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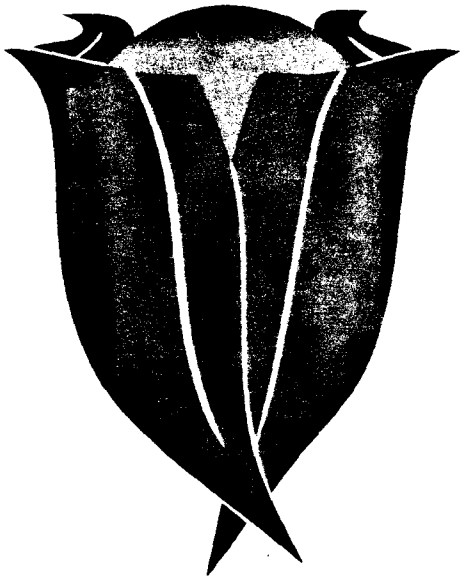

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ANIMAL GERM PLASM IN NORTH AMERICA

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The purpose of this review, bearing on animal germ plasm, is to provide the laymen agriculturists with a general appreciation of the genetic nature of livestock populations on the North American continent, and of the tremendous potential they provide in the never ending quest for a more efficient and nutritious food supply at the disposal of mankind. It does not purport to contain the solution to the world food supply problem, for that problem is much more than one of production capability; rather, it attempts to focus attention on the extremely important and renewable basic resource which is the animal germ plasm, the potential for still greater exploitation of this germ plasm in its broadest sense, and the need to assure its continued maintenance with at least its present level of diversity.

Germ plasm has a genetic connotation. It embodies the concepts of continuity of life from generation to generation, diversity of inherent and heritable characteristics, and the potential for increased average fitness in a given environment. As a consequence, these concepts imply a large storage of latent qualities in all individuals, such that the population can tap these hidden traits if the environment requires that they be expressed. Of course, these are the same natural forces which differentiate species, and impel them to continually evolve toward maximum fitness.

We will be dealing with the consequence of these natural forces, modified by man's imposition of his own selective and directional preferences. My approach, as will soon become obvious, is an empirical one, not bound by the rigidity of experimental proof typical of a truly scientific discourse, but more along the lines of a subjective assessment colored and tempered by personal views.

1. Introduction

Food: Key to social progress:

It is seldom disputed that the availability of food is a major factor in social progress. This does not imply that food supply is a determinant force toward peace, or political and economic stability. It simply means that the production and availability of food is a basic concern of all human societies, and as such takes precedence over the expression of so-called higher human achievement, exemplified by intellectual progress which only man is capable of. Thus, to many, food is considered the key to social progress.

It may be worth noting that food is a very flexible means of encouraging and stimulating the development of a nation, probably more flexible than what is so often regarded as the ultimate tool in this context, namely money. Food has the advantage of providing an immediate stimulant, and with current technology can be employed as a lever toward a wide variety of associated activities, all contributing toward the progress sought. Briefly, one could develop a very powerful thesis on the proposition that the production and exchange of food will soon become the most convincing element in many agreements between nations which would otherwise remain at odds.

Animal component of the food system:

In the development of a food strategy within the context of global world food supply, the role of the animal world will remain a predominant one. Since time immemorial, man has relied on the animal world for at least part of his existence. Before becoming sedentary, man hunted the animals as a source of food and clothing. Following sedentarization, man increased his dependence on animals, relying on some of them for draft, on others for protection, and on all of them as a safe investment of capital and as evidence of his total assets.

Despite unbelievable advances in man's way of living, animals still represent a very important part of his daily life. Leaving aside all entertainment and social needs that animals fill in relation to man, there remains their major contribution, which is to man's diet. And in this regard, society will not change its views in the foreseeable future. While the per capita consumption of meat and eggs admittedly varies markedly from nation to nation, it is established that the consumption of these staples increases very drastically as nations evolve towards modern standards of living. And we must not conclude from this tendency that modern trends lead toward less efficient food production systems, despite arguments advanced to that effect by some people, because most species of animals

can be maintained in a symbiotic association with man, and not in competition for the same source of basic nutrients. Ruminants can gaze, particularly in areas not readily accessible, and consume a natural product which otherwise would be wasted. And monogastrics can be sustained in very large numbers on materials which are not consumable by man, and therefore would also be wasted. There is no doubt that man will continue to rely on animals for a good part of his diet for yet a long time to come.

The component of the animal world which is of immediate interest to us is livestock, including poultry. It is the one which is of importance on the North American scene, and indeed in a very large proportion of the world. Let us recognize, however, that some people depend on other classes of animals, not the least of which is fish. But for the purpose of this discussion, we will limit our views to cattle, sheep, pigs and poultry and simply allude to the potential of other species of animals.

Evolutionary derivation of livestock:

It may be worth refreshing our memories from past school days era in regard to the evolutionary relationships between classes of livestock, and between them and other classes of animals. These relationships are shown summarily in Table 1 (a, b, c).

As we go up the evolutionary scale, the first junction of interest is at the level of a very large Class distinction, namely the Mammalia on the one side, and the Aves on the other, the first level of distinction between species of farm animals and birds. From the Mammalia through the placental animals, we derive a very large number of Orders, four of which are shown, either because of their use by man or of their familiarity to man. One Order is of paramount importance at the present time,that of Artiodactyla, because it is the order from which most livestock is derived. Thirty years ago, the second Order of importance, indeed maybe the first one, would have been the Perissodactyla, because horses are derived from it. While some people may still violently argue in favour of it, on the whole it would not be for purposes of food production.

Still at the level of Order, Lagomorpha retains our attention, because it contains rabbits and associated animals which, at some time in the not too distant future may take on much more relevance to food production than they have at the present time.

Of the six families shown under Artiodactyla, only two have a direct bearing on a discussion of livestock, namely Bovidae to which belong our cattle and sheep, and Suidae which is the broad swine family. The cattle genus, Bos, has four different forms or sub genera; one of them is Taurus to which belong to most of our cattle breeds. Two varieties of cattle are distinguished, the typical cattle breeds of the Western World, and the

Table 1 - a. Evolutionary Derivation of Livestock

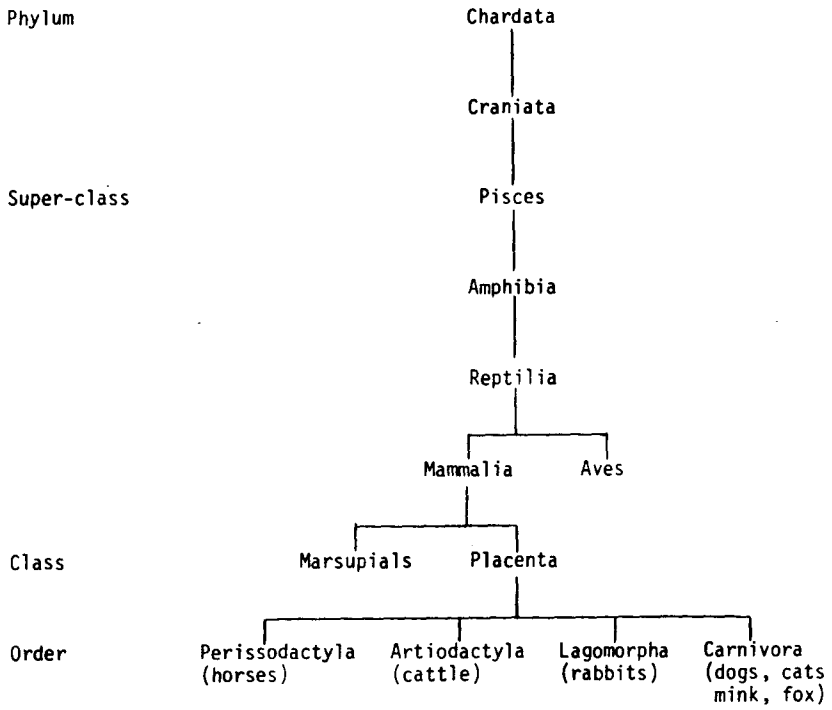


Table 1 - b. Evolutionary Derivation of Livestock

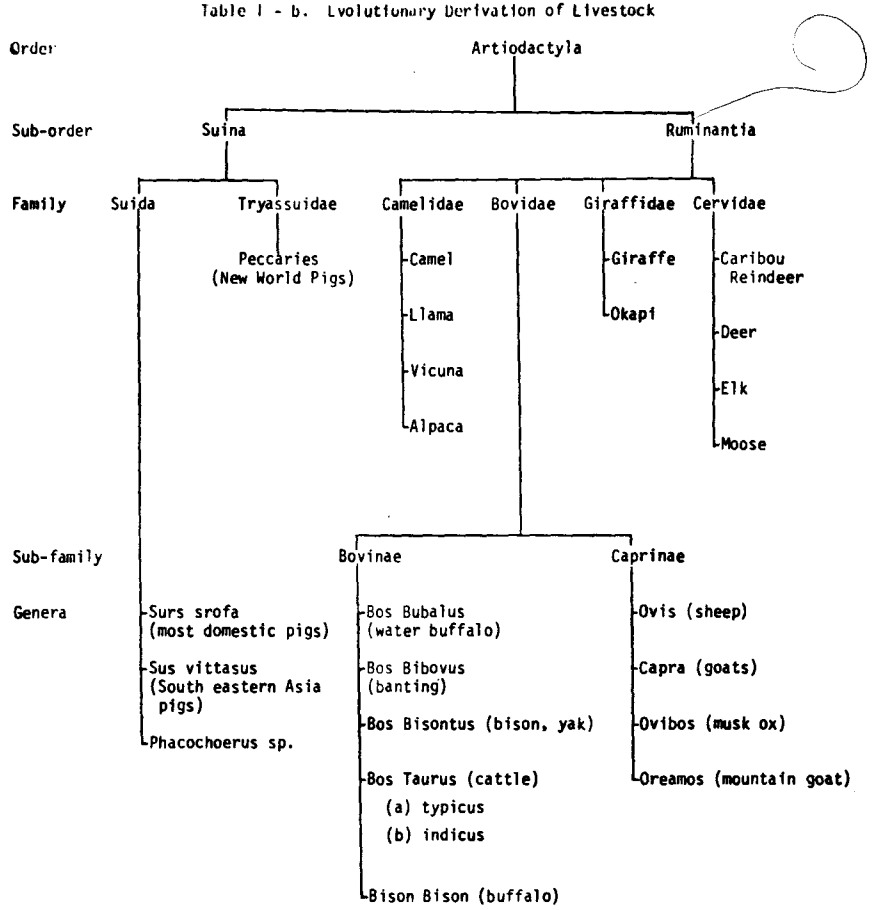
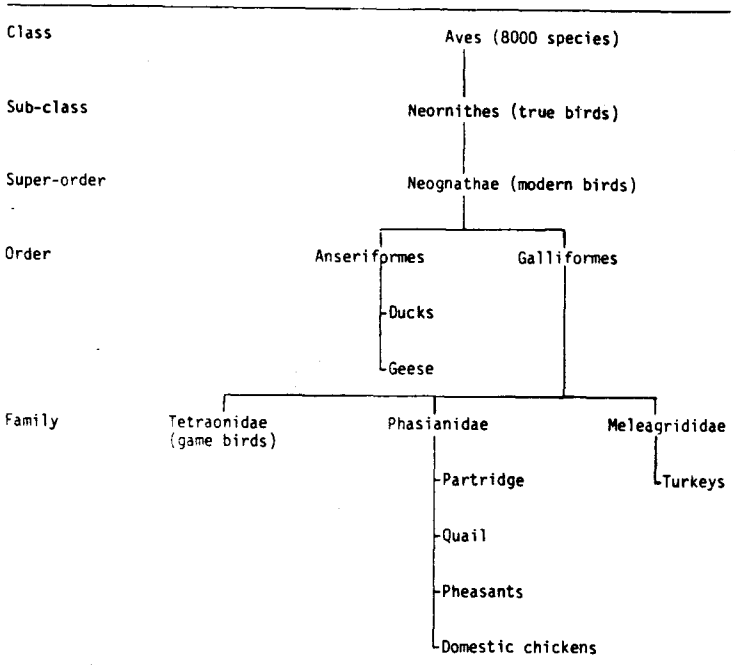


Table 1 - c. Evolutionary Derivation of Livestock (Birds)



Indian breeds. Closely allied to the cattle are the bisons, which can interbreed with cattle but with infertile hybrids. In its sister sub-family are the sheep and goats, with several other genera of somewhat similar but distinct and wild groups. These different genera do not freely interbreed among each other, although they have been observed to occasionally do so. However, there is no scientifically substantiated evidence that hybrids have ever been produced.

Differentiated from ruminants at the level of Sub-Order are the swine, with several families but only one of economic importance. Two distinct species of the Genus Sus have been recognized, namely the scrofa to which our domestic pigs belong, and the vittatus which includes pigs from southeastern Asia, known to have evolved separately from the scrofa species since pre-historic times.

The Aves have evolved along their special lines into numerous differentiated groups, one Order giving rise to waterfowl, the other to our usual meat and egg type birds.

A surprising fact which a review of this type reveals, is the very small, almost insignificant, number of different types of animals which are exploited for man's use. Even from this limited survey, which is hardly a sketch of the entire scope of the species and genera available, there appears to be unlimited potential for capitalizing on inborn qualities of many of the different types of animals, in order to harness their attributes for man's purpose. Breeds as we know them were first developed from non-specialized animals and, through a crude process of selective breeding, gradually evolved into the highly sophisticated beasts which grace our herds and flocks. Considering the much more powerful tools animal breeders now possess, and aided by ever advancing technology, there are unlimited possibilities for increased effectiveness of utilization of species and genera of animals now considered wild and justified solely on ecological grounds.

From this approach to the utilization of animal germ plasm, we cannot help but note the very real need to preserve the existing genetic types, not only to enliven our open spaces and presumably keep "nature in balance", but especially to assure an availability of genetic material which could provide man the basic resource with which to modify and improve existing types, or to evolve completely new models better suited to his requirements. We will return to this need for maintaining the continuity of germ plasm; suffice it to say that we must be altered to the risk of losing invaluable and irreplaceable genetic material, and it behooves us to put in place protective measures which would prevent such disasters.

2. Scope of Animal Germ Plasm in North America

In the vernacular of the animal scientists, species are sub-divided into breeds, and in specialized cases these give rise to lines. The livestock breeds as subdivision of species are equivalent to varieties or cultivars in the plant world.

Concepts of breed development:

Many of our breeds evolved in Europe prior to the 20th century for the purpose of fitting a special need within a relatively small locality. Geographical barriers, including distances of several hundred kilometers, constituted almost absolute separation of the different breeding groups. There thus evolved a very large number of breeds of livestock without much regard to their overlapping qualities. As a matter of fact, it was a basic requirement for a given locality to have its own breed of cattle, and to have it distinguished from other breeds by obvious color markings or shape attributes. From that sense of parochial pride emerged the concept of purity of breeds and the paramount importance for guaranteeing it through recordings in herdbooks, with the corresponding recognition of ultimate achievement on the part of those breeders who were sufficiently qualified to have their animals registered as pure stock.

Crossing lines and breeds:

In the 1930's, the science of genetics mastered the concept of heterosis, and was able to predict the advantages of crossing genetically divergent populations in order to obtain hybrids far superior to either of the parents. This first led of course to the development of hybrid corn. It was followed closely by applications in the poultry industry, with the result that entire industry was completely revamped before 1960 on the basis of inbred line development and hybridization for commercial stock.

But these concepts, of such widespread commercial influence on the poultry industry, made very little inroads in other classes of livestock. Researchers kept looking for ways of producing inbred lines such that crossing them would bring the boon experienced with corn and poultry, but low reproductive rates, long generation intervals, and overwhelming costs of maintaining large populations defied their best efforts, except in relatively sporadic instances. Thus there was little impact of this theoretical and powerful breeding tool on the practical commercial breeders. Until the early 60's, the popular concept of animal improvement still relied on purebreeding and animal registration.

In the last 20 years, the attitude towards purebreeding and the approach to the utilization of breeds have changed markedly. The livestock

community was suddenly made aware of the very large number of breeds available in the different countries of the world, including countries where environmental conditions were somewhat similar to those of North America. Tentative overtures were made to try some of these breeds. As sometimes occurs, fate had its finger in the process and helped to confirm hopes into convictions. There happened to be available in the United States some Charollais cattle which had made its way into the southern states through not too official channels. While these animals were not the best of their breed, when utilized with some of the range cattle, the hybrids exhibited unexpected performance.

From these sporadic and empirical trials spread the notion that benefits would, in fact, accrue from crossbreeding and that foreign breeds should become available for that purpose. These notions of course became supported by very solid and extensive research giving evidence of substantial benefits to be derived from crossing domestic breeds, as genetic theory would have it.

The cattle experience was confirmed by the crossbreeding trials pursued with sheep and pigs, where even new breeds had been evolved based on crossbred populations. These new breeds were as homogeneous as the recognized breeds, and a better fit to a particular purpose or environment.

Breed importations:

Thus originated the movement of livestock from many parts of the world towards North America. The only constraint to their importation, over and above the availability of funds on the part of the importers, was the need to protect, in absolute terms, the general health status of the animal populations already on the continent. To this aim, new quarantine facilities were built by Canada on Grosse Ile in the St. Lawrence and by France on the island of Miquelon. These quarantine facilities served the needs of Canada and most of the United States requirements. Their role was complimented by numerous inspections of the animals involved both before shipping as well as upon arrival at destination.

The wave of entry of cattle breeds on the North American continent, mainly from Europe, lasted from the latter part of the 60's through about 1975, a period of about eight years.

From the very start, there was some effort on the part of serious constructive breeders, and in particular on the part of Agriculture Canada, to import breeds which would fit into a specified development strategy for the beef industry, the main components of which were increased growth rate, leaner carcasses at slaughter, and improved maternal qualities. To this end, knowledgeable animal breeders scoured western European countries to identify the breeds with the required traits, and select the individuals

which were best representatives of their breeds.

But these serious attempts at beef improvement through the importation of breeds were the exception rather than the rule. Breeds were imported on the sole justification that they were new on the North American continent at that time. Their availability therefore conferred upon their owners a highly preferential commercial status. Unbelievable speculation surrounded many transactions of breeding stock from breeds with still few individuals. But gradually the importation fever abated, and the gambler impulse of straight breed speculation cooled down, such that at the present time there are requests for importation permits, but at a more rational level than a few years back. The use of imported breeds for crossbreeding on anything and everything is also less of a wild impulse, with decisions taking on a practical economical sense, although still admittedly somewhat empirical.

It is of interest to glance at the array of breeds of livestock on the North American continent, for an appreciation of the broad availability of animal germ plasm to our livestock industry.

Cattle germ plasm:

Breeds available on the North American continent are indicated on Table 2. There are six that owe their existence and continued presence on the basis of their capability for milk production, although they vary considerably in the chemical composition of their milk. At one extreme we find the Jersey cattle with the highest level of butterfat, of protein, and of solids not fat, while at the other extreme is the Holstein breed with the lowest percentage of these components in its milk. The others are in between in all three aspects. It may seem odd at first glance that the one breed with the poorest milk in terms of its chemical composition is the one which makes up to 80% of our dairy cattle population in Canada. The answer to that, of course, is total yield, in which this breed excells. Through successive generations, the breed has been selected for total milk volume, because that determined revenue. Through this process, we find on the North American continent the most highly specialized cattle for total milk production of anywhere in the world. By the same token, there results a definite dominance of this one breed of cattle over other dairy breeds, although the latter are still present in sizeable populations, except possibly for the Canadian cattle, numbering barely a few thousand head limited to small localities in the province of Quebec.

Of the 11 meat breeds from early importations, three have marked the agricultural development of the continent, namely the Angus, Hereford and the Shorthorn. It may be worth noting that the Shorthorn breed, from its country of origin, has contributed to the development of some

Table 2. Survey of Cattle Breeds in North America

Breed	Derivation (Origin)	Characteristics
d. Recently Imported Breeds		
Blonde d'Aquitaine	S. W. France	Large size, heavy calves
Charollais	France	Large, late maturing, double muscling
Chianina	Italy	Very large, high dressing %
Gelbvieh	Germany	Meat and milk, good muscling
Limousin	France	High dressing %, good conformation
Maine Anjou	France	Large size, good milk prod., used in X-breeding
Meuse-Rhine-Ijssel	Holland	Large size, shorter gestation period
Marchigiana	Italy	Very large, hardy, heat tolerant
Murray Grey	Australia	Early maturing, small to med. size
Normande	France	Milk, med. size, well muscled
Parthenay	France	Very hardy, med. size, ease of calving
Pinzgauer	Bavaria	Med. size, very old breed, meat and milk
Romagnola	Italy	Large size, early maturity, good cut out %
Salers	France	Milk and beef, heavy calves at weaning
Simmental	Switzerland	Meat and milk, large size, heavily muscled
Tarantaise	Alpine France	Small to med., good milk prod., hardy

Table 2. Survey of Cattle Breeds in North America

Breed	Derivation (Origin)	Characteristics		
a. Milk Breeds				
Ayrshire	Scotland	4.0% BF	3.36% Prot.	8.62% SNF
Holstein	Holland	3.7	3.21	8.54
Jersey	Channel Islands	5.2	3.87	9.36
Guernsey	Channel Islands	4.9	3.63	9.13
Canadian	Brittany & Normandy	4.4	-	-
Brown Swiss	Asia, then Switzerland	4.0	3.53	9.04
b. Meat Breeds from Early Importations				
Aberdeen Angus	Scotland	Medium size, early maturing, double muscling		
Brown Swiss	Switzerland	Milk and meat, large		
Brahman	India	Heat tolerance, insect resistance, medium size		
Galloway	Scotland	Polled, hardy, hill type		
Hereford	England	Hardy, early maturing, low milk production		
Highland	Scotland	Hardy, late maturing, small to medium size		
Lincoln Red	England	Medium size, dual purpose		
Red Poll	Denmark, then England	Medium size, long isolated as a breed		
Shorthorn	England	Has contributed to 30 breeds (Lincoln Red, Normande, Maine Anjou, Charollais, etc.)		
South Devon	England	Draft animal, muscled, large size		
Welsh Black	Britain	Hardy, medium size, longevity		
c. Meat Breeds of Recent and Local Origin				
Beefmaster	U.S.A. (50% Brah., 25% Her., 25% Short.)	Large, hardy, good conformation		
Brangus	U.S.A. (Angus x Brahman)	Medium size, resistant to insects		
Hays Converter	Canada (Holst. x Her. x Br. Swiss)	Large, fast growing, excellent udders		
Santa Gertrudis	U.S.A. (Short. x Brah. x Mexican cattle)	Medium size, heat tolerant		

Continued...

30 other breeds, in Great Britain and on the European continent, as well as in North America and in Australia.

There are four beef breeds of more recent origin, three of which have evolved in the United States and the fourth in Canada. All are based on crossbred populations. The three American breeds have some Brahman blood to increase their tolerance to heat and their resistance to insects. The Canadian breed, called Hayes Converter, and admitted to the herd book in 1975, was designed to grow rapidly, to finish without excessive fat, and to confer good maternal qualities on the brood cows.

The fourth group of cattle breeds available in North America is made up of 16 breeds of recent importation, all of them from Europe, except one from Australia. Most are typical meat breeds, some more highly specialized along that line than our traditional North American cattle. Several are dual purpose, in that they are very well fleshed but are utilized in their native environment mainly for milk production. Others are rated as straight milk breeds, but next to our own they would hardly be rated as top milk producers. However, they have the advantage of not only producing sizeable milk productions, but also yielding high quality carcasses at slaughter.

It can be seen that the North American cattle breeder has easy access to some 25 different cattle breeds, to exploit either pure breeds or in a crossing program for a specific purpose. He also has access, though to a more limited extent, to 13 other breeds. One cannot therefore support the proposition that there is a lack of breed material to choose from.

Swine germ plasm:

A survey of the swine breeds in North America is given in Table 3. We note there are nine breeds which have traditionally made up the rostrum of swine breeds in this country. All of these breeds are still widely distributed, with the exception of the Tamworth which is becoming somewhat limited.

Among the old breeds imported, only the Berkshire, the Large Black, and the Tamworth remain, though their popularity is declining rapidly in favour of more fertile breeds, predominantly white.

Four other breeds, all of United States origin, enjoyed some degree of popularity in years past. Two are no more available, the Suffolk and the Victoria. The O I C and the Spot are of restricted availability, the latter having served widely in crossbreeding programs until recent years.

In the last 40 years, 12 breeds or lines have evolved in North America, 10 in United States and two in Canada. Several of these existed as lines in some experimental studies, and never really made it as true commercial breeds. In this group is listed the Lacombe breed, developed in Canada

Table 3. Survey of Swine Breeds in North America

Breed	Origin	Derivation	Litter Size Born	Litter Size Weaned
a. Old Breeds, Wide Popularity				
Landrace	N.W. Europe	Native Celtic Breeds		
Yorkshire	England, H.B. 1844	Large White (Cantonese)	10.9	9.0
Berkshire	England, ca 1830	Old English-Cantonese-Caserta		
Chester White	Penn., U.S.A. 18th cent.	English Imports		
Duroc	U.S.A. ca 1822	Old Duroc-Jersey Red	9.5	5.6
Hampshire	Ken., U.S.A., 19th cent.	Old English	8.9	5.3
Large Black	England, H.B. 1899	No Clear Doc.		
Poland China	Ohio, U.S.A. ca 1835	Berkshire - (Miami)		
Tamworth	England ca 1850			
b. Old Breeds, Limited Popularity				
O I C	Ohio, U.S.A. ca 1865	Chester White		
Spot	Ind., U.S.A. early 1900's	Poland China-Gloucestershire Old Spots		
Suffolk	U.S.A.	Small White		
Victoria	Ind., U.S.A. ca 1850	PC-B-CW-Suffolk		
c. Breeds of Recent Origin				
Beltsville #1	Md., U.S.A. 1934-51	75% Ld-25% P.C.		
Beltsville #2	Md., U.S.A. 1940-52	58% L.W. 32% D, 5% Ld 5% H.		
Maryland #1	Md., U.S.A. 1941-51	62% Ld 38B.		
Hereford	Mo., U.S.A. 1902-20	CW, PC, D, H		
Minnesota #1	Minn., U.S.A. 1936-46	52% T 48% Ld		
Minnesota #2	Minn., U.S.A. 1941-48	40% Y 60% PC		
Minnesota #3	Minn., U.S.A. 1950	Spot, LW, Belts #1 & 2, Minn. #1 & 2, San Pierre		
Montana #1	Mont., U.S.A. 1936-48	58% Ld 42% H.		
Palouse	Wash., U.S.A. 1945-56	65% Ld 35% CW		
San Pierre	Ind., U.S.A. 1953	CW, B.		
Lacombe	Alta., Can. 1945-52	55% Ld, 22% CW 23%B	10.5	8.3
Managra	Man., Can. 1956	Ld, Wessex S.B., Welsh, B, Minn., T.Y.	9.3	7.8

which in the last 15 years, has had a considerable impact on the Canadian hog industry.

The last decade has witnessed a noticeable change in the preference of breeders for white breeds, the coloured breeds having previously enjoyed wide popularity for many years.

With the increasing reliance on crossbreeding, the concept of producing sire and dam lines, to be crossed for market hog production, is gaining ground. Breeds such as the Hampshire and Duroc have established themselves as excellent sire lines because of their superior growth and carcass quality. Such breeds as the Landrace, Yorkshire, Chester White and Lacombe, as well as their derivation into the Minnesota #3, the Palouse, and the O I C, are becoming dam lines. The other breeds, in general, are slowly declining, because they cannot compete with equal degree of excellence.

Another fact worth noting is the almost total absence of sound objective performance traits which can be used to compare the breeds under any given set of environmental conditions. The scientific literature is loaded with performance records. However, these do not reflect relative breed performances, and therefore have no validity in comparing breeds, or are derived from tests pursued 20 years ago or more, and so have little relevancy to the present time. This disconcerting fact is particularly true with respect to maternal qualities, the most determinant factor for an economical swine breeding enterprise.

Sheep germ plasm:

There is documentation on over 400 breeds of sheep spread all over the world. Most of the breeds are of local interest; no more than 50 have any global significance. Our breeds were developed during the 17th to the 19th century, and were brought to the New World by the early settlers.

A survey of the sheep breeds in North America is given in Table 4. The imported breeds were basically meat breeds, and came in large part from England, with France contributing the Rambouillet and Finland the Finnish Landrace. Two of the breeds belong to the fat tail type sheep, namely the Tunis and the Karakul, and their distribution as yet is exceedingly limited. Nine other breeds evolved in the United States and two in Canada, though they are based on ancestors which themselves were imported. The most recent addition to the score of sheep breeds in North America is the Polypay, created by the USDA during the 1970's.

Because of the decline in the sheep population in the last 50 years, and the fact that sheep have reached such small numbers as to endanger the existence of at least several breeds on the continent, many studies have been directed towards identifying major factors which would in-

Table 4. Survey of Sheep Breeds in North America

Breed	Origin	Derivation	No. estrus cycles/year	Prolificacy
a. Imported Breeds				
Cheviot	Eng.-Scot.	Leicest-Blackface	-	114-178
Cotswold	England	Leicester-Hampshire	-	114-150
Dorset	England	Leic., South, Mer., Old Dorset	10-17	127-160
Eng. Leicester	England	Old Leicester	-	120-165
Hampshire	England	South. x Wiltshire Horn	8-10	175-200
Lincoln	England	Leicester x Old Lincoln	-	125-160
Oxford Down	England	Cotswold x Hamp. x South.	-	125-175
Rambouillet	France	Spanish Merino	11-13	105-160
Shropshire	England	South. & Cannon Chase	-	125-175
Southdown	England	Sussex	-	125-150
Suffolk	England	South x Old Norfolk	9-12	130-180
Clun Forest	Eng. & Wales	Shropshire	-	115-175
Corriedale	N. Z. & Aust.		-	125
Scottish Blackface	Scot.	Blackface mountain type	-	109-139
Wiltshire Horn	England	Berk. x Southdown	-	-
Romney Marsh	England	Old Romney	-	105-145
Border Leicester	Scot.-Eng.	Leicester x Cheviot	5- 9	113-200
Tunis	Tunisia	Barbary	-	140
Karakul	U.S.S.R.	Ancient breeds	-	100-125
Finnish Landrace	Finland	Northern short tail type	-	240-250
b. Breeds of Domestic Evolvement				
American Merino	U.S.A.	Spanish Merino	-	115-135
Columbia	U.S.A.	Lincoln x Rambouillet	-	120-165
Southdale	U.S.A.	Columbia (South. x Corr.)	-	153-172
Navajo	U.S.A.	Churro	-	140
Panama	U.S.A.	Rambouillet x Lincoln	-	-
Romeldale	U.S.A.	N. Z. Romney x Ramb.	-	-
Targhee	U.S.A.	Ramb. x Linc. x Corr. x Col.	12	120-165
Romnelet	Canada	Romney Marsh x Ramb.	-	139-157
Newfoundland	Canada	Mixed meat breeds	-	130-160
Polypays (Morlamb)	U.S.A.	(Targh. x Dor.) x (Ramb. x Finn.)	-	-

crease the economic return from sheep and thereby assure the industry a viable existence. Such studies have usually revealed two traits of paramount importance, namely long breeding seasons, during which the sheep exhibit several sexual cycles, and prolificacy. In surveying breeds available on the domestic scene, it is of interest to note how they rate with respect to these two most important traits.

Breeds that stand out in terms of the number of estrus cycles during the year are the Dorset, the Rambouillet and the Targhee, all well known for their ability to breed during so-called out of season. They are followed closely by the Hampshire, the Suffolk and the Romney breeds.

In terms of prolificacy, the Finnish Landrace is by far the superior breed. It averages about two and one-half lambs per litter. Other breeds which trail far behind, but are nevertheless noteworthy in this respect, are the Hampshire, the Suffolk, and the Border Leicester, although the latter is so variable in this regard as to be of doubtful superiority.

The Polypay sheep was developed for extended breeding capability combined with high prolificacy, but no sound records are yet available on its relative performance in this regard.

Looking beyond the North American continent, other super-fertility breeds, beside the Finnish Landrace, can be identified. Notable among these are the Blackbelly from Barbados, the Booroola Merino from Australia, and the D'Man from Morocco. These high fertility breeds have the disadvantage of slow growth rate and rather poor carcass quality. However, in combination with the appropriate North American meat breeds, and given the fairly high heritability of growth and carcass traits, these disadvantages should be readily overcome.

The sheep industry has not yet been marked by the technological developments and innovations which can assure it an economic advantage in comparison to other breeds of livestock. It will need profound adjustments in modern production techniques before it can reach a level of competitive productivity. There is good evidence that the components for a modern revamping are already available; the various options need to be tested commercially, and development strategies need to be evolved to encourage rapid progress toward the objective sought.

Poultry germ plasm:

In looking at the poultry industry from a germ plasm standpoint, one is quickly made aware of its total departure from the trend set by other classes of livestock. The industry does not depend on a number of breeds, fragmented among a large number of breeders, as was the case in the other areas reviewed. The domestic fowl industry is totally based on highly selected lines maintained by large industrial suppliers, with an appropriate

line crossing pattern to meet a specific objective, whether it be egg laying or meat production. Birds are supplied to commercial producers as hybrids to be utilized solely for the production of a marketable product. These birds being hybrids out of specific lines, they cannot be used for breeding purposes without bearing the very heavy penalty of genetic segregation, resulting in much lowered and noncompetitive production levels. Thus, the industrialized supplier of hybrid birds enjoys the rewards of a captive market, since he has to continually supply the commercial producer with production stock.

Professor Crawford, from the University of Saskatchewan, writing on the state of the Canadian poultry industry, has these comments to make.

> "Breeding of commercial stocks has been taken over by multinational corporations who sell poultry as tradenamed crossbreds. Only one major breeder of commercial chickens, producing both broilers and layers, remains in Canada, and there is one major breeder of turkeys. Commercial production flocks are derived from these and from American and European corporations."
>
> "During the period of change from local breeding to breeding by distant corporations, there was immense loss of genetic variability."

Such a purely mercantile approach to an industry as important as the poultry industry can have disasterous effects for the future, if no precautions are taken to maintain some availability of genetic diversity, in order to evolve stocks in line with changed conditions of management and environment. It was to stay this trend toward the elimination of basic genetic stocks that Dr. Crawford, and his colleagues from various other institutions in Canada, have seen to the maintenance of several foundation breeds of poultry, as well as stocks of various other types of birds. A summary of the stocks maintained is given in Table 5.

Of the domestic fowl, most stocks are strains of White Leghorn. The other strains, particularly the old breeds, are represented in exceedingly limited number. Indeed their small population size puts their continued existence in constant jeopardy.

Turkeys experience the same industry situation as the domestic fowl, in that the breeding strains are maintained by very few large international corporations, and only the hybrids are supplied to the commercial producers. Only four lines of turkeys are maintained at public institutions in Canada, although three are kept in fairly large numbers and definitely assure the continuation of the population.

The other birds maintained at public institutions are for the purpose

Table 5. Poultry Stocks Maintained at Public Institutions in Canada*

Domestic Fowl		
S. C. White Leghorn	-	29 strains
Brown Leghorn	-	2 "
New Hampshire	-	4 "
Plymouth Rock	-	4 "
Rhode Island Red	-	1 "
Light Sussex	-	2 "
White Wyandotte	-	1 "
Light Brahma	-	1 "
Dark Cornish	-	1 "
Fayoumi	-	1 "
Hamburg	-	1 "
Houdan	-	1 "
Hungarian Yellow	-	1 "
Jersey Giant	-	2 "
Junglefowl	-	1 "
Meat Strain	-	4 "
Mutants	-	13 "
Turkeys	-	4 "
Guinea Fowl	-	1 "
Ring Necked Pheasants	-	1 "
Japanese Quail	-	25 "
Domestic Ducks	-	3 "
Muscovy Ducks	-	1 "
Domestic Geese	-	6 "
Canada Geese	-	1 "

*Information derived from: Catalogue of Poultry Stocks Held at Research and Teaching Institutions in Canada, compiled by R. D. Crawford, Department of Animal and and Poultry Science, University of Saskatchewan, Saskatoon. February 1980.

of research in production techniques or for medical reasons, but are not justified on the basis of maintenance of germ plasm. One might note the very limited number of lines of ducks and geese, and the very near total absence of research conducted with these birds. This lack of research support to areas which offer potential development appears totally unjustified in the eyes of those who project renewed interest in these poultry productions.

3. Effective Utilization of Available Germ Plasm

More information on relative breed merits:

As has been shown, there is appreciable scope in the availability of germ plasm of cattle, sheep and swine, as they presently exist in North America. The obvious question which follows is what best use can be made of this germ plasm. In looking for the answer to this question, one is struck by the lack of objective measures of relative merit of the various breeds and lines, such that sound breeding schemes can be formulated. There is a very clear need to establish conditions whereby such information would become available. At first glance, the task would appear monumental; however, on the assumption that genetic environment interactions for production traits are not of paramount importance, simplified testing procedures could be evolved which would keep the task within manageable limits.

Sampling other breeds for specific traits:

In maximizing productivity, there is no doubt that crossbreeding systems of mating will be further exploited. Commercial crossbreeding should follow some logical pattern, based on known performance of parent breeds, and on a clear definition of the objectives to be obtained. In this context, and on the basis of the fragmentary information available, one might theorize schemes as holding promise for improved productivity. With beef cattle, the development of a crossbred dams with good milking ability and propencity toward twinning, mated to an early maturing beef breed to produce a fast growing market animal with high dressing qualities should be entirely feasible.

In pigs, a well known breeding system involves the combination of white breeds for brood sows bred to such meaty breeds as the Hampshire and the Duroc for market hog production. Other breeds which seem to offer capability for further improvement of existing systems are the Modern Danish Landrace for its maternal qualities, the Pietrain for its exceptional muscling particularly in the primral cuts, and some

of the Chinese breeds for their reputed outstanding prolificacy. These latter breeds are known for their foraging qualities, and these should be made use of in a modern breeding scheme.

In sheep, several European breeds are of interest, but outstanding among these is the Romanov originating from Russia which exhibits as good prolificacy as the Finnish Landrace but has better carcass quality and an apparent advantage in survival ability. One breed with exceptional carcass characteristics is the Isle de France, somewhat comparable, at least in confirmation, to the New Zealand South Down. These breeds would provide existing sheep germ plasm with genetic material beyond the actual normal variation of productivity.

Utilization of presently wild species:

As was pointed out earlier, the whole approach to the use of animal germ plasm is exceedingly narrow when one views the wide spectrum of animal types, many of which either already meet or come close to meeting some specific useful purpose for mankind. This is particularly true with grazing animals. The idea is not entirely novel.

In fact, there are trials underway in Scotland where deer are raised in natural environment with small measures of management to improve the nutritive quality of the forage. They are also raised on pastures, but the level of production is relatively low. However, this does not negate their usefulness where the land is untillable and represents large areas. Elands are used for milk and meat in the Ukraine. The animals are easily domesticated, and are amenable to marked increase in production. Muskoxen, caribou, yaks, are only a few of the still wild species which have been tried and found useful in given environmental conditions.

It is not appropriate to this review to thoroughly investigate the entire potential of the animal world as to its capability for food production. Suffice it to point out that we need to take as broad an approach as possible with all classes of animals in order to take advantage of the tremendous variability in the existing germ plasm. Innovative breeding techniques make these approaches still more feasible. There are exciting and promising areas of exploration, and if we have any deep concern about the food production for tomorrow's world population, we should explore them before the urgent need is brutally thrust upon us.

4. Conservation and Continuity of Germ Plasm

Technological changes:

We willingly admit the world we live in is subject to change, and indeed sometimes changes more rapidly than anticipated, socially, technologically and in other respects as well, with consequent disruptive effects on our deep rooted ways of doing things. Supplying the world with food is no exception. The changes in farming practices that have occurred in the last 30 years make to-day's operations totally different from what they were before 1950. The livestock world has followed a parallel course. The dairy industry has gravitated around the Holstein breed, the swine industry is based largely on about six breeds of which the white ones are the dominant ones, and the sheep industry is showing a clear trend towards the wide use of breeds of high prolificacy. Poultry is the ultimate in this respect, where almost all the old former genetic stocks have been discarded for commercial production in favour of unique genetic lines and their hybrids, highly specific in their requirements.

Erosion of genetic diversity:

The bitter irony of this situation lies in our compulsion to change fast, to readily adapt, to discard genetic types or forms not commercially competitive at that point in time, and thereby eliminate the very substance on which changes and adaptations are based. The process invariably leads to the loss of genetic diversity, and that avenue is a dead end with regards to genetic progress.

There are not yet many cases in point with regards to livestock, except possibly for the Canadian breed of cattle, and the Tamworth breed of pigs, for the trend is too recent to have had irreversible effects in these species. But the poultry industry is facing this very serious threat at the present time, as eloquently stated by Dr. Crawford, and I quote:

> "Public agencies have not shown much interest in halting the erosion of genetic resources, nor have they shown much interest in conservation of resources for the far distant future. The real extent of losses may never be known. Hopefully there is still time to preserve some of the survivors."

Thus, the continuation of the poultry stocks in public institutions in Canada at the present time may play a key role in the continued evolvement of the poultry industry, but under conditions different from those which prevail today. In this regard also, poultry hobbyists and fanciers may come into their own, for they often maintain for show and entertainment purposes stocks which would otherwise have long been discarded.

Germ plasm banks:

Up to recent times, the maintenance of basic types, or forms which assured a wide genetic diversity presented tremendous problems of space, resource requirements, and funds, even when kept in herds and flocks of minimal size.

These difficulties can be surmounted in some large animals particularly through the techniques of semen storage, artificial insemination and ova transplant, but these still do not apply to all species, e.g. poultry because of our inability to successfully freeze semen.

We are fast getting to the point where an urgent solution will have to be provided to this problem of genetic erosion. We should without delay focus our attention on it while there is still time to look objectively at solutions, without the constant threat of impending disaster. As far as poultry is concerned, it is almost certain that it has already reached a stage where a reconstitution of genetic diversity would be exceedingly difficult. Nevertheless, the general problem remains, and begs for solutions through the concerted effort of all those who have declared their concern for the food supply of tommorow's world.

SUGGESTED SUPPLEMENTARY READING

RENDEL, J. 1970. Conservation of animal genetic resources. Science Journal.

LINDSTROM, U.B. 1976. Utilizing animal gene resources. World Animal Review, no. 18.

JEWELL, P.A. 1971. The case for the preservation of rare breeds of domestic livestock. Vet. Rec. 89: 524-527.

CRAWFORD, R.D. 1980. Catalogue of poultry stocks held at research and teaching institutions in Canada. Dep't of Anim. and Poult. Sci., Univ. of Sask., Saskatoon, Sask.

——— 1979. Preservation of poultry stocks in Canada. The Ark, Vol. VI No. 2: 44-46.

CHURCH, D.C. 1969. Digestive physiology and nutrition of ruminants, Vol. I. Digestive Physiology. O & B Books, Corvallis, Oregon.

HSU, T.C. and Benirschke, K. (Ed.). An atlas of mammalian chromosomes. Springer-Verlag, N.Y., Publ.

Breeds of Cattle. Canadex publications on livestock breeds. Agriculture Canada, Information Services.

MASON, I.L. 1969. A World dictionary of breeds, types, and varieties of livestock, Technical Communication (revised), Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh, Scotland.