fibre production which limits the number of productive females.

This practice together with low fertility and high calf mortality produces small numbers for replacement and limits selection for productive characteristics.

Where animals are separated by age and sex mating is from December to April using 3-4 percent of the males during the whole period. In general, females are mated at about 2-3 years of age and their productive life is 10-12 years. Males start their first service at about 3 years old.

Where animals are not separated by sex and age mating takes place only in the rainy season (December-March) which indicates that it is not important to keep all animals together as mating is limited to one period. Birth rate is about 50 percent and calf mortality during the first three months is about 50 percent. Actual production rate is + 5 calves for 100 females in productive age. Because of these reasons take-off is low as only old animals are involved and meat production is not of good quality.

The shearing season is annual or biannual and takes place between October-November.

Technically annual shearing is better because of:

a. Health: better parasite control;
b. Economics: the fleece is less affected by the environment;
c. Management: animal selection for production is possible at one year's old.

A great variation exists in individual production (1-8 lbs/animal/- year) which offers a great potential for improvement by selection.

3. MANAGEMENT PRACTICES RECOMMENDED FOR PRODUCTION IMPROVEMENT

<u>Reproduction</u>

During the last two decades much information on reproductive biology has been collected which can be summarized as follows.

a. Ovulation is induced by mating and comes 26 hours after service; ovulation can also be induced by hormonal treatment (LH, GNRH).
b. Oestrus is continuous without the presence of a male (mating). After parturition oestrus reappears within 24 hours, but even if females are serviced ovulation takes place only 10 days postpartum.
c. Twenty percent do not ovulate after service due to bad nutrition.
d. Conception is + 95% but 40% of the foetuses die during the first month. These losses diminish as the females recover after parturition.
e. There is no false pregnancy, which occurs in other animals with induced ovulation.
f. Continuous association (for more than 15 days) of males and females inhibits male sexual activity.
g. Females can be mated at 1 year of age only when they have achieved 50-60% of the adult weight (35-40 kg).
h. Gestation is 342 days; births take place during the brighter hours (06.00-14.00 hrs in the tropical mountain zone).

The above information indicates that the biological principles governing reproduction in camelids are peculiar to the species and must be taken into account in applying techniques to improve birth rates.

Sexual activity should not take place for a minimum of 10 days after parturtion as mating serves no purpose and can provoke uterine infections. Males should be maintained in sexual activity to service females in heat. This can simply be done by taking 6 percent of healthy males and dividing them into two groups and using them on alternative weeks. It has been shown under actual pastoral conditions that 50 to 60 percent of females are suitable for reproduction by servicing females of one year of age if they have reached a suitable liveweight.

Health

Increased birth rate has no significance if causes of mortality are not recorded. Some diseases even if not fatal such as mange and gastrointestional problems are important particularly for range animals. Information is available on the most important economic diseases. Intestinal parasites are the same as sheep but some ecto parasites are specific to camelids. Mange is caused by Sarcoptes scabiei var. ancheniae and Psoroptes aucheniae specific to camelids.

The main cuase of calf mortality is enterotoxemia (Clostridiunm welchi types A-C).

Feeding

Natural pasture is the principal feed for camelids; the most common feed consisting of gramminea, cipreacea and juncacea and in less quantity leguminosas. These pastures have poor soil which is phosphurous and nitrogen-deficient with overgrazing due to bad management. Quantitatively and qualitatively pasture production is better in the rainy season (November-March) and at its worst in the dry season.

However a good potential exists for pasture production improvement such as better water utilization according to the old indigenous irrigation system used in some communities.

Experimental work has shown not only the importance of irrigation but also the introduction of new plants to improve pasture production in the altiplano.

Further studies are required on efficient pasture use, for example, stocking rate throughout the year in association with sheep or separately.

4. GENETIC IMPROVEMENT BASED ON SELECTION

Owing to low replacement rate, selection is limited. Farmers should therefore try to increase birth rates and reduce mortality, culling undesirable animals and retaining those with the most important economic characteristics such as colour of wool, weight of fleece and liveweight. According to Velasco (unpublished data) in alpacas a uniform colour is dominant over a mottled colour.

An animal of uniform colour is one without white hairs while a mottled animal has parts covered with white hair. White is the dominant colour in alpacas, while brown is dominant over black. Velasco, with 106 pairs of mother-daughters, using the repression factor of daughters, calculated the hereditary index by liveweight (.69 + .2) and by fleece weight (.35 + .2). These results show that alpacas can be selected with little error at 264 days.

PERCENTAGE OF ALPACAS BY AGE AND SEX IN ONE HERD. MEAN FROM 227 185 HEAD FROM 13 BIG FARMS IN PUNO (1979)

Age	Female	Male	Castrated	Total
Calves (0-1 year)	9.7	11.4		21.1
Sub-adults (1-2 years)	8.4	8.9		17.3
Adults (2 years)	42.0	4.3	15.3	61.6
Total	60.1	24.6	15.3	100.0

AVERAGE YEARLY MORTALITY BY AGE IN EXPERIMENTAL FARM "LA RAYA" 1973-1979

Age	X ± S	Range
Calves (0-8 mths)	26.7 ± 19.5	9.3 - 56.6
Sub-adults (8-24 mths)	5.1 ± .3	4.1 - 6.6
Adults (>24 mths)	2.9 ± .7	2.0 - 3.6

ALPACA FERTILITY FROM SMALL FARMERS 1/

Farmers	Population Total	Females		Calves		
		Total	Mating	Born		Dead
				n	% 2/	
1	205	101	78	53	67.9	32.0
2	245	127	79	63	79.7	44.0
3	235	113	85	68	80.0	50.0
4	184	86	86	28	32.5	17.8
5	120	46	46	27	58.6	48.1

1/ 1980 enquiry in Puno.

2/ On serviced females.

ESTIMATES OF ALPACA FERTILITY IN SOME LARGE FARMS (1980) 1/

Farm	Mothers		Calves Born			Calf Deaths %
	Populations total	No. Services	n	%		
				a	b	
Tulapa	6 061	4 874	3 179	65.2	52.4	40.5
Giletamarka	1 224	1 014	515	50.7	42.0	15.3
Umachiri	2 978	2 550	1 643	64.0	55.0	68.4
Kunurana	2 562	2 100	433	20.6	16.9	18.0

Nuñoa	3 164	2 860	1 716	60.0	54.2	41.7
Alianza	6 756	6 509	4 195	64.0	62.0	9.0
Sais Vilque	3 167	3 167	1 815	57.3	57.3	47.4
Carumas	1 718	1 718	446	25.9	25.9	26.0

1/ Based on records of the Ministry of Agriculture, Zona Agraria IX, Puno, Peru.

a. On mothers served
b. On total of mothers

WEIGHT MEAN OF ALPACA FLEECES

Biannual Shearing (lbs)	Author	Annual Shearing (lbs)	Author
4.5	Toledo y S. Martin 1980	3.5	Moro 1968
6.5	Calderón L. 1952	3.2	Bustinza 1970
7.7	Gallegos 1954	2.4	Calderon et al. 1972
7.7	Magagno 1956		
4.8	Moro 1968		
7.7	Cuadros 1971		

CROSSES OF BLACK AND BROWN ALPACAS

	Black x Black	Black x Brown	Brown x Brown
Black	5	3	4
Brown	0	5	27

Velasco J. (Unpublished data)

BIRTH RATE OF ALPACAS OF LA SAIS PICOTANI

Mating	Year	%
Traditional (Sheep system)	1966	53.1
	1967	59.0
	1968	51.2
	1969	55.4
	1970	63.2
	1971	61.5
IVITA 1/	1972 1973	81.0 80.0

1/ 6% of males divided into two equal groups used altenatively. Each group works one week replacing the other.

EFFECT OF ALTERNATE MATING ON BIRTHS IN ALPACAS
(Sais Picotani 1972)

Class	No. Services	% Parturition
Adults	924	83
Primiparous 1/	475	77
Total	1 399	81

1/ One year of age.

NUTRITIVE VALUE OF NATURAL PASTURE BY OESOPHAGEAL FISTULA VS. HAND COLLECTED NATURAL PASTURE

Feed fraction	Alpacas			X (A)	Hand-collected (B)	Differences % A - B
	1	2	3			
Protein %	18.8	18.3	17.0	18.0	10.1	+ 78.6
FDN % 1/	57.8	56.2	63.2	59.0	65.5	- 9.9
DIVMS % 2/	59.9	54.5	72.2	50.0	43.9	+ 34.2

1/ Natural detergent fibre.

2/ *In vitro* digestibility of dry matter.

PRODUCTION OF INTRODUCED PASTURES
(4 200 m above sea-level)

	Annual total of dry matter 1/
Gramineas	kg/ha
Lolium perenne 5.23	12 821
Lolium multiflorum tetraploide tetilla	12 461
Lolium perenne alemana	12 745
Leguminosas	
Trifolium pratense K.	22 100
Trifolium pratense alemana	18 450
Trifolium repens L.	15 756

1/ Four collections per year.

AVERAGE NUTRITIVE COMPOSITION OF ANDEAN ALTIPLANO NATURAL PASTURE IN TWO PERIODS OF THE YEAR

Period of the year	Protein %	CA %	P %	Cu %	Co PPM	DIVMS 1/ %
Rainy	8.5	.28	.21	4.78	.20	45
Dry	4.1	.28	.07	4.14	.18	35

[1/] DIVMS = In vitro digestibility of dry matter.

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IMPROVEMENT OF PIGS IN THE TROPICS: GENERAL PRINCIPLES

J.W.B. King 1/

1. INTRODUCTION

The principles for the improvement of pigs do not differ around the world but the way in which they are implemented will depend on selection objectives and on the existing population of pigs and the way in which it is to be utilized for production to meet particular markets. Overlying all these considerations are likely to be requirements for adaptation to local climatic conditions and to diseases, and endo- and ecto-parasites. Much judgement will therefore be required in specifying programmes appropriate to particular circumstances and the purpose of the following review is to discuss some of the issues which arise.

2. NATURE OF THE INDIGENOUS PIG POPULATION

Populations of indigenous pigs will undoubtedly vary in their history and breeding structure. At the one extreme there may be large, ill-defined populations made up of individuals without any of the uniformity usually ascribed to breeds, but nevertheless filling a particular niche and performing a particular function. It is unlikely that more than fragmentary knowledge exists about the pedigree of individual animals and yet the population as a whole probably represents a valuable asset to the animal agriculture of the region. At the other extreme there may well be small pedigreed populations that have been carefully husbanded for several generations, recorded in detail and about which a great deal more is likely to be known. When both kinds of population are present in the same region, problems may well arise in defining distinctness and deciding whether performance levels between a small pedigreed nucleus and the population at large are genetic or merely environmental. If trials to establish this are needed, the general experimental principles described by Sellier (1980) are useful for planning appropriate designs.

3. USE OF THE INDIGENOUS POPULATION

The advantages of crossbreeding in the pig appear to be so great that it is most likely that the genetic resource of the indigenous breed would not be utilized in some form of crossbreeding. Although critical evidence is scanty, the general principle is that the amount of heterosis observed is usually greater in unfavourable environments, thus giving a further incentive to some crossbreeding system for use in the tropics. To organize the crossbreeding that is required may present some organizational difficulties and at first crossbreeding may take the very simple form of crossing the females of the indigenous breed with males of an exotic breed as a means of producing pigs for meat production. This first crossing method does not use heterosis in the sow so tht extending the crossing system to use first cross sows for breeding will probably be advantageous providing adaptability to the local environment is not lost. In the interests of simplicity, a backcross to boars of the parental exotic breed is the simplest method of using a crossbred sow and avoiding the necessity for having a third breed.

Because of organizational difficulties, attempts are frequently made to perpetuate the crossbred population from inter se matings, thus producing a synthetic population (or eventually a new breed) which may be multiplied for use in that environment. Although attractive from the administrative viewpoint, the serious loss of heterosis may well mitigate against the system, as well as requiring the use of breeding females not well adapted to the local conditions. Ingenuity in devising ways in which a discontinuous crossing system can be implemented may therefore be rewarding.

In later discussion, it is assumed that the indigenous breed will in fact be used as the mother of slaughter pigs, or as a contributor to a crossbred sow. The improvement of maternal performance is therefore of paramount importance in the indigenous population.

4. SELECTION OBJECTIVES

The potential number of characteristics in which genetic changes might be desired is great and some grouping and simplification may help the task.

4.1 Female Reproduction

- Piglets weaned per litter (as a convenient integration of numbers born and viability).
- Weaning weight of the litter (particularly when weaned piglets are sold from one producer to another).
- Re-breeding interval (leading to a measure of piglets per sow per annum).
- Sow feed costs.
- Sow carcass value.

4.2 Male Reproduction

Genetic changes may not be necessary but possibly the ability to produce fertile sperm at high ambient temperatures may be required.

4.3 Slaughter Pig Production

- Growth rate
- Food conversion

- Viability to slaughter
- Carcass yield
- Carcass value

All the characteristics listed above may be dependent upon inbuilt genetic resistance to climatic stress, diseases and endo- and ectoparasites. The extent to which these adaptive characteristics show genetic variation will be unknown and the problem of whether or not to attempt selection for them will be considered later.

5. SELECTION METHODS

To achieve the desired objectives, reliance is placed on various measured traits, not necessarily those listed as selection objectives. Nevertheless the more directly it is possible to reflect a selection objective in a measured trait, the greater the response is likely to be. Some indirect measures are valuable since they facilitate the employment of selection methods which would otherwise not be feasible. The prime example of this is the estimation of carcass merit from live animal fat mesurements which makes it possible to carry out large scale performance testing and to dispense with progeny testing.

For the improvement of female reproductive traits which have a low heritability, the use of additional litter records on the same individual and of records from close relatives is valuable. Thus the device of keeping potential breeding stock from a first litter and retaining that sow for a second litter to record litter performance, will almost certainly be a valuable method. Using the records from relatives will require the calculation of selection indices with appropriate weights and, because of the varying numbers of relatives which will be available in any given case, the use of a computer becomes useful.

In measuring the performance of the growing pig, it is appropriate to use weight intervals rather than age intervals for record purposes since this avoids many non-genetic variables. Measurement of fat thickness as a predictor of leanness would also be best done at a fixed weight, but since this may be inconvenient, correction of the measurement to a fixed weight is appropriate. With the higher heritabilities observed for most traits observed on the growing pig, the additional benefits to be gained from use of information on relatives will be small and not a high priority in devising an appropriate selection method.

6. SELECTION METHODS FOR ADAPTIVE TRAITS

Selection of individual animals for adaptation to climatic conditions will probably not be feasible and is probably not to be regarded as an essential feature of the selection procedure. In cattle, where climatic room exposures and body temperature measurements have been made in the selection of stock adapted to the tropics, the current tendency is for such tests to be dropped and reliance placed on natural exposures.to climatic extremes. Similarly with pigs, Horst (1982) from his review of the literature could find no indicators of heat tolerance.

With resistance to diseases and parasites, although laboratory tests may be feasible, or can possibly be devised for the future, natural exposure will probably be all that can be achieved. For many diseases natural exposure is subject to drawbacks because of the complexities introduced by maternally acquired immunity. For the time being some hard decisions may be necessary in deciding upon those diseases which will be excluded by sanitary measures and those where endemic exposures will be the normal course of events. Realistic assessment of the diseases to which stock may be exposed during the production phase of their use will be needed to avoid undue optimism about veterinary measures which are unlikely to succeed in widespread practice. Selection can then be practised in that environment using what Horst (1982) calls 'productive adaptability' where the performance of the animal is used indirectly as a measure of whether or not it is adapted to the stresses it has encountered.

For the future, great store is set on the possibilities of being able to detect genetic markers which can be used as indicators of resistance actors. Although in other animals a few useful associations have been found, this type of investigation must at this stage be regarded as speculative not a method which can be relied upon for solving present problems.

7. BREEDING PLANS

Breeding plans can be assessed by computation of expected progress using the known dependencies on selection intensity, accuracy of selection, extent of genetic variation and on the inverse relationship to generation interval. The influence of some of these factors can now be noted.

Obtaining reasonable selection intensities can be a problem with, relatively small populations and to maximize the opportunities, it is desirable that all potential breeding animals born should be subject to the selection procedure. While some independent culling levels for particular traits may be ncessary, they should be kept to a minimum and unnecessary selection of uniformity of colour or type avoided. Where there are requirements for special recording, as in the measurement of food conversion, then the allocation of pens should follow the principles laid down by Smith (1969).

The accuracy of selection will depend very much on the traits under consideration. As noted already, there may be scope for using records on relatives or characters with low heritability, but little to be gained where the heritabilities are higher. Weight given to different traits is best determined by the use of a selection index although uncertainties over the parameters to be used in such an index will often make it necessary to use values obtained from the literature. These can be combined with estimates of the variability of the local population to give procedures which will allow a start to be made on selection. For a discussion of these problems, see James (1982).

The extent of genetic variation available in the population will depend on the past history of selection, on past bottlenecks and on effective population sizes. If the indigenous population under improvement is a unique one, then it may be worthwhile devising some form of open breeding plan which allows the immigration of additional breeding animals from outside the nucleus on the basis of superior performance. As has been shown by James (1978), this measure can increase effective population size and reduce rates of inbreeding.

In many practical breeding schemes, the generation interval does not receive as close attention as other selection parameters. One reason for this is that the discard of comparatively young breeding animals may add considerably to the cost of the breeding operation. Arrangements to pass animals from the breeding nucleus to commercial crossing herds may therefore be useful in offsetting this cost. Optimum structures should be computed for alternative circumstances, using the general principles enunciated by Ollivier (1974). It is unlikely that sows should be maintained for more than two litters or boars for more than twenty matings if the generation interval is to be kept at an optimum level.

During the course of selection, unexpected and unwanted correlated responses may need to be monitored. For example, the tropical conditions are such that small body size is an adaptive characteristic, so large increases in adult size may have adverse effects as suggested by Horst (1982). Similarly, the reduction of fatness and increase of lean will not only lead to an animal with reduced energy stores, but may also produce increased heat production with consequent ill effects for climatic adaptability. Such adverse possibilities are not a recommendation for making no changes, but for measuring those that do occur so that some kind of genetic control seems particularly appropriate to monitor the value of selection procedures. The ability to deep freeze sperm makes it possible to provide such controls at reasonable cost and further economies can be made by not taking controls from every generation but by introducing them after a period of selection.

8. RATES OF INBREEDING

The rate at which the improved population becomes inbred will be a major concern in the design of improvement plans. Although some indigenous populations, such as the Meishan from China, appear to have had a long history of inbreeding without serious consequences for fecundity, such isolated experiences are not a general recommendation for neglect of inbreeding. Intense selection will inevitably lead to high rates of inbreeding and some balance will need to be struck. Definitive advice is not possible but attempts to maintain rates of inbreeding at those found in major pig breeds at round 1/2 percent per generation would be a pragmatic choice and one which would certainly be tolerated for a long term programme. For shorter term programmes, high rates of inbreeding could be tolerated.

9. GENERAL REQUIRMENTS

Finally some general observations might be permitted. A major requirement for the success of pig breeding operations is the organizational one both in the conduct of breeding operations in the nucleus herd and in the dissemination of that improvement to the population at large. This requirement should be stressed and placed high on the list of priorities.

Some new technologies may have exciting prospects but probably have low priorities for implementation in many basic schemes of the kind described here. To take a statistical example, the use of BLUP methods will probably add little to a scheme if the breeding population has been well structured for improvement purposes. Similarly, reproductive techniques such as AI and embryo transfer would not appear to be essential ingredients. This is not to deny the value of existing and future research on indigenous populations but to counsel critical appraisal of priorities. Organization and structuring of pig breeding operations should be near the top of that list of priorities.

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