USAID CASHMERE BREEDING PROGRAM EVALUATION: MONGOLIA

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PREFACE

Background

The United States Agency for International Development program in Mongolia funds a number of projects to promote improvements in Mongolia's ability to produce and export quality cashmere products. Two programs work in the agricultural sector to introduce improved breeding and commercial herd management practices. ACDI/VOCA's *Farmer to Farmer Program* implements a breed improvement program designed to produce pure-bred Mongolian breeding stock, and to increase the numbers of such breeding stock available to commercial growers through sales or auctions. This program is on the verge of expansion to create new elite breeding herds. *The Gobi Regional Economic Growth Initiative*, implemented by Mercy Corps International, has an agricultural program that works with commercial herders on improving herd management, record-keeping, and breeding, and will also be expanding it's program to include other breeding activities.

Purpose of Evaluation

The two USAID funded projects have breeding programs whose operational objectives are different and which also differ on questions of methodology and practice. There is no question that the programs in Mongolia have contributed to a definite improvement of the situation since their inception, but some questions remain as to whether or not the most effective techniques are being used. USAID is interested in achieving results and wishes to ensure that the methods employed by its contractors are as effective as they can be given the factors prevailing in Mongolia.

The objective of this assignment was to evaluate the activities of the USAID funded programs involved in breeding to determine if these programs best address the needs of the Mongolian cashmere industry. Additionally the consultant was tasked with conducting an evaluation of the goals of all programs and their commercial applicability as well as the principles on which the programs are based and the methodologies they employ or the activities they have designed.

The consultant, Dr. Barrie J. Restall, was in Mongolia from May 12 to June 9, 2001. At the close of his assignment the consultant conducted two workshops. One, a two-day technical workshop for breeders, breeding researchers and personnel involved in the breeding programs; where Dr. Restall discussed in-depth his findings and technical improvements that can be made to improve the breeding of cashmere goats. The second, was a short seminar for government officials, NGOs and donor organizations focusing on strategies for increasing Mongolia's competitiveness in the cashmere industry through improvements in fiber production. Dr. Restall presented a draft report with his findings to USAID prior to his departure.

The consultant would like to thank the principals and staff of ACDI/VOCA's *Farmer to Farmer Program* and to Mercy Corps' *Gobi Regional Economic Growth Initiative* for their informative discussions, arranging various visits, and providing reports and other documents that assisted with the overall evaluation of their programs. Additionally Dr. Restall would like to thank Dr. Badarchin Myakhdadag of the Ministry of Food and Agriculture and Dr. Zagsduren and his group at the Research Institute of Animal Husbandry, Mongolian Agricultural University, for the provision of cashmere goat production data and discussions.

INTRODUCTION

The broad terms of reference of this assignment required the consultant to assist USAID funded projects and the Mongolian cashmere industry as a whole to promote, disseminate, and implement the best possible breeding practices for the improvement of their cashmere goats.

This report contains a summary of the findings on goat breeding in the Mongolian cashmere industry, and the two specified USAID sponsored projects, in the context of modern animal breeding practice.

General Impressions of Mongolian Cashmere Breeding

Some salient features of the Mongolian cashmere breeding industry are:

1. Cashmere processors, and others, are concerned at the varying quality of Mongolian cashmere and are encouraging the production of fine cashmere. This is perceived as a National issue.

2. There are no nationally organized breeding programs for the improvement of cashmere goats and cashmere quality.

3. Several groups, including the two specified USAID funded projects, have begun breed improvement programs at the regional and herder level.

4. There are some differences in approach to breed improvement that are perceived as difficulties but which are entirely compatible.

5. There are fundamental problems with the measurement of cashmere production and quality that render inappropriate some currently recommended methods of breed improvement. Alternatives are available.

6. There are peculiarities in the relationships between the characteristics of cashmere production measured on the Mongolian goat that need further study to validate and improve the efficiency of the selection methods for improvement in cashmere production and quality.

7. There is a shortage of suitable bucks for cashmere goat improvement in Mongolia.

8. There are several systems for the breeding and dispersal of improved goats that can exist side by side, but not all stakeholders are aware of the choices.

General Recommendations

At this early stage in the Mongolian cashmere breeding programs, it is appropriate to develop strategic cashmere breed improvement plans at national, regional and herder level that will:

- **Plan for the long term;**
- **Utilize the existing resources effectively; and**
- **Use appropriate methods at each stage of development.**

A systematic approach to developing such plans will require disciplinary expertise in genetics and modern animal breeding methods in the formative stages, and periodically as the plans are implemented.

In this regard, the strengthening of existing Mongolian animal breeding expertise is essential for continuing the development of the cashmere goat breeds in Mongolia.

As Mongolian resources are limited, co-operation between all interested parties and the breeding groups should be facilitated and coordinated where appropriate.

The various government and non-government agencies involved in promoting cashmere goat breeding need to consider the long term consequences of any preferred sets of breeding objectives and implement appropriate policies to protect, encourage and assist the goat breeders in attaining the chosen goals.

Any strategic plans for cashmere goat breeding will need to integrate with other initiatives influencing animal production and profit in general, including those concerned with rangeland management, animal health and management, and marketing. The breeding programs should be viewed as a component of the whole system.

Notwithstanding the above recommendations, breed improvement schemes have commenced, and no doubt more will arise, irrespective of the presence or absence of strategic plans. As far as possible, these schemes should adopt modern animal breeding practices in such a way as to facilitate future integration into development schemes in general.

Findings

This report, **USAID Cashmere Breeding Program Evaluation: Mongolia,** contains recommendations for the improvement of the Mongolian cashmere industry and a summary of the merits of the two breed improvement programs funded by USAID. The report focuses on general as well as a more technical dissection of some key issues, including the validity of some currently recommended breeding practices, cashmere measurement problems, and the development of appropriate selection strategies.

Additionally, the report provides a set of selection strategies that may serve as examples of a useful methodology for the Mongolian cashmere breeders, irrespective of whether they are individual herders, co-operative breeding groups or commercial breeders. These selection indices aim at increasing cashmere production while maintaining quality – a key goal to USAID's support to this sector. This is the most pertinent and important section of this report and it is recommended that it be made available to all interested parties.

The Mongolian Government Resolution 199 clearly promotes cashmere breeding and processing as a major priority for the rural sector. The Ministry of Land and Agriculture have already commenced surveys of the indigenous goat breeds and the breeds derived from the Russian crossbreeding. The two USAID funded projects, ACDI/VOCA's *Farmer to Farmer Program* and Mercy Corps' *Gobi Regional Economic Growth Initiative* have commenced breeding activities and some private ones as well funded in part by cashmere processors.

Given the importance of these initiatives it is essential that efficient methods be used to exploit the genetic resources available. A number of issues were observed that indicate problems with achieving these goals. These are dealt with in some technical detail in the following sections.

At the center of the selection problems are the measurement techniques for the important cashmere traits and the lack of information on their genetic and phenotypic relationships.

A further problem is the lack of a systematic operational protocol for the nucleus breeding groups (or indeed any breeding group). The technical people involved have, more or less, knowledge and experience of these systems but the application does not appear to be rigorously applied and many operational issues involved have not been addressed. In the handbooks produced by both the *Farmer to Farmer Program* and the *Gobi Initiative* there are some operational errors; in other parts important operational issues (elimination of young males) are canvassed but not put into an overall operational plan. These are discussed in detail in another section of this report.

I. DEVELOPING BREEDING PROGRAMS FOR THE MONGOLIAN CASHMERE GOAT INDUSTRY

There are systematic methods for the development of breeding programs in general and this section summarizes the pertinent issues at each stage for the Mongolian cashmere industry. An understanding of this systematic approach and its implications provides the necessary background to a detailed consideration of any current or future initiatives. The steps involved in developing a breeding program include:

1. Selection Objectives
2. Genetic Resources
3. Selection Criteria
4. Performance Recording
5. The Use of Recorded Information to Make Selection Decisions
6. The Use of the Selected Animals
7. Monitoring progress

The considerations involved in each step, with specific reference to Mongolia, are given below.

A. Selection Objectives

The first process in developing a breeding plan is to choose appropriate objectives. This requires careful consideration because genetic changes achieved through breeding are slow, permanent, cumulative and involve long periods of time. In general, selection objectives are based on economic considerations but may also involve other issues.

For the Mongolian cashmere industry there are three perspectives to consider: herder, processor, and national (the government).

The Herder

For the herder, breeding should lead to an increase in income through improved production and quality of the product. The herder's income from cashmere production is a product of the cash return per head and the number of animals in the herd. The expectation is that breeding will improve both the quality and quantity of cashmere that can be harvested from each goat.

The Processor

Processors state that they want fine (15 micron or less) cashmere in order to compete with the best Chinese cashmere, although they are able to process coarser fiber. Several told of high rejection rates of very coarse cashmere from Mongolian herders, a result of past crossbreeding schemes initiated by the Russians, and the current practice of keeping aged goats. They were concerned that Chinese traders paid well for the product they did not want. While processors in general appear willing to offer some premium for fine cashmere, those interviewed were unaware of how the premium effected herder income,

or the magnitude necessary to provide an incentive to breed for fine cashmere.

The Nation

There may also be a National perspective. The government may wish to increase the production of fine cashmere for reasons of future export competitiveness, national pride, the development of value-added industries, or other political reasons.

Important Considerations:

During the interviews conducted by the consultant there was a general ignorance found on the possible disadvantages of breeding fine cashmere to those herders whose goats grow coarse cashmere (the crossbred sector). A simple example can illustrate this point:

> A herder with a crossbred herd has an average per head production of 400 grams of 17 micron down. This he sells to Chinese traders for $25 per Kg, realizing an average return of $10 per goat.
>
> The herder then embarks on a breeding scheme to reduce the diameter of the cashmere to around 15 microns, using bucks from another herd that averages 300 grams of 15 micron fiber per head. We can calculate that in 8-10 years his herd will produce an average of 325 grams of 15.5 micron cashmere per animal. The reduction in cashmere weight is due to the unfavorable genetic association between cashmere weight and diameter; a decrease in one results in a decrease in the other. At the same cashmere price, the herder receives an average of $8.12 per goat. He would need to receive $30.80 per kg to obtain the same per head income as the original coarse goats.

In this simplified example, a 23% premium is required for the fine cashmere to maintain income parity, and several processors considered this differential to be too large, while others thought it acceptable to obtain the right product. The obvious strategy for processors is to pay less for the coarse down but this strategy appears to be impracticable while Chinese traders actively operate in the industry at this market.

These issues may seem remote from actual animal breeding, but there must be common agreement on and an understanding of, the consequences of selection objectives before an acceptable set are pursued. This is for the simple fact that genetic changes are slow and permanent, and we are setting objectives for the next 10 to 15 years and longer.

The requirements of the processors or end users and the determinants of value are usually the goals of any animal breeder. The specific objectives should be based on the characteristics that determine cashmere value while retaining animal fitness. The various sectors need to consider the long-term consequences of such objectives and implement appropriate policies to protect, encourage and assist the goat breeders in attaining their goals. In order to further explore the issues effecting the development of a breeding program, the following assumptions regarding objectives have been made:

The National objectives are

- To develop a large volume of quality cashmere;
- To preserve the genetic diversity of the indigenous goat breeds;
- To improve herder income; and
- To facilitate value added processing developments.

The Herder/Breeder's objectives are:

- To breed goats producing an average of 15 micron cashmere or less;
- To gradually increase the amount of clean cashmere per head; and
- To maintain cashmere fiber length.

The herder/breeder pursues the objectives within the various colored breeds and strains of goats. Curiously, at least some owners of crossbred derived herds desire to breed fine cashmere, despite being able to sell the heavier, coarser fleece to Chinese traders. This may stem from a desire to regain Mongolia's former prominence and reputation as a source of high quality cashmere fiber.

We need to consider the genetic resources available to attain these goals and the particular traits that will be used to select the animals.

B. Genetic Resources

Mongolia has two main goat gene pools:

Indigenous Mongolian goats. The Livestock Division of the Ministry of Food and Agriculture and the Research Institute of Animal Husbandry at the Mongolian Agricultural University have made preliminary surveys of several strains or breeds of Mongolian goats and kindly made their results available for this evaluation. From this data it appears that the indigenous animals have cashmere of the desired fineness, varying in combed down yield, with various colors of both guard hair and cashmere. An appropriate selection objective for these herds is to improve cashmere weight while maintaining the fine diameter of the cashmere, within each breed or strain, retaining their ability to adapt or fitness for the environment in which they exist.

Crossbred goats and their derivatives. These goats are a product of Russian crossbreeding policies and at least three of these crossbred derivatives have been given breed status. These animals are very variable and yield large quantities of coarse cashmere (17-22 microns). Despite being able to sell fiber from these animals, herders and others appear to desire to breed finer cashmere. The objective for these herds is to reduce fiber diameter to around 15 microns while retaining as much cashmere weight as possible.

Different breeding strategies are required for these differing objectives. The appropriate selection criteria can be chosen for each of these objectives.

C. Selection Criteria

The main parameters that determine the value of cashmere production are:

- Clean down weight per head
- Diameter of the cashmere fibers
- Length of the cashmere fibers
- Color of the cashmere

To this list we may add luster and crimp ("style") and fiber strength. However, genetic progress is fastest with selection for fewer traits in large herds so it is desirable to limit the number of selection criteria. The traits chosen need to be measured as precisely as possible and according to standard protocols as any breeding scheme is only as good as the information fed into it. This is particularly important for cashmere production because of the very strong positive genetic

relationship between clean down weight and fiber diameter that makes simultaneous improvement in both extremely difficult.

If economic weights are given to the possible selection criteria according to the contribution of each to final value, the choice may be narrowed to the most financially important traits. This information is not available in Mongolia so some assumptions are made in the choice of the selection criteria.

Processors consider that Mongolian cashmere has acceptable length for processing, and as color sorting can be carried out post harvest, selection can be carried out within colored breeds or strains. This narrows the choice of selection criteria for cashmere production to the first three criteria highlighted above.

***1. Weight of Clean Down**:*

At the present time, weight of clean down is estimated from the combed weight of fiber harvested from the animal. This combed weight contains cashmere fiber, hair fiber, dirt, vegetable matter, grease, scurf, lice egg casings, and possibly other contaminants. The yield of clean cashmere can vary from 20-80% at the extremes (figures supplied by Department of Agriculture and various processors). Processors report average yields of clean down of 50%. While combed down weight is obviously related to clean down weight, and may be used as an indirect estimate of clean down weight (see later), in the longer term it is desirable to use clean down weight especially in nucleus breeding schemes.

Some Mongolian technical groups saw the development of such techniques as a major expense beyond their current resources. However there are techniques for measuring clean down weight that may be modified for Mongolian purposes. While costs should be carefully considered, a technique as involving sub-sampling, washing and separation of the down from hair by hand, may be useful for final selections in a nucleus breeding scheme, where the additional cost would be justified.

OFDA techniques exist for determining the yield of cashmere in a mixed sample of cashmere and guard hair (see references below); the sub-samples of combed fleece would need to be freed from dirt, grease and other contaminants before measuring in the OFDA, a process that would involve a preliminary wash. The Australian Wool Testing Authority has developed such a process for small samples. Other organizations specializing in animal fiber measurement may also be able to contribute to the resolution or development of a suitable technique.

It should be noted that the OFDA technique can be modified to measure medullation in goat fibers and may be useful in detecting the “intermediate” fibers considered a problem in the crossbred goats and their derivatives. A reference to this application of OFDA technology is included below.

SUGGESTED RESOURSES:

Organizations that may contribute to the issue include:

The Australian Wool testing Authority Ltd,
PO Box 190
Guildford, NSW 2161
Australia
Phone 61-2-9681-1200
(Contact Mr Angus Ireland, e-mail angus.ireland@awta.com.au

The International Wool Textile Organisation (www.iwto.org)

Pertinent Publications:

Lupton, C.J., Minikhiem, F.A., Pfeiffer, F.A., and Marschall, J.R. (1995) Concurrent Estimation of Cashmere Down Yield and Average Fibre Diameter Using the Optical Fibre Diameter Analyser. In 'Proceedings of the 9th International Wool textile Research Conference" Volume 2, Biella pp 545-54.
(Write c/o: Texas Agricultural Expt Station, Texas A & M University System, 7887 North Highway 87, San Angelo, Texas 76901-9782, USA.)

Peterson, A.D. and Gherardi, S.G. (1996). Measurement of Cashmere Yield and Mean Fibre Diameter Using the Optical Fibre Diameter Analyser. Aust. J. Exptl. Agric. 36: 429-35.

Petersen, A.D., Gherardi, S.G., and Brims, M.A. (1994). The Measurement of Medullation in Mohair Using the Optical Fibre Diameter Analyser. Proc. Aust. Soc. Anim. Prod. (1994) 20: 363.

Research groups in Mongolia may wish to undertake the task of developing a method for measuring clean cashmere weight from combed fleece samples. The apparent cost of a potential technique should not prevent its development. Even if a suitable technique is relatively expensive, it may be used on a restricted number of selected animals as part of a multi-stage selection process that can be designed specifically to minimize measurement costs. Examples of such selection strategies are given later.

RECOMMENDATION: A priority task is to develop a rapid and cheap method for determining clean down weight in individual fleeces.

2. Diameter of Down Fiber:

The diameter of cashmere fibers is generally associated with cashmere quality and there are several testing facilities in Mongolia located in the processor factories and research centers, using either OFDA or optical microscopic techniques. Based on a limited amount of data from these testing houses it is evident that there is some variation between them. The precision of measurement is very satisfactory but the measurement of the same sample of fleece at different testing centers has yielded dissimilar absolute measures in a limited test.

This is not unusual: in an extensive test involving 10 testing laboratories using either micro projection, OFDA, laser scan and/or the cross-section method for diameter determination (Herrmann, 1996), considerable variation was found between the methods, and between laboratories using similar methods. This variation was up to 4 microns, and projection microscope methods were the most variable. In general OFDA and laser scan methods are more reliable due to the fact that they measure many more fibers than other methods; however there tends to be significant variation between laboratories using these techniques. This is generally associated with the degree of contamination or guard hair content of the fleece sample.

For breeding purposes, the selection of animals on diameter from any particular generation must be based on measurements from the one laboratory, as it is the relative measures that are used for

selection, not the absolute values. Where it is not possible to have all the samples from one generation to be measured in the same laboratory, the measures would need to be adjusted to a common standard before comparisons and selections are made. This can be done by "calibrating" each laboratory with a set of cashmere standards and determining a correction factor to apply to the diameter when measurements are taken. A protocol for such a calibration has been given to one project group in Mongolia. Essentially it involves the measurement of a large number of fleece samples covering the full range of diameters encountered in practice by a number of different laboratories with the sub-sampling and preparation of fleece for measurement following set protocols.

Such a calibration would be essential if the diameter information was intended for marketing or processing use, where quality needs to be precisely described. Various co-operating testing houses could be calibrated with a set of standard fleece samples as outlined above.

It should be noted that while the visual estimation of diameter of cashmere may be suitable for preliminary fiber classing prior to marketing, it is too imprecise for animal selection. The genetic relationship between clean down weight and diameter is strongly positive and unfavorable for the simultaneous improvement of both. The selection of breeding stock on diameter should never be based on the visual appraisal of diameter.

SUGGESTED RESOURSE:

Herrman, Suzanne & Wortmann, Franz-Josef . (1996) First Results of the Round Trial of Fibre Diameter testing Facilities. European Fine Fibre Network, Occasional Publication No. 4 Macauly Land se Research Institute Aberdeen Scotland.

<u>RECOMMENDATION</u>: Co-operating testing laboratories adopt a calibration and standardization procedure.

3. Length of Down Fiber:

Processors consider the length of Mongolian cashmere to be suitable for their purposes and they do not see a need for a change in cashmere length. However cashmere length is used as an indirect estimator of clean down weight in Australian goats, and is included in some of the selection indices generated for Australian goat breeders. In Australian cashmere goats there are strong genetic and phenotypic correlation between clean down weight and length that permits its use as an indirect measure.

The consultant was able to examine sets of data from Mongolian goats kindly supplied by the *Farmer to Farmer Program*, the Department of Food and Agriculture and Dr. Zagdsuren's group at the Mongolian Agricultural University. These data sets do not show the same phenotypic relationship between length and combed down weight as was found in Australian goats. While this may be due to the peculiar environmental conditions under which Mongolian goats grow cashmere, or other unknown reasons, it would be prudent not to use length as an indirect measure of clean down weight, nor to use Australian selection indices that include it. Even if the underlying genetic relationships are similar to the goats here as those found in Australia, until there is sufficient information on Mongolian goats these indices should not be used.

While this may be considered to be an overly cautious approach, it will prevent possible future problems, and alternative strategies are available as will be detailed later.

The situation may be clarified when it is possible to measure clean down weight directly and dispense with the use of combed down weight as an estimator, and when we know more of the environmental influences on cashmere growth in Mongolia. In the mean time we must entertain the possibility that there are different genetic and phenotypic relationships between these variables in Mongolian goats than are found in other goat populations.

Further information on the variability of fiber length measures in cashmere goats is given by **Litherland et al** (1995), who concluded that there was considerable unexplained variation in the length measures and their relationship with down weight. (**Litherland, A.J., Paterson, D.J., and O'Neill, K.T**. 1995. Length as a Predictor of Down Rank in New Zealand Goats. NZ J. Agric. Res. 38: 361-365).

Irrespective of the above considerations length measures are of intrinsic interest and some standardization of methodology is required. Length can be measured on the animal or in the combed fleece or both. The breeding groups encountered by the consultant were found to have appropriate sampling methods for both "on animal" and "in fleece" measurement, and improved precision may come from standardization of the time of measurement on the animal and the techniques of measurement of fiber length in combed fleeces.

RECOMMENDATION: **Research into the measurement of clean down weight, fiber length and the relationship between these variables and diameter, is necessary to facilitate the development of efficient breeding. plans for**

The above discussion is concerned with cashmere production and it must be remembered that fitness or adaptation is a very important component of animal production in the harsh, demanding environment found in Mongolia. Selection criteria should include some measure of fitness. The live weight of goats at the beginning of spring, already used by a number of breeding groups, would appear to be a simple, readily measured indirect trait for fitness.

Once the selection criteria have been chosen, a suitable recording system must be considered.

Ideally we would like objective measurement techniques for all traits, and while they exist, they are not all available in Mongolia. There are serious problems associated with the measurement of clean down weight, diameter. This is a major limitation to the improvement of cashmere production in the Mongolian goat herds because the inability to estimate clean cashmere (down) weight with the required degree of precision for efficient selection in schemes involving the simultaneous control of fiber diameter. Until this problem is resolved it will not be possible to confidently devise efficient selection procedures to improve cashmere weight while maintaining fiber fineness.

D. Performance Recording

The breeding program relies on precise information on the selection criteria and a system of organizing the information such that it can be readily used to rank animals on their genetic value.

Both the *Farmer to Farmer Program* and the *Gobi Regional Economic Growth Initiative*, and possibly others, appreciate the importance of performance recording and have introduced information recording systems to their clients. At first review, the performance recording

procedures used in the two projects evaluated contained both useful and unnecessary information. However, upon additional review it would be more useful for the project teams to re-evaluate the information to be recorded for each individual breeding group, developing protocols with the minimum of essential information.

With respect to the information recorded, careful consideration should be given to the future use of the information. For example, there is no value in recording 11 bits of information on an ear tag, as was recommended for one project; ear tags serve to identify animals and should be as simple as possible to eliminate transposition errors. The *Farmer to Farmer Program's* handbook for herders does contain useful recording forms, which may be improved further with some minor edits (see the section titled: The Herder Handbook – Suggested Improvements).

Both the *Farmer to Farmer Program* and the *Gobi Initiative* lacked appropriate database software to record information such that it could be readily accessed and used. Cashstud, which is currently being used, is not a suitable program for this purpose and may not be able to be used on personal computers in the future. Spreadsheet programs in general are not suitable for performance recording although they are common; if relational database software is not available, then one of the commercial performance recording schemes should be considered.

The formation of national pedigree associations should be seen as a "stud" breeding exercise and part of the marketing strategy used by commercial buck breeders. Performance recording schemes should be encouraged rather than breed pedigree associations, although it is likely enthusiastic breeders will create them from time to time. Show judging of stock is associated with pedigree societies and generally involves a lot of energy that would be better spent in performance recording and the evaluation of genetically superior stock. However stock shows have a certain usefulness as forums for exchange of information and while ever they persist should be used to reinforce performance recording.

In most modern animal breeding systems sires are sold on performance rather than pedigree, as was the case with many former stud industries. Pedigrees are useful for calculating the genetic value of animals because the performance of relatives can be used to increase the precision of estimates of the breeding value for individuals using such procedures. Pedigrees are also necessary where production may be sex linked such as in the dairy industry where sires must be progeny tested. However in the cashmere goat populations studied, the production traits are strongly inherited, and individual performance records can be used for selection. In the absence of direct studies we assume that similar genetic relationships pertain to Mongolian goats, and performance recording should be emphasized in both the selection and dispersal of sires.

A national performance recording scheme for cashmere goat breeding is essential if the aims of Government Resolution 199 are to be realized with respect to breeding cashmere goats. This needs to be carefully planned, with consideration given to the future needs of the national cashmere goat breeding effort such that a standard protocol that records essential information is available as a blueprint for all breeding groups. Such schemes exist in many countries and use sophisticated statistical techniques to determine the breeding value of animals. They may incorporate sire referencing schemes that allow the comparison of sires across herds. Australia has national performance schemes for wool (RAMPOWER, WOOLPLAN), lambs (LAMBPLAN), meat goats (KIDPLAN), beef cattle (BEEFPLAN), pigs and dairy cows. RAMPOWER, for example, can be readily adapted for cashmere goat breeding. Similar schemes operate in France and the United States for almost every livestock breed so there is a wide selection available.

It is important that performance records obtained now are retained using database computer programs that will permit a transition to a national performance recording scheme when and if it becomes appropriate.

RECOMMENDATION: A standard protocol for recording the minimum information needed for efficient selection should be developed as a blueprint for all breeding groups.

Explanatory literature from several performance recording schemes that operate for various livestock breeds in Australia has been left with the USAID office in Mongolia. These schemes all have websites and "how to" information can be readily obtained. The project personnel should pay particular attention to the data recorded, the identification systems recommended and the report outputs, in such schemes as KIDPLAN and RAMPOWER. These web sites have a feedback section where questions can be asked and assistance obtained.

Examples of Performance Recorded Sire Programs

Performance recorded or "selected" sires can come from several sources in a free market system. There are three basic variants that can be applied to the Mongolian market:

1. ***Commercial buck breeding enterprises*** whose aim is to breed and sell selected sires for profit. These enterprises employ nucleus breeding schemes and modern animal breeding technology to produce and sell bucks on performance to herders seeking animals to improve their herds. This variant is the modern "stud" industry. The *Farmer to Farmer Program* exercise and the private buck breeding enterprise directed by Dr. Zagsduren are of this type. It is a common model in modern livestock breeding and has largely replaced sale by pedigree in most production oriented animal industries.

2. ***Non-profit co-operative nucleus breeding schemes***. Herders or breeders with similar objectives may co-operate and form a nucleus breeding herd with the advantage of a large herd size, to provide them with selected sires of the desired type at a minimal cost. This variant appears to be commencing in the *Gobi Initiative*, and may be occurring elsewhere.

3. ***Self replacing herds in which sires are bred in the herd***. They have the disadvantage of a smaller herd size than is possible with larger co-operative nucleus schemes, but may be preferred by breeders with large herds whose objectives are not catered for in other buck breeding sources. In effect they operate mini nucleus breeding schemes and may buy sires from outside from time to time.

These variants are completely compatible and offer choice to breeders and herders.
All three variants (and possibly others) may arise in the Mongolian breeding industry in the future and clearly there is a choice. Commercial buck breeders will naturally advertise and promote their schemes, without necessarily indicating the choices, in regions or situations where no systematic selected buck source is available. This is normal commercial behavior and a consequence of the change from a controlled to "free" economy.

From the pure breeding perspective all three models can employ nucleus breeding schemes with differing degrees of efficiency depending on structure and size. Given the current limitations with respect to objective measurement and the relationships between the parameters of cashmere production, the expectations for improvement in performance parameters need to be modified.

E. Use of Recorded Information to make Selection Decisions

Performance recording schemes provide estimated breeding values for each animal for the traits of interest, and breeders use the information to make selection decisions according to their breeding objectives. Sophisticated schemes may calculate breeding values based on specific selection indexes that combine and weight the traits pertaining to the breeders particular objectives.

Amongst the Mongolian goat breeding groups there is a general awareness of the value of performance recording, but there is less awareness or understanding of the efficient use of the information and the limitations which may pertain.

In both the *Farmer to Farmer Program* and the *Gobi Initiative* the use of sophisticated selection indices developed for Australian goats has been recommended. This advice, while well intentioned, is misguided. The selection indices recommended were developed specifically for Australian cashmere goat breeders and were calculated from detailed studies of the genetic correlation and inheritabilities of the clean down weight, cashmere diameter, cashmere length and bodyweight. Similar detailed genetic correlation and inheritabilities have not been determined for Mongolian goats and it is dangerous to use the Australian parameters without some validation.

Based on performance records courtesy of the Ministry of Food and Agriculture, the *Farmer to Farmer Program* and Dr. Zagsduren; calculation of the phenotypic correlation between combed fleece yield, cashmere fiber diameter and down length showed considerable divergence from similar correlation from Australian, New Zealand and Scottish cashmere goats, in both magnitude and, in some cases, direction.

The phenotypic relationships between combed down weight, down diameter and down length were observed to be different to those calculated for other cashmere goats in Australia, China Scotland and New Zealand.

Further data sets were kindly made available by Dr. Zagdsuren, Research Institute of Animal Husbandry, Agricultural University of Mongolia. The phenotypic correlation calculated from these data sets are shown in **Table 1**.

Table 1. Phenotypic Relationships Between Cashmere Fleece Measures in Mongolian Goats

BREED	Phenotypic Correlation		
	Combed Down x Length of Down	Combed Down x Diameter of Down	Length x Diameter
Shinejinst 1 Males	0.115	0.17	
Shinejinst1 Females	0.358		
Shinejinst 2 2yo	0.16	0.217	-0.14
3yo	-0.04	0.508	-0.14
4yo	0.204	0.071	0.001
5yo	0.409	0.045	0.065
Zamaar Black	0.332	0.182	0.184
Bomboger Red	0.129	-0.096	-0.175
Shinejinst 3 1 yo			0.88
2 yo			0.30
3 yo			0.56
4 yo			0.57
5 yo			0.64
6yo			0.42

With one or two exceptions the correlation between combed down weight and down length are low and variable in comparison with other reported relationships. The length by diameter correlation for the Shinejinst 3 set are more consistent, and were sampled and measured by a research group who might be expected to be more consistent and skilled in the application of the measurement techniques. However the variability in the other sets indicates that they are not suitable for use in selection decisions.

There may be one or more reasons for the observed variability in the Mongolian data.

1. Sampling variation
2. Different sampling protocols used for different batches of fleece samples
3. Different measurement protocols
3. Relationships altered by environmental conditions
4. The Mongolian goats are inherently different to other cashmere-producing animals

It is difficult to believe that Mongolian goats are different to other cashmere breeds particularly when cashmere goats in China show more consistent and similar genetic and phenotypic relationships to the cashmere goats in Australia, New Zealand, and Scotland. In view of these similarities we can assume that the genetic relationships in Mongolian goats follow the same general form even thought the magnitude of the relationships are unknown at this time. Selection strategies based on the general genetic relationships can be designed that minimize any distortions that may be introduced by reliance on the variable phenotypic relationships or their measurement. Examples of these will be given later.

It is possible that the extreme conditions of the Mongolian climate during the cashmere-growing season alter the relationships between the parameters shown. The Mongolian goats lose between 20-40% of body weight during the winter, while still managing to grow a cashmere undercoat. Some insight into this situation comes from an experiment carried out in Australia in which goats of two genotypes were subjected to a high, maintenance or below maintenance level of nutrition during the cashmere-growing season. The phenotypic relationships found in that experiment are shown in **Table 2**.

Table 2. Phenotypic Relationships Between Cashmere Fleece Measurements in Australian Goats Fed Three Diets

Level of Nutrition	Correlation		
	Down Wgt x Length	**Down Wgt x Diameter**	**Diameter x Length**
High	0.489	0.76	0.364
Maintenance	0.491	0.570	0.071
Below Maintenance	0.754	-0.03	0.005

(**Restall, B.J., Restall, H., Restall, M., and Parry, A**. 1994. Seasonal Production of Cashmere and Environmental Modification I Australian Cashmere Goats. European Fine Fibre Network Occasional Publication No. 2 ; 61-71)

This data can be compared to the correlation given earlier. In this experiment, diameter of the down was reduced by the restricted diet, and there was evidence that maintenance for fiber growth was higher than for live weight. Although this data is limited it may indicate that the correlation between diameter of down and other parameters will be altered by low nutrition, and this would be expected in the Mongolian goats. However the relationship between length and down weight was not consistently different to expectation, unlike the Mongolian data.

This question may be examined again in controlled experiments with Mongolian goats if possible. Alternatively the phenotypic relationships may be re-assessed with all collection, sampling, sub-sampling and measurements undertaken according to strict protocols. At the same time, research should be undertaken to determine the genetic and phenotypic parameters of cashmere production in the various Mongolian goat breeds.

As controlled breeding groups are being established for various indigenous and crossbred breeds, performance recorded data could be used to obtain estimates of genetic parameters using such computer programs as ASREML, which is available from the internet.

At this stage of the Mongolian cashmere breeding industry it would be entirely inappropriate to use the Australian selection indices. It is recommended that a method of independent culling levels be used until such time as more information is available and that combed weight of fleece rather than length be used as an estimator of clean down weight. While this method requires similar assumptions about the genetic relationships between the parameters, as well as complex calculations, it is more flexible and far easier to implement than the selection index methods.

F. Use of the Selected Animals

Both the *Farmer to Farmer Program* and the *Gobi Initiative*, and the private Mon Amical Fine Fibre buck breeding enterprise directed by Dr. Zagsduren, use, or intend to use, Nucleus Breeding Schemes. These are efficient breeding schemes that maximize genetic gains and ideally could be established in different regions for the various indigenous breeds and strains that are known. However, like any other breeding scheme they are only as good as the information fed into them. There will be little real progress toward the objectives in such schemes until the measurement problems are resolved. It will be possible to control fiber diameter but control of clean cashmere weight is unlikely at this time. These schemes should not be established without careful consideration of these problems. However there is a "rehearsal" and training value in the established schemes, and they will help to consolidate and characterize the indigenous genotypes.

Because so little is known of the differences (if any) between the indigenous groups and their adaptability to various regions, it would be preferable at this stage to consolidate the breeds/strains in to the various regions where they are predominate. Once done, work could be done to further characterize them and commence a nucleus breeding scheme only if it was feasible and practicable.

Despite these considerations, local operators may consider that there is value in continuing their established nucleus breeding schemes, and initiating more. All involved need to have realistic expectations of the value and results of these operations.

The crossbred goat breeds and their derivatives are a special case. If it is desired to improve the quality of their cashmere, after consideration of the likely financial penalties, a system of gene replacement by back-crossing can be readily implemented. Usually 4-5 back-crosses are carried out to complete a virtual gene replacement. In effect the crossbred female goats are used as "ovens" to carry the indigenous goat genotypes. The result is a replacement of the crossbred goats with indigenous genotypes. Some selection may be exercised during the back-crossing if numbers permit, and selection for controlling diameter and improving clean down weight can then commence when a suitable measurement technique is available.

The nucleus breeding schemes within the indigenous breeds and strains could be a source of sires for use in back-crossing. Despite the limitations mentioned previously, they would provide a source of systematically managed sires with some selection value for fitness and fiber diameter.

G. Monitoring Progress

It is important that progress is monitored continually by regular performance recording and analysis. Various animal measures are being recorded at the herd and breeding station level and unless some value can be demonstrated, the recording may lapse in the future. Regular analyses and summaries of trends are necessary to troubleshoot the system so that needed periodic adjustments can be done in a timely fashion.

Recorded information is only of value if it is used for productive purposes.

II. SELECTION STRATEGIES FOR MONGOLIAN GOAT BREEDS

It should be clearly understood that the Australian Selection Indices recommended by other consultants are not suitable for Mongolian goat herds. These indices were developed for specific purposes and for use in Australian goat herds and were never intended to be applied to goat herds world wide. The Australian cashmere goat herds are managed differently to Mongolian herds, the down is shorn before shedding begins, and clean down weight is either measured directly or estimated indirectly from a cashmere length measure obtained from three sites on the goat at a very specific time of the growth season. In regard to the latter, Litherland (1995) has concluded that the length/down weight relationship in Australian goats is different to other national herds. In view of this finding, and the variable length/combed down weight correlation evident at this time in the Mongolian herd data, together with the different harvesting methods used, it would be inappropriate to use the Australian selection indices in Mongolian breeding herds.

Until genetic parameters are available, we have to assume that the Mongolian fleece inheritance is similar to those breeds studied in depth, irrespective of the influence of the environment. Selection methods based on these relationships using only two fleece parameters can be developed and this section presents several examples that could be used in indigenous Mongolian goat breeds where

the objective is to maintain fine fibre diameter and live weight while increasing down (cashmere) weight.

A. Examples of Selection Strategies - Introduction

Six examples of selection strategies have been calculated to illustrate the advantages of this methodology. They are based on the parameters that are readily measured in Mongolian goat herds: combed down weight, live weight and cashmere fibre diameter; and are designed to suit various situations. Some assumptions regarding flock dynamics and other considerations are necessary and they are listed below. They can be varied and those presented here are used merely to allow calculation of the selection strategies given as examples. The actual formulae used to develop the selection strategies and the calculations are complex and iterative and are not detailed here.

Assumptions made are:

1. The underlying genetic relationships between the production traits in Mongolian goats are the same as for Australian and other groups that have been studied.

> *This is an important assumption and needs to be verified by calculating genetic relationships from appropriate sets of Mongolian goat data. However the genetic relationships are similar for goats in Australia, Scotland, New Zealand and China and Mongolian goats are likely to be similar irrespective of the phenotypic relationships derived to date.*

2. The flock structure of the breeding herd consists of 5 age groups of females and 20% need to be replaced each year.

3. Three male replacement sires are needed each year for each 100 females. To allow for deaths, accidents, infertility etc., 4 will be selected for each 100 females.

4. The reproductive rate is 1.0 such that 100 females produce 50 female and 50 male offspring each year.

> *This may be lower than the general case in Mongolia, and can be varied for different herds.*

5. The general death rate is 10% per annum.

6. All animals born each year are kept until the first fleece measurements are made.

> *This may not be the usual practice for Mongolian herds in which young animals are progressively culled at various times in their first year of life. However for breeding herds, especially nucleus breeding herds, retention of all animals is essential. If this is not possible culling procedures should be designed to preserve the genetic variation in that birth group.*

7. Appropriate analyses of the effect of environmental factors (age of doe, age at selection, type of birth etc.) have been carried out and appropriate corrections are made to the production parameters.

With the above assumptions, for each 100 females bred each year, there will be 50 female and 50 male offspring. Five of each sex will die, and 20 female replacements must be selected from the surviving 45 (45%). Similarly, 9% of the surviving 45 young males need to be selected as replacement sires (including spares).

The following examples show varying selection strategies, and the expected progeny changes as a result of the selection, for a herd with the objectives of maintaining cashmere diameter and live weight and increasing cashmere weight. The list is not exhaustive and other strategies can be generated with different assumptions and/or objectives. Percentages are used instead of actual numbers so that the strategies can be applied to any herd size.

The selection criteria used in the examples are: ***combed cashmere weight*** which is assumed to correlate strongly with clean cashmere weight, and is thus an indirect measure of clean down weight; ***diameter of cashmere*** which is measured directly on a sample of the combed fleece, and ***live weight*** measured in the autumn.

B. Strategy 1 - No Female Selection

This strategy does not exercise any selection pressure on the females; replacements can be chosen at random after a preliminary fault cull. Control of the production characters is exercised solely through selection of the males, which is carried out in two stages.

Stage 1, Combed down weight is measured for all males and the heaviest 30 % are retained.

Stage 2. Diameter measurements are obtained on the retained 30% and the finest (lowest diameter) 30% selected to give the needed 9% of sires.

The EBVs and the expected progeny changes for this strategy are shown below:

Table 3. Selection Strategy 1. No Female Selection

	EBV Diameter	EBV Cashmere Wgt	EBV Live weight
Females	0.0	0.0	0.0
Males	0.0	21.4	-0.38
Expected Progeny Change	0.0	10.7	-0.19

This strategy would result in no change in the diameter of cashmere in the progeny, a 10.7 gram gain in cashmere weight and a slight loss in live weight. In practice, the loss in live weight may be controlled by the preliminary fault cull.

C. Strategy 2 - Females Selected for Combed Down Weight Only

This strategy exercises some selection pressure on down weight through the females, and again controls diameter by a two-stage selection process in the males.

Stage 1. Combed down weight is obtained for all animals. The 45% of females with the heaviest combed down weights are retained for replacements. The 55% of males with the heaviest combed down weights are selected for diameter measurement.

Stage 2. Diameter measures obtained on the 55% of selected males, and the 16% of males with the lowest diameters are selected as sires.

The expected progeny changes are:

Table 4. Selection Strategy 2. Females Selected for Combed Down Weight Only

	EBV Diameter	EBV Down Weight	EBV Live Weight
Females	0.31	18.0	-0.23
Males	-0.29	10.4	0.27
Expected Progeny Change	0.01	14.2	-0.25

This strategy involves more effort and a greater cost in diameter measurement but there is a greater gain in down weights in the progeny than in Strategy 1. Diameter is held constant, while down weight increases by 14.2 grams in the progeny. Live weight decreases slightly.

D. Strategy 3. Females Selected for Live Weight Only.

In this strategy female replacements are only selected on live weight, and combed down weight and diameter are not measured on the females. The control of down weight and diameter is through male selection, which is carried out in two stages.

Stage 1. All females are weighed and the heaviest 45% selected as replacements; there is no female selection on down weight or diameter. Combed down weight is measured on all males and 30% of males with the heaviest down weights are selected for diameter measurement.

Stage 2. Diameter is measured on the selected 30%, and the finest 30% are selected as sires.

Expected progeny changes are:

Table 5. Selection Strategy 3. Females Selected for Live Weight Only

	EBV Diameter	EBV Down Weight	EBV Live Weight
Females	-0.02	-2.2	0.89
Males	0.00	21.4	-0.38
Expected Progeny Changes	0.01	9.6	0.26

This strategy results in a 9.6 gram increase in down weight and a small increase in live weight. The small live weight loss expected from the previous strategies has been eliminated but the cost has been a lesser gain in down weight in the progeny.

E. Strategy 4 - Females Selected on Combed Down Weight and Diameter

In this strategy both combed down weight and diameter are measured on both males and females and a two-stage selection exercised on each.

Stage 1. Combed down weight measured on all young animals. 67% of females and 30% of the males with the heaviest down weights are selected for diameter measurements.

Stage 2. Diameter is measured on the selected males and females. Finest 67% selected to give the 45% of replacement females. The finest 30% of the measured males are selected to give the sires.

The expected changes in the progeny are:

Table 6. Selection Strategy 4. Females Selected on Combed Down Weight and Diameter

	EBV Diameter	EBV Down Weight	EBV Live Weight
Females	0.01	9.6	-0.17
Males	0.00	21.4	-0.38
Expected Progeny Change	0.00	15.5	-0.28

This strategy also involves a greater cost in diameter measurement but results in a higher gain in down weight in the progeny, with a small decline in live weight.

F. Strategy 5 - All Males and Females Measured and Selected on Combed Down Weight and Diameter

This strategy is the most expensive as both parameters are measured on all animals and combined in an index. While this strategy is more expensive than the other examples it might be considered for a nucleus breeding herd.

The index for ranking the animals is :

EBV = Combed Down Weight x 0.3916 + Diameter of down x (-9.8599).

If deviations from the progeny group mean values for each parameter are used the index simplifies to:

EBV = Combed Down Weight Deviation – (25 x Diameter deviation)

Males and females are considered separately, the indexes calculated and the top 45% of females and 9% of males selected for breeding.

The expected progeny changes are:

Table 7. Selection Strategy 5. Combed Down Weight and Diameter Measured on All Males and Females

	EBV Diameter	EBV Down Weight	EBV Live Weight
Females	0.00	10.8	-0.19
Males	0.00	22.9	-0.41
Expected Progeny Change	0.00	16.9	-0.30

This strategy is the most expensive in terms of measurement costs and time but results in the greatest gain in down weight in the progeny, while holding diameter constant. There is a slight decrease in live weight.

G. Strategy 6 - All females and Males Measured and Selected on Live Weight, Combed Down Weight and Diameter

This strategy differs from the others in that it is designed to keep both down diameter and live weight constant while increasing the weight of combed down in the progeny. Both males and females are weighed and combed down weight and diameter measured.

The measures are then combined in the following index:

EBV = Combed down weight x 0.3676 + Live weight x 0.7187 - Down diameter x 9.1365

If deviations from the group mean for each parameter are used the index simplifies to

EBV = Combed down weight + (2 x Live weight) – (25 x Down diameter)

The animals are ranked on the index value within same sex groups and the top 45% of females selected as replacements and the top 9% of males selected as sires.

The expected progeny changes are given in Table 8.

Table 8. Selection Strategy 6. Combed Down Weight, Down Diameter and Live weight Measured on All Animals

	EBV Diameter	EBV Down Weight	EBV Live Weight
Females	0.00	10.3	0.00
Males	0.00	21.8	0.00
Expected Progeny Change	0.00	16.0	0.00

This strategy involves considerable recording and costs but results in control of both live weight and down diameter while giving a similar increase in down weight as strategy 5.

These examples are presented to illustrate how this method can be used to devise selection strategies for any particular set of objectives, manipulating the genetics by different selection pressures on either the males or females. The strategies can be generated for any particular flock given the flock statistics (death rates, reproductive rates, replacement percentages etc). Nucleus breeding herds may consider the more expensive strategies, such as examples 5 and 6, with the increased costs justified by the importance of the herd in the general improvement scheme.

The examples given do not consider the practical issues in implementing the particular strategy but they can be modified to accommodate practical restrictions. The method has considerable flexibility in this respect.

Specific strategies may be devised for key breeding herds such as co-operative breeding units or nucleus breeding herds, where greater costs might be accommodated and more energy expended to overcome practical restrictions. These types of breeding units may also have more control over matings, identification of offspring and parents etc. As measurement techniques are refined or reduced in cost, the strategies can be modified to suit. If genetic information on Mongolian goats is obtained from progressive analyses of the breeding data, the calculations can be modified to replace the genetic parameters used in the examples.

If the objectives of the breeding scheme are different to those in the given examples, appropriate strategies can be calculated. A Mongolian application would be the development of strategies for the Mongolian breeds derived from the Russian crossbreeding exercises. In these cases the strategies would be calculated to reduce cashmere diameter to desired levels, while minimising the accompanying reduction in combed down weight. These calculations would require the herd statistics for each breeding flock

The operational issues raised in applying these strategies need to be carefully considered in regard to Mongolian conditions and husbandry practices. This includes the choice of mating methods (group mating, hand service, AI etc), identification of parents and offspring, management of offspring until measurement, accurate recording and appropriate data collation and manipulation. It is likely that herds in different regions and conditions will use different methods, and these should be detailed in appropriate protocols. The compilation of these protocols will ensure that any practical operational limitations will be foreshadowed. As can be appreciated from the examples given, selection strategies can be refined to accommodate varying practical considerations.

RECOMMENDATION: The production of a set of suitable selection strategies is one of the important issues at this stage of development of the Mongolian cashmere industries, and it is strongly recommend that the methodology illustrated here be used until more efficient methods are available.

H. Survivability

An important trait in Mongolian goats is the ability to survive and reproduce in the harsh Mongolian environment and some consideration needs to be given to this issue in devising selection schemes. While the environment exercises some natural selection, it is prudent to ensure that any selection scheme does not produce less fit animals. Suitable selection criteria for 'survivability' would be the ability to produce and rear a kid to a certain live weight in a certain period of time each year. This criterion has been successfully used in producing the Beefmaster easy care breed of cattle in the Colorado rangelands of the United States. In conditions where the use of such criteria is not feasible, some measure of live weight is commonly substituted. Mongolian goats are usually weighed in the spring, at the end of winter when they have lost a lot of weight, and in the autumn after grazing the summer pastures when weight would have been regained.

If winter has been severe, some losses would have occurred and surviving animals would be expected to have suffered major weight loss; variation in live weight in the spring could conceivably be mainly due to differences in skeletal size.

The autumn live weights may be more variable and would be expected to reflect the animal's ability to harvest nourishment and gain weight. A weight measure at this time may be a better estimator of fitness or survivability than a weight in the spring. Alternatively, some function of daily weight gain between spring and autumn, as a function of initial live weight may be a better estimator of fitness.

Research groups in Mongolia would have live weight records and survivability data that could provide an insight into this question and allow a suitable "survival " parameter to be chosen for use in selection programs if necessary.

III. COMMENTS ON THE USAID FUNDED BREEDING PROJECTS

General

Both the ACDI/VOCA *Farmer to Farmer Program's* and Mercy *Corps' Gobi Regional Economic Growth Initiative's* breeding projects have wider scenarios than breeding and any specific comments regarding the breeding activities should be considered in the broad context. These remarks pertain only to the breeding components for both. Both projects equally bear the limitations outlined above. These limitations also modulate the expectations and the future financial returns calculated for the breeding activities within the projects.

The manuals or handbooks produced by both projects contain similar information, a mixture of good advice, some errors and some inappropriate methodology and both require extensive revision (please see the section titled The Herder Handbooks – Suggested Improvements). This is particularly necessary for the operational aspects of nucleus breeding schemes. It is understood that a joint manual was discussed but agreement was not reached on content.

This issue is readily resolved if a loose-leaf manual is used with sections on different topics. Manuals may then be composed to suit different clients, and the updating of information can be readily accomplished. Examples of such manuals and materials were left by the consultant with USAID at the end of his assignment.

In both manuals it was found that in sections of manuals the consultant's own writings had been reproduced verbatim. This indicates that the authors were either too lazy to paraphrase or did not understand the subject matter. The first is excusable the second dangerous. It is normal practice when quoting extensively from another's work to request a review by the original author, to ensure that material is not used out of context or in error. This is a common professional courtesy usually undertaken without charge. It should be adopted here.

There are some problems with the recommended practices for the nucleus breeding schemes in both projects, particularly with the selection of young male stock before winter, and the correction of performance records for environmental influences. The consultant discussed these issues with the project advisers (Dr. Zagsduren and members of the Research Institute for Animal husbandry).

The formation of these nucleus schemes is a useful "rehearsal", and an opportunity to train operators, and consolidate breed or strain genotypes while exercising some selection on fitness and fiber diameter. Males bred in this system may well be superior to others available but until they can be measured with precision the term "selected" may be substituted for "superior" or "Elite" to avoid misunderstanding. This applies equally to any breeding scheme for cashmere goats at the present time.

Both breeding projects, along with any others in Mongolia, are limited by the measurement problems discussed earlier. As this effects much of the methodology outlined in the various manuals.

RECOMMENDATION: A complete review of the breeding scheme protocols for all projects.

A. ACDI/VOCA's Farmer to Farmer Program

This project has a clear commercial aim of producing superior sires with respect to cashmere production for sale and profit. They operate with three indigenous breed types, one of which is more advanced in establishing a nucleus breeding scheme than the other two. They have collected foundation stock and purchased sires from the private Mon Amical Fine Fibre joint venture breeding enterprise directed by Dr. Zagsduren, who also provides advice and assistance to the project.

The Cashmere Breed Improvement Project involves some 87 active herders controlling some 6,100 selected does, and the first progeny from matings with purchased selected sires have been born. Assessment according to the project protocols is being carried out. The project has required the herders to keep systematic comprehensive records, both animal and financial, and to follow good management and veterinary practices. This is a valuable training contribution to the general level of goat husbandry in the area. Upon review of several herder record books (courtesy of Dr. Zagsduren) they appear to be well kept. This practice is a benefit of the program in that it introduces systematic procedures with herders and the associated educational opportunities to improve many aspects of animal husbandry.

Their herd recording system is quite comprehensive but carries the risk of recording too much information, some of which may never be used. Users who perceive their efforts as wasted may cease recording. Some refining of the system is required. Ideally a standardized recording system will be developed for all breeding programs that specifies the minimum information needed for efficient selection.

The transposition of these records to a computer system that enables them to be used is a problem for project staff. The program is handicapped by the lack of appropriate computer software to record and manipulate data from the breeding herds. The Cashstud program obtained from one of their consultants, while a generous gift, may not be suitable for computers in the future and relational databases are more useful. Programming expertise is needed to setup stock flow and herd composition spreadsheets such that projections of stock numbers and changes can be tracked accurately. Programs will eventually be needed to calculate estimated breeding values once the measurement problems are overcome.

According to the reports examined and the discussions with project staff and advisers; three Pure Bred Cashmere Goat Registry Associations have been formed in the Bayankhongor aimag with a total of 135 breeder members. Three breeds of goat are involved and they desire to establish a national umbrella organization for Pure Bred Goat Associations.

While this is perfectly permissible, it is the view of the consultant that a Performance Recording Breed Association is a more useful entity as it places the emphasis on performance as opposed to pedigree. Giving prominence to pedigree runs the risk of having pedigree information dominating the perceived value of breeding stock rather than performance. At this developmental stage of the cashmere breeding industry it is preferable to educate all sectors as to the value of performance testing.

The project has gained considerable impetus from the industry wide shortage of sires for cashmere breeders, and it aims at producing sires in the first instance for the goat herders in the Bayanhongar aimag, and estimates that it will generate 700-800 selected sires by the end of its third year. This target will only be achieved if the assumptions concerning death rates, survival

and reproductive rates hold, breeders are able to carry out the required matings, and environmental conditions permit.

The project's principals appear keen to promote their activities as a model for other breed improvement projects in Mongolia. It should be clearly recognized that this commercially oriented model is one of at least three possible variants available to herders desiring selected or improved sires. As yet, none of the variants have the techniques to carry out efficient selection for the improvement of cashmere production and quality.

B. Mercy Corp's Gobi Regional Economic Growth Initiative

The breed improvement component of this project falls under their Agricultural Development Cluster, that aims at improving the market value of animal products. Thus the thrust of this project's breed improvement component is fundamentally different ACDI/VOCA's project, and there is no specific profit motive for the sale of sires to other breeders. Rather the objective is to improve the value of the product herders have for sale through breeding better animals.

The project has 205 herder groups in 5 Gobi aimags, involving nearly 2000 herders and thus has established a very powerful extension infrastructure for various aspects of agricultural and animal production and marketing. As it is currently emphasizing co-operative developments it is likely to develop breeding co-operatives (the second buck source variant mentioned previously) over a wide area.

The project envisages using the nucleus breeding scheme model and has commenced evaluating animals in several locations for six groups. Additionally, its staff is assisting regional agricultural officers and herders to design and implement back-crossing schemes for crossbred goat herds, so they are involved with both of the Mongolian gene pools.

Their manual and protocols suffer the same general criticisms that have made previously, and will benefit from the recommended review. As their nucleus breeding co-operatives are in the formative stage they will benefit from any revision of the methodology.

The project staff have limited knowledge of modern animal breeding practices and will need careful guidance in the formative phase particularly with respect to the operational aspects of nucleus herd schemes.

Given the coverage of this project and its likely extension, the co-operative breeding schemes that it promotes could develop into the major source of selected sires for the Mongolian cashmere industry, with the commercial buck breeders having a minor share and/or supplying very specific genotypes.

C. The Herder Handbooks – Suggested Improvements

The handbooks produced by both the ACDI/VOCA *Farmer to Farmer Program* and Mercy Corps' *Gobi Regional Economic Growth Initiative* are a mixture of good and bad advice, factual errors and inappropriate methodology. Below please find the major problems and issues relevant to breeding, for expansion here.

Both handbooks would benefit from a systematic approach to setting out detailed procedures at each operational stage taking into account Mongolian conditions and traditional management practices. An annual calendar of activities would serve to summarize the management progression with each activity expanded in a later more detailed section. A loose-leaf format would allow a

logical organization with sufficient flexibility to permit additions and upgrades to be inserted in the appropriate place.

The ACDI/VOCA Farmer to Farmer Herder Handbook

Chapter 7 of the ACDI/VOCA handbook contains practical protocols for controlled mating and rearing systems under Mongolian conditions and these sections could serve as a model for other activities in the annual management calendar. This is the only chapter in either manual that specifically addresses an operational issue in the breeding scheme calendar with respect to Mongolian conditions and management traditions. Chapter 2 of the same handbook contains recording forms that can be easily modified to eliminate duplications and some unnecessary information. *There is no indication of where or how the information is to be collated and used; it could be linked to other chapters that describe the use of the information in selection or grading*. This lack of cohesion may be due to the fact that different authors have produced the chapters independently. This may also be the reason for **some glaring inconsistencies**. *For example Chapter 4 advises no more than two characters for selection while Chapter 6 lists at least three.*

There are some serious errors that indicate that a disciplinary review was not undertaken before publication. The example on **p.33** of the ACDI/VOCA handbook, the use of a purchased superior buck and its impact on future production is wrong as it does not include the between herd selection differential that would increase the initial gain. This should either be removed or corrected.

A more serious error appears in Chapter 5 ("How to Select Breeding Bucks"). A three-stage selection process for young males at 10-14 days, 4-5 months and 1 year of age is advised. According to this protocol, the first selection eliminates animals born from young or old does; these animals are not weak because of their genetic makeup but because they have young or old parents. This is an environmental effect and this process would eliminate good genotypes with respect to fleece characteristics before their genetic merit could be assessed.

KEY POINT MISSED:
It is normal practice to make corrections for known environmental effects, such as age in days from birth, age of doe, and type of birth, before ranking animals on any particular trait for selection. Neither manual describes this process or why it is necessary. This is a serious omission as without these corrections considerable bias can be introduced to the selections and animals of superior genetic merit may be overlooked.

In the same Chapter 5 the section of male kids at 4-5 months is based in part on coat characteristics as these are stated to be related to adult cashmere production**. This is simply not true**. The relationship between kid coat characteristics and adult fleece production has been extensively investigated and no relationship has been found in any of the experiments. There is no evidence that any attribute of the 4-5 month old kid can be used to predict adult performance, despite anecdotal claims to the contrary.

If male kids have to be culled at these early ages because of managerial considerations, it would be preferable to select them at random, or randomly within sire groups, to preserve the genetic variation in the particular birth group and to eventually obtain some estimate of the group production averages. This data then can be used to assess progress or calculate deviations for use in selection indexes.

No mention is made of the importance of rearing all the young the animals in same sex groups, ensuring that all animals receive the same environmental conditions. If this is not done, the

animals to be assessed will have experienced different environments so that comparisons between them will be biased and could lead to serious selection errors. Corrections to production data for known environmental influences should be carried out routinely.

Both handbooks recommend use of the Australian selection indices, as discussed previously in this report, this is neither prudent nor recommended.

The Mercy Corps Gobi Regional Economic Growth Initiative Herder Handbook

Mercy Corps' handbook differs from ACDI/VOCA's in that it uses a "How To" format with considerable detail in some of the chapters. Some chapters appear to be written by authors unfamiliar with the traditional Mongolian husbandry practices and may be contrasted with the preferred approach adopted in Chapter 7 of ACDI/VOCA's handbook. Nevertheless the detailed step-by-step format has some merit. The general organization of the handbook with respect to breeding would be improved if it were based on an annual management calendar. In the format viewed, chapters concerned with breeding were widely separated. The selection methods advocated are inappropriate, as has already been detailed, and these sections need to be replaced. Despite having considerably more detail, there are similar errors and omissions in the breeding chapters to those found in the ACDI/VOCA *Farmer to Farmer* handbook.

RECOMMENDATION: **The breeding chapters in both handbooks require extensive revision and re-organization. It would be advisable to use a well-experienced disciplinary expert to consult with local disciplinary experts experienced in Mongolian conditions to develop systematic protocols for all phases of the breeding operations.**

D. Summary

Both projects employ non-technically trained personnel in some key roles and this is cause for concern. Control of the operational aspects of the breeding exercises should be in the hands of a well-experienced disciplinary trained personnel. Staff required to work at the operational level should have disciplinary training, as well as the hands on training that has been implemented. This will ensure that they understand the importance of all the procedures, can trouble shoot on the spot, and not make silly mistakes. The use of farmer consultants is a two edged sword. While this can result in much practical advice, it is often based on production systems in other countries and not necessarily appropriate for Mongolian conditions.

Neither project has a suitable database system to record, process and collate the performance and pedigree data. This is essential if efficient selection is to be achieved and should be given a high priority. At the operational level, using spreadsheet models can facilitate predictions of flock dynamics; these will assist in foreshadowing equipment, labor and feed requirements for various management procedures. Examples are available.

It is obvious that both projects would benefit from strong disciplinary control and direction of the breeding component. There could be more co-operation between various groups interested in the improvement of cashmere breeding, although both projects visited appear to have good relationships with local agricultural authorities. The absence of coordinated operational planning in such an important national industry is cause for concern.

Despite these criticisms, the cashmere breeding programs at present will not do any harm. The grading processes used will result in some degree of uniformity in the flocks/breeds processed; color, shape and cashmere diameter are controlled at desired levels in the indigenous flocks and there is little danger of a coarsening of the cashmere fiber diameter. However it is unlikely that any real progress has been made in increasing down weight. These flocks will form an excellent base on which to apply more appropriate selection methods as outlined in this report.

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