A large portion of the world's 400+ million head of goats cannot be identified as belonging to a specific breed or well defined genetic type. A common definition of a breed might be group of animals which are reasonably distinct and true breeding, can be identified by a name or term and which have an association to maintain and promote the breed. If the latter requirement is dropped there would still be hundreds of breeds or genotypes of goats on a world basis. Certainly time, space and information available does not permit attempting to treat all of these in this paper.

One approach to the difficulty of dealing with the large number of breeds is to attempt to group or classify into categories. There is obviously no simple, complete or wholly acceptable way of doing this. Mason (1981) has attempted a classification based largely on shape of ears and horns with some emphasis on the role served. For the sake of this discussion the author has attempted a classification or grouping based on form and function, but it is being presented with the realization that a large part of the world's goat population is not provided for in this grouping.

Perhaps the best known group is that of the dairy breeds of European origin. Many of these were developed in the Alpine region and, thus, are at times referred to as the Alpine breeds. Some of the better known examples are the Saanen, Toggenburg, Alpine and Poitevin. Others are listed by Mason (1981) and Ricordeau (1981). These goats are most successfully produced under good feed conditions in temperate climates but are often used for crossing or on a limited scale in less favorable environments.

Another largely distinct group of goats are the long legged, long or lop-eared goat found throughout much of Africa and Asia. Many are also Roman nosed which often results in a malformation of the mouth. Many are polled or have only short horns. This goat is thought (by the author) to have originated in Africa, but it can be traced through similar features from the Southern part of Africa through the Middle East into Asia. It has, also, been introduced to many other parts of the world. Some breeds in this group include the Nubian, Damascus or Shami, Zaraibi, Jamunapari, Beetal and the Bhuj. One could easily visualize an adaptive advantage for these long legged upstanding goat under browsing conditions. However, limited research has not necessarily supported this theory as some do not appear to offer superior adaptation to adverse feed conditions (Figueiredo, et al. 1983). This is particularly true of the more exaggerated shallow bodied types such as the Beetal or Bhuj. This group of animals is generally characterized by late maturity or late sexual maturity.

A third group is that of the dwarf types. These are found in both Africa and Asia. Some recognized breeds or types include the Small East African, West African Dwarf, the Black Bengal and the animal known as the Pygmy in the U.S. Mason (1981) and others mention the term...
"achondroplastic dwarf" in connection with these animals. This may well be an explanation for their short stature but in the writer's experience there is no evidence of the abnormal features sometimes associated with achondroplastic dwarfs. In other species this condition is inherited as a simple recessive. If a recessive gene in a homozygous state is the explanation for the small stature one might expect a cross to be of normal stature. This is not necessarily true. In contrast to the long legged type, sexual maturity of these small animals is very early and other reproductive parameters are also generally favorable.

Those breeds of goats which are exploited for fiber production are somewhat distinct. The most distinct breed in this group is the Angora. Others include the Cashmere and perhaps the Don goat of the U.S.S.R. The term Cashmere is actually more indicative of a product than a type of animal. The term Pashm or Pashmina is sometimes used interchangeably with Cashmere. Hair is at times harvested from other goats besides those producing Mohair (Angora) or Cashmere but this is usually limited in amount or is a secondary product. For instance, the Baladi (native) or Syrian Mountain goat has been historically used to produce the black goat hair used in making tents for the desert nomads (Bedouin) of the Middle East.

The previous discussion makes no distinctions in regard to goats which are exploited for meat or for skins. All goats produce these products but no breed clearly stands out as being unique or superior. The one possible exception in respect to meat is the Boer of South Africa. Tropical goats with minimal hair cover appear to produce more valuable skins. The breeds often mentioned as producing superior leather are the Maradi or Red Sokoto of Niger and Nigeria. The product produced from these is often merchandized as Moroccan leather.

A large part of the world's goat population is unaccounted for or does not easily fit the above categorization. Many of these represent an amorphus collection which does not meet the requirements for being called a breed. Other types often called breeds are largely color variations which have been fixed in the genotype (Shelton and Figueiredo, 1981). Still others fit within the above breed groups or represent crosses between them.

Reasons for Crossbreeding

Crossbreeding may be practiced for one or more of the following reasons: (a) To exploit the phenomenon of heterosis, (b) Breed effects and complimentarity, if any, (c) An initial stage in the transition to another breed, (d) To provide a base population for use in the establishment of a new breed. Decisions concerning breed of choice and method of use for crossbreeding would be greatly dependent on the reason for which crossbreeding is being considered.

Crossing for Milk Production

Only a small portion of the world's goat population is milked. However, the value (to man) of the milk or products obtained from milk is thought to exceed that of any of the other products obtained from goats including meat (Shelton, 1978). The explanation for this is that milk is produced on a reoccurring basis, whereas meat or skins are only obtained at slaughter. Fibers are harvested annually or biannually but fiber is harvested from only a very small part (less than 5%) of the world's goat population.

If the goal is to commercialize milk production from goats, even as a by-product of a home milk supply, it is the writer's belief that only
genotypes which have benefitted from some selection for milk production should be considered. The established dairy breeds of European origin are generally recognized as being the most productive. Others such as the various types of Nubian or the Damascus should be considered in environments to which they provide superior adaptation. Questions relating to crossbreeding deal largely with the desirability of crossing the recognized or the established dairy breeds on unimproved goats in less favorable environments. The writer was not able to locate references to crossbreeding studies between established dairy breeds. The small size of most dairy goat flocks would create problems in the maintenance of the breed groups required to utilize a systematic crossing program. A much more pertinent question relates to the use of established dairy breeds to improve milk production of unimproved types and usually in unfavorable environments. This subject has been rather extensively reviewed by Sahni and Chawla (1982), Ricordeau (1981), and Garcia and Gall (1981). No attempt will be made in this paper to repeat these extensive reviews. Some data (adapted from Sahni and Chawla, 1982) reported in Table 1 provides a comparison between three Alpine breeds (Saanen, Alpine and Toggenburg) in temperate and tropical or subtropical environments. These data show a reduced performance of these breeds in tropical or sub-tropical environments.

Table 1. Lactation Levels of Alpine Dairy Breeds in Temperate and Tropical Environments

<table>
<thead>
<tr>
<th>Breed</th>
<th>Lactation yield in kg.</th>
<th>Temperate</th>
<th>Tropical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saanen</td>
<td>682</td>
<td>389</td>
<td></td>
</tr>
<tr>
<td>Alpine</td>
<td>642</td>
<td>283</td>
<td></td>
</tr>
<tr>
<td>Toggenburg</td>
<td>631</td>
<td>267</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from Sahni and Chawla (1982).

However, data from some countries suggest that much of this reduced performance can be overcome by management or nutrition. Data on Anglo Nubians are not included in the above tabulation because of the nature of the data available. Extensive information is available to suggest that they would have lower milk yields, higher butter fat content and, in some cases, be less seriously affected by adverse environments.

Data reported in Table 2, also adapted from Sahni and Chawla (1982), indicate the expected response from crossing certain European breeds (mostly Saanen and Alpine) on native goats in the tropics.

Table 2. Results of Crossing Exotic Dairy Breeds (Mostly Saanen and Alpine) on native breeds in the tropics (lactation yield in kg.).

<table>
<thead>
<tr>
<th>Native</th>
<th>1/2 Exotic</th>
<th>3/4 Exotic</th>
<th>7/8 Exotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>154</td>
<td>308(14)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>161</td>
<td>-</td>
<td>399(10)</td>
<td>-</td>
</tr>
<tr>
<td>140</td>
<td>-</td>
<td>-</td>
<td>323(2)</td>
</tr>
</tbody>
</table>

1 The number in parenthesis represents the number of experimental comparisons on which these data are based.
These data appear to show clearly that crossing with the established dairy breeds contributes to improved milk production. The data in Table 2 represent a summarization of data from a number of experiments. Table 3 contains results from specific experiments conducted in India, by the same authors, relating to crossing Alpine and Saanen on Beetal goats. The latter is considered one of the milk or dual purpose breeds in India. These data again suggest a substantial advantage for the use of improved exotics for milk production. It also seems to suggest the F1's were superior to those with 75% exotic breeding.

Table 3. A Comparison of Beetal and Crosses with Exotic Dairy Breeds Under Indian Conditions.1

<table>
<thead>
<tr>
<th>Breeds Under Indian Conditions</th>
<th>Beetal</th>
<th>Saanen &amp; Alpine combined</th>
<th>3 Breed cross</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>F1 or A backcross</td>
<td></td>
</tr>
<tr>
<td>Milk Production, kg.</td>
<td>164.3</td>
<td>303.1</td>
<td>291.4</td>
</tr>
<tr>
<td>Lactation length in days</td>
<td>184.7</td>
<td>248.2</td>
<td>230.0</td>
</tr>
<tr>
<td>Kidding intervals days</td>
<td>321</td>
<td>361</td>
<td>332</td>
</tr>
</tbody>
</table>

1 Adapted from Sahni and Chawla (1982).
2 Data on 3 breedcross is based on small numbers and apparently represents 75% exotic as with the backcross except that both exotic breeds are present.

The data presented tend to leave unanswered some very important questions. For instance, should producers make repeated crossing in some controlled manner or should attempts be made to establish new populations based on interse matings of crossbred groups? It seems likely to the writer that best results will be obtained from repeated crossings. Under conditions of developing countries this will often be difficult to implement and, thus, attempts at establishment of new breeds may be warranted. However, there is a dearth of success stories from developing new breeds. Another question which might be addressed is how the exotic crosses involving European breeds compare with local or indigenous types which have received some selection emphasizing milk production? Allegedly, the Beetal and Jamunapari of India are milking or dual purpose types. The data presented shows that exotic crosses are clearly superior in milk production. Another type which has received some selection emphasis on milk production is the Damascus (Shami), African or Egyptian Nubian (Zaraibi) and similar types found from North Africa through the Middle East. The writer did not find data relating to direct comparisons with these and exotic crosses. Though, in general, favorable results have been reported with the Damascus, particularly from Cyprus (Louca, et al.1975). Also, Aboul-naga, (1985) reported increased milk production from these types (Damascus and Egyptian Nubian) or their crosses on Barki goats under Egyptian desert conditions, although the actual lactation levels were generally low for all types.

One point which stands out from the literature is the generally low level of milk production of adapted native or indigenous types. This would appear to suggest a negative relationship between adaptability and level of lactation. Milk production and meat production should not necessarily be antagonistic, at least under reasonably good feed conditions. Ricordeau (1981) reports a positive genetic correlation between milk yield and reproduction and growth. The two (meat vs. milk) may well be antagonistic in terms of management. Perhaps the best
example of exploitation of goats for meat and milk production is that of Cabrito production in Mexico in which the does are milked following weaning of kids. It is the writer’s opinion that milk production should not be encouraged or attempted unless a suitable level of nutrition can be provided. For instance, Tuncel (1985) reported highly favorable results from crossing exotic types (Saanen) on native (Kilis) goats under experimental conditions in Turkey but inferred unfavorable results when this practice was extended to field conditions.

**Crossing for Meat Production**

Most goats are exploited only for meat production. With the possible exception of the Boer, no breeds have been developed or identified which are clearly superior in terms of meat production. In the writer’s opinion there is a great deal of confusion in breeding for meat production regardless of the species. The goat has little claim to fame (Shelton et al., 1984) in terms of growth rate, dressing percent, meat or carcass quality, feed efficiency, etc. The contribution of the goat to the world meat supply is derived largely from the fact that they can be produced in less favorable environments or from resources not well utilized by other species. Other factors are specialized products (Cabrito in Mexico) or the preference by certain population groups for the meat produced by the goat. The percent of the total population expressing a preference for goat meat is small and even most of these expect to purchase goat meat at a lower price.

Nutritional efficiency of meat production is largely a function of:

(a) net reproductive rate, and (b) slaughter weight as a function of weight of breeding stock maintained. Other major factors which should be considered are traits or features which contribute to quality or value in the carcass (and other products) and any market demands which are unique to the production site. The subject of meat production has been reviewed by Naude and Hofmeyr (1981), Taneja (1982) and Shelton, et al. (1984).

Most researchers, even animal breeders, concentrate on body weights or body weight gains as a measure of meat production while ignoring other attributes. This is almost certainly a mistake with respect to the goat where adaptation is of paramount importance and where the reproductive potential is quite high.

If one looks at growth rate alone the European dairy breeds (Saanen, Alpine, Toggenburg) or those of the long legged, long eared group (Nubian, Beetal, Jamunapari, Damascus) tend to come to the forefront as potential meat breeds. If one looks at reproductive efficiency, including age at sexual maturity and kidding interval, etc., it is often the small goat which excels. Fortunately, there are some data in which these types have been compared in terms of overall production efficiency. The most thorough or detailed study which involves a breed and crossbreed comparisons is that of Singh and Singar (1981). This study involved the four Indian breeds: Jamunapari, Beetal, Barbari and Black Bengal. The first two are typical examples of the large, long legged, lop-eared breeds. The Black Bengal is a very small dwarf type. The Barbari is intermediate between the large and small types. The general conclusions from these studies are as follows:

1. Growth rates or body weights at a given age favor the larger breeds.
2. All reproductive parameters tended to favor the smaller breeds, especially the Black Bengal and its crosses.
3. In terms of efficiency of growth or carcass yields, the larger breeds were not superior to the smaller breeds when slaughtered at comparable stages of growth (ie 50% of mature weight).

4. Thus, overall efficiency of meat production favored the smaller breeds in this study.

To extrapolate from these conclusions to more general situations one must consider whether these results are specific to the breeds involved. It is the writer's thesis that broad generalizations can be made that smaller types tend to be more prolific and that measures of feed efficiency and carcass value may be similar if slaughtered at comparable stages of maturity. However, contrasts in reproductive efficiency with the specific breeds involved in the Indian study may well be greater than can be generalized to the larger population.

One breed which must hold special interest in connection with meat production from goats is the Boer. Little experimental data is available comparing this breed with others under controlled conditions. Reiser, et al. (1985) have presented preliminary data collected in North Tunisia in which the Boer was compared with a local breed and three European breeds (Alpine, Saanen and Poitevin). In general, the Boer equaled or excelled in growth, litter size and kid weight. In terms of kid weight produced per doe and gross income, the Boer proved superior to all other types. When these factors were expressed as a function of size or metabolic weight of the doe or as net income, the Boer was not more efficient or more profitable than the local goat.

The Anglo Nubian has been widely recognized and utilized as an improver breed for meat production. Assuming the Boer is not available, the use of the Anglo Nubian for this purpose is a reasonable choice. It has been shown that Anglo Nubian crosses contribute improved growth over native types in Northeast Brazil (Fernandes et al., 1985). In addition, the Anglo Nubian is comparable to other large breeds in reproductive rate (Ricordeau, 1981). There is a widespread belief that they are better adapted to tropical conditions than the Alpine types. Research data do not seem to be adequate to provide a clear cut recommendation as to how the Nubian should be used. The choices would appear to be, (a) as a sire breed in a systematic crossbreeding program, (b) to produce F1 females, (c) for grading to Anglo Nubian or (d) to establish a new breed based on a crossbred foundation. All of these appear to present viable options under some conditions. Their use as a sire breed should prove of value but opportunities to utilize them in this manner will be limited. There remains serious doubt if grade or pure Anglo Nubians will be more efficient meat producers than many native types.

Opportunities to Improve Meat Production in Goats

Management and improvement of goats for milk and fiber production are reasonably straightforward and efficient industries exist for exploitation of these products. Problems of varying degrees are encountered in breeding for a high level of milk and fiber production and adaptation to adverse environmental and nutritional conditions. However, many problems or, conversely, many opportunities exist to improve the goat as a meat producer. Although most goats are exploited only for meat production, a large portion of these are found in adverse environments and/or in areas where overgrazing is a common problem. The "offtake" from these flocks is generally low compared to the potential. A primary challenge is to reduce stocking rate in many of these areas, thereby contributing to a reversal of resource deterioration and to
improve productivity with the result that "offtake" is maintained or increased. The approach to be taken and the contribution of animal breeding to meeting this challenge is not clear. The dominant factor to date in regards to genetics has been natural selection for adaptation or survival. Observations to date suggest a negative relationship between adaptation and certain measures of individual productivity.

Some specific problems encountered with goats include high abortion rates (Figueiredo et al., 1983), high death losses and slow growth of kids, (Garcia, 1982), poor feed efficiency, (Singh and Singor, 1981), low dressing percent (Shelton, et al. 1984) and small bony cuts of meat which generally sell at a disadvantage relative to other meats. Genetic approaches to dealing with these specific deficiencies has received little attention.

In addition to the above problems, neither animal breeders nor producers have faced the issues of how to breed for meat production. It is clear that we do not "get something for nothing" and increases in production carry with them a cost which when considering the goat may be of particular importance. If costs increase in a linear way with increased production then the gain may be nil. There is strong supporting information to suggest this is the case for gain brought about merely through increases in size. If these increases (in size) carry with them losses in such traits as reproductive efficiency or fitness, the end result could be the opposite to that desired.

A primary opportunity to improve usefulness of animals to man is to shift the animals metabolic priorities to produce those products desired by man. The success of selecting for both milk and fiber production is an example of this. Since highly fertile (Black Bengal) and large growthy (Boer, Anglo Nubian) types are available, the opportunity to improve efficiency of meat production through the use of the latter as a terminal sire should be apparent. However, most goats are produced under conditions (small holder or communal grazing) where a structured crossbreeding program would be difficult to implement.

There is some indication of species and breed differences in respect to sexual dimorphism and that goats exhibit this to a greater degree. Since surplus males constitute the most important source of meat, sexual dimorphism resulting in larger size of males offers a potential means of increasing efficiency of meat production. This approach should be explored.

Animals which have been successfully selected for rapid rates of gain and improved carcass yields are generally characterized by high levels of feed intake. Feed intake above the levels required for maintenance contributes to more efficient accretion of meat. The small well adapted goat clearly does not exhibit this tendency and, by analogy with other species, those types which have benefitted from a high degree of selection for increased levels of production generally lack adaptation to adverse conditions. Yet, there are examples of animals in other species which possess both desirable adaptive traits and superior growth rates when conditions are favorable. Ways to accomplish this in the goat need to be studied.

Crossing for Fiber Production

The two goat breeds used for fiber production (Angora and Cashmere) are widely separated geographically and produce distinctly different products. For instance, good cashmere is in the range of 15-18 microns in diameter whereas mohair from adult goats ranges from 25 to 40+
microns. Crosses between the two types on a routine basis would result in a clip which does not meet the requirements of either product. Thus, routine crossing between the two is not indicated. Many types of goats, such as the Spanish in the U.S. or the feral goat of Australia and New Zealand, may produce a limited amount of undercoat or down comparable to Cashmere (Gallagher and Shelton, 1973) but in uneconomic quantities. Workers in Australia and New Zealand (Clarke, 1982) are attempting to use these types or crosses between these and Angora to develop a Cashmere producing goat. Crosses between the Don goat and the Angora have been made in the U.S.S.R. (Misharev and Zaporozhtsev, 1974) but it is the writer's belief that this was done primarily to provide a base for grading up to the Angora. The most pertinent question concerning crossing of fiber producing goats is that of crossing Angora on other types for grading up to Angoras. This practice was used in U.S. and R.S.A. when this industry was first established. Thus, there is producer experience with this practice but research documentation has been limited. Currently there is a major resurgence of interest in the Angora in many countries. Therefore, the practice of grading up holds considerable interest. Preliminary results from two limited studies are available. One of these was done in India and reported by Patil (1982) and Koratkar and Patil (1982). The other was reported by Thompson and Shelton (1982). In general, these data indicate a long time period required to upgrade to an Angora with a suitable fleece. In the Indian study the half-breed was not shorn. With the 7/8 or 15/16 Angora a percentage of the population exhibits an unsatisfactory type of fleeces with a high kemp content and low fleece weights. If each cross is kept for a normal generation interval, then 15-25 years would be required in the grading up process. If Angora does of any type are available, then multiplication of this population may provide a more satisfactory approach. Embryo transfer has been used successfully in some countries to generate numbers. The fact that the F1 (Angora x native) shows good hybrid vigor in kid production may partially justify the crossbreeding approach. No hybrid vigor, or even the reverse, is seen in fleece weight as the F1 does not equal the mean of the parental types. New Zealand producers (Bigham-1985) have been successful in merchandizing to good advantage the fiber produced by the crossbred animal. This product, known as Cashgora, has sold at a price well above that of Mohair. Other countries have not necessarily exploited this potential. The down or undercoat of the F1 approaches but does not equal that of Cashmere in fineness.

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