FINAL REPORT

Covering Period: August 11st, 1987 - August 1th, 1992

Submitted to the Office of the Science Advisor
U.S. Agency for International Development

A STUDY OF GOAT CROSSBREEDING FOR INCREASED MEAT PRODUCTION

Principal Investigators: Dr. J. Hillel and
Dr. D. Rattner
Grantee Institution: The Hebrew University of
Jerusalem

Collaborator: Dr. S. K. Sah
Institution: Tribhuvan University

Project Number: C7-110
Grant Number: DPE-5544-G-SS-7020-00

A. I. D. Grant Project Officer: Dr. Charles Lawson

Project Duration:
August 11th, 1987 - August 1th, 1992

TABLE OF CONTENTS

SUMMARY	3
RESEARCH OBJECTIVES	4
MATERIALS AND METHODS	5
ANIMALS	5
ISRAELI BREEDS	5
NEPALI BREEDS	5
HOUSING AND MANAGEMENT	5
FERTILIZATION	6
GROWTH	6
PRODUCTION	7
MEAT	7
MILK	7
ECOLOGY	7
RESULTS	8
BREEDS	8
MATING	9
SEASON EFFECT ON CONCEPTION	9
BIRTH WEIGHT	9
MORTALITY	10
MILK PRODUCTION AND GROWTH OF KIDS BEFORE WEANING	11
GROWTH AFTER WEANING AND SLAUGHTER RESULTS	11
GROWTH AFTER WEANING	11
SLAUGHTER RESULTS	12
F2 KIDDINGS	12
BREED EVALUATION	12
IMPACT, RELEVANCE AND TECHNOLOGY TRANSFER	13
ACTIVITIES, OUTPUT	14
PROJECT PRODUCTIVITY	14
FUTURE WORK	15
TABLES	16

SUMMARY

The project was planned to examine the possibility and feasibility of increasing meat production from local Nepali goats by crossing them with Mediterranean goats.

Two Mediterranean breeds were tested: the Damascus and the Mamber. Bucks and frozen semen were shipped from Israel to Nepal and used to fertilize local does.

Staff members of the IAAS were trained in using A.I. with frozen and fresh semen, performing planned matings, kids' rearing in a large herd, follow-up of growth, slaughter and product analysis. A shed for the herd was planned and constructed. Existing laboratory was equipped and used for A.I.. Herd feeding was planned and performed by local workers.

Two of the IAAS staff members visited Israel and were trained in herd management and disease diagnosis and treatment.

Two main concepts were introduced: 1. Market oriented goat meat production was introduced to an economy based on family farming system. 2. Increasing meat production by one generation cross with an exotic breed,in contrast to past attempts to introduce the exotic breed itself.

RESEARCH OBJECTIVES

Nepal is one of the poorest countries in the world. Its economy is based in a large part on agriculture. The economic system is mainly family oriented: most of the production is used by the farmers themselves and only the surplus is marketed.

Goat meat is very popular in Nepal from two main reasons: 1. According to law, based on religious restriction, cattle meat is not used, the use of pig meat is also limited to few castes only. 2. The goat is used in several religious ceremonies as a sacrificial animal.

Goat population is comparatively large, about ten million goats in a country with about 16 million people. The local breeds are small body sized, average weight of an adult female is less then 20 kg. Annual meat production per doe is about 5 kg. Goat milk is not consumed.

Several attempts were made in the past to introduce to Nepal exotic breeds like the Jmunapari from India, the Sannen from Switzerland or Israel, and others. These attempts did not result in the establishment of the breeds in Nepal.

The main objective of the present research was to explore the possibility to increase meat production by crossing the local does with Mediterranean large body-sized Mediterranean breeds. In Mediterranean countries, goats are bred for milk and meat production, and are in general much larger than the Nepali goats.

Two methods of fertilizations were tried: shipment of bucks and frozen semen. Among the many available Mediterranean breeds, two breeds were compared: Damascus and Mamber, although others, like Sannen or Alpine, could be good candidates too.

Other results of the projects could be the improved performance of F1 females as does; large scale, market oriented, goat meat production; rationally planned nutrition, mainly of the kids.

MATERIALS AND METHODS

ANIMALS

ISRAELI BREEDS

Of the three Israeli breeds planned, only two were actually used. The Sannen breed was omitted. The bucks from the Mamber and Damascus breeds were randomly taken from the local population. An effort was made to use animals from different sources, to represent the population. Two bucks of each breed were shipped to Nepal, the rest were represented by frozen semen.

NEPALI BREEDS

All the Nepali goats were of the Khari breed. Each doe was eartagged when purchased.

The does and bucks were purchased from 13 different locations, spread over an area of 30 km. radius, in the Lumbini, Gandaki and Narayan zones, on both sides of the Narayani river and north of the Rapti river. The purpose was to construct a herd of variable origin, that would represent the population. As it was reported by the Nepali investigator that there are two varieties of the Khari - large and small - it was planned to use both. Large and small goats were purchased and the assignment was done by a local investigator.

HOUSING AND MANAGEMENT

Initially the herd numbered 290 does and 5 local bucks. The bucks were separated from the does and the herd was housed in an old available pig shed. During the project a new goat shed was constructed.

The herd was grazed at least 6 hours daily during the whole year around. Does after kidding were confined with their kids for a week. After weaning the kids were fed in the sheds. Additional food was supplied mainly in critical periods: before and after kidding, during lactation, before mating season (flushing) and during seasons when pasture was not abundant.

Veterinary medical survey was done daily. Anti parasite (internal and external) treatment was carried out regularly. All does were weighed monthly.

FERTILIZATION

All intended matings were done after heat check by aproned bucks. There were comparatively many unplanned matings which were of no use. Does in heat were either individually mated by assigned bucks of all three breeds or artificially inseminated by fresh or frozen semen. The does were assigned to the bucks (breeds and individuals) randomly.

F1 does were all mated by local Khari bucks.

Heats were checked generally every 3 months for a period of 20 days.

GROWTH

During nursing kids were weighed fortnightly, after weaning - monthly. Kids of the same sire breed from each mating period were grouped together. Concentrates were presented twice daily, with amount adjusted to consumption. Surplus was weighed. About 100 grams of roughage per kid were given daily.

PRODUCTION

MEAT

Kids were slaughtered at the age of 9 and 12 months. Each kid was weighed before slaughter and all parts were weighed after it.

MILK

Doe milk production was estimated by weighing the kid twice daily before and after suckling once in two weeks. During the weighing day the kids were separated from their mothers.

ECOLOGY

IAAS campus in Rampur is situated in the Narayani river valley, elevation about 300 m. above sea level. The area is flat, with few trees, most of the vegetation is annual shrubs. The region is swampy. During the project years maximum temperature recorded was 37.3 centigrades, the minimum 2.8 centigrades (table 1). Rainfall was over 2000 mm. per annum. Relative humidity was above 80% most of the year (table 2). The driest months were in the spring, from March to May, with values between 52% to 72%. Highest values were recorded during December and January, 94% to 98%.

RESULTS

BREEDS

Based on prior information that two Khari breeds exist it was planned to use both, the large and the small. The Khari in the area where does were purchased for the present study seem to include some mixture with other breeds. There are many goats with fawn coloured fur, but many show other colours, mainly black or pied. The does were divided into large and small breeds by a local investigator after the collection. When comparing the body weights adjusted to age a significant difference was found. But when the origin of the does of the two so-called breeds were checked it was found that both came from each of the 13 places of origin. Knowing the local management methods, it did not seem likely that we were dealing with genuine breeds, since in the villages, the same bucks are serving the whole population. We concluded that the so-called breeds were an artifact, and related to the whole herd as one Khari breed. Weight changes were found during the year - during the summer, there was usually a decline in weight; during the winter the weights increased (table 3). Two other factors influenced body weights: age and gestation-parturition cycle. The does continue to grow to the age of 3-4 years. During gestation they gain and after parturition and during lactation they lose weight. The common body weight of an adult female is about 20-22 kg.

MATING

No significant difference was found in conception rate of does mated naturally to bucks of each of the three breeds. There were difficulties in mating Khari does with imported bucks because of body size differences. To overcome this two means were practised: a small podium was used to lift the doe of the ground, or artificial insemination with imported bucks' semen. There was a significant difference between methods: the results of inseminations with frozen semen were about half that of other methods ($F=9.3$, $p \leq 0.002$) (table 4). As can be seen in the table, each sire breed fertilized about one third of the herd. Successful matings were 73 for the Khari, 56 for the Damascus and 61 for the Mamber. The Khari bucks mated all F1 females, 33 matings, which are included in the total. Of these, 12 kidded, so that for the comparison there were 61 kiddings sired by Khari bucks. Note that the difference in fertilization rate between the local and the imported breeds was caused by the use of frozen semen in the latter.

SEASON EFFECT ON CONCEPTION

Mating were performed during ten months, no attempts were made in January or February (table 5). The table summarizes the results of natural mating and AI with fresh semen (results of frozen semen are omitted). The best results were achieved from May - June matings, the poorest from July - August matings. Spring and fall matings results were in between. The Khari may be mated all year around, but there is a decrease in conception rate during the monsoon season.

BIRTH WEIGHT

Birth weights according to sire breed, kid sex and litter size are given in table 6. There were significant differences between birth weights of kids born singles or twins, males and females. There was a significant difference between kids born to Damascus bucks and kids born to Khari bucks. Kids born to Mamber bucks did not differ significantly from either of the other two breeds.

MORTALITY

Doe mortality was very high. Out of 270 does purchased in August - September 1989 179 died during the work, 66.9% in comparison to loss of 6% per year estimated (table 7).

Moreover, 110 which amounted to 40.7%, died during October - December 1989. According to our opinion this heavy mortality resulted from three main reasons: 1. The does were collected from many locations where they were held in small units. When combined to one herd the adjustment to the new management and cross infection formed a high stress. 2. The conditions in Rampur were far from ideal to goats (high humidity, lowland pasture). 3. The lack of experience of the staff.

In 1990 again, mortality of most of does occurred during October - December, 37 out of 58 total mortality. However, two years are not enough to draw conclusions about season mortality. In 1990 an epidemic of Enterotoxaemia was suspected.

Kid mortality was as presented in table 8. No significant difference was found between breeds or seasons with respect to these numbers. Losses of over 50% are much too high for such a project, but the possible high rate of loss in the crosses with exotic breeds did not appear.

MILK PRODUCTION AND GROWTH OF KIDS BEFORE WEANING

Milk production was estimated by weekly weighing of kids during the suckling period (90d.) (table 9). In the whole kids population there was a significant correlation between total milk production or average daily milk production and kids' average daily gain. The correlation was significant also for each sex separately, and for the D and M breeds, but not for the K breed. On the basis of breed - sex subgroups, the correlations were not significant. This is apparently the result of small sample size. The estimated average milk production per doe was 42.2 kg., with a maximum of 165 kg.. The average daily gain was 53.9 g., no difference was found between breeds or sexes.

GROWTH AFTER WEANING AND SLAUGHTER RESULTS

Kids were slaughtered at two ages: 9 months and 1 year. Number of kids slaughtered are given in table 10.

GROWTH AFTER WEANING

Daily gain estimates for the three breeds crosses (males only) were 55.1, 46.2 and 41.4 g for Damascus, Khari and Mamber respectively. The Damascus cross differed from each of the other breeds ($t \leq 0.02$ and $t \leq 0.0001$ from the Khari and Mamber respectively). Daily gain declined with age only in Mamber crossed kids ($t \leq 0.025$). For live body weight at slaughter only healthy kids that reached that age were analyzed (table 11). Least square mean (kg.), standard deviation and sample size of Damascus, Khari and Mamber kids respectively were 19, 1.49, 19; 16.98, 1.55, 16; 13.08, 1.84, 16. Significant difference was found between Damascus and Mamber crosses ($t \leq 0.05$). Feed efficiency (kg. body weight / kg. concentrates) did not differ between the breeds (0.14, 0.15 and 0.15 for D, K and M respectively.).

SLAUGHTER RESULTS

Least square means of used parts (kg.) and dressing percentages were 10.8, 48.3%; 10.1, 50.3%; 6.8, 43.9% for Damascus, Khari and Mamber respectively. The difference between Damascus and Khari on one hand and Mamber on the other was significant, $p \leq 0.05$.

F2 KIDDINGS

Attempts to mate female kids were started after they reached one year of age. The total number of females that survived to that stage was 22: 6 Damascus cross, 9 Mamber cross and 7 Khari. Out of them 2 Damascus (33.3%), 7 Mamber (77.8%) and 3 Khari (42.9%) gave birth. Mean age at birth was (days) 618.5, 650.4 and 652.3 for Damascus, Mamber and Khari crosses respectively.

BREED EVALUATION

The conception rate in all three crosses was the same. Although the kids born to Damascus bucks weighed more than the kids born to local bucks, no difficulties in kidding were observed. As expected, sire breed had no effect on twinning rate or on doe's milk production. For the purpose of increasing meat production the Damascus breed proved to be the best. It showed its priority in body weight of kids at all ages, from birth to one year. None of the exotic breeds showed higher kids mortality than the native one. The Mamber breed gave the best results in sexual maturity of the F1 female kids.

IMPACT, RELEVANCE AND TECHNOLOGY TRANSFER

The main idea of using first generation cross as a commercial product, or more specifically as a meat source, was introduced to the faculty members of IAAS. Also the system of market oriented mass goat meat production was presented. As a central animal science research institute, IAAS may further develop this approaches in its contribution to the Nepali agriculture. Such approaches are needed in the country that is still in urgent need of increased food production, and at the same time faces a rapid population growth as well as an industrial revolution.

From the practical aspect, the project output ought to be transferred to the field by an extension service or perhaps by a commercial enterprise. This is left, at present, in the hands of local authorities and private developers.

The general ideas are relevant to many other developing countries that are in a situation similar to that of Nepal: popularity of goat meat, scarcity of food for the people, and family based agricultural production.

Beside the minor contributions to IAAS such as the opening of the I.A. laboratory and construction of a new goat shed, the main contribution of the project was in the training and practice of the collaborators. This included the topics of management of a large scale goat herd, systematic veterinary follow-up in the herd, the use of artificial insemination with fresh and frozen semen, a planned analysis of the product - meat production by the different crosses.

ACTIVITIES, OUTPUT

Dr. S. K. Sah was trained in Israel, December 1988 - March 1989, in goat management.

Dr. I. P. Dhakal was trained in Israel in veterinary diagnosis, June 1990.

Meetings of the animal science faculty and staff of IAAS were held on: March 10, 1990; October 10, 1990; and March 15, 1992. The principal investigators, D.R. and S.K.S. attended the V Internaticnal Conference on Goats in New-Delhi, March 1992.

The imported bucks and their crossbred progeny were exhibited at an agricultural fair held in Rampur in the fall of 1991.

PROJECT PRODUCTIVITY

The project results showed that by using the Damascus bucks on Khari does in Nepal, a better growth rate of the kids can be achieved and the total meat production per doe increased. This cross is superior to the local purebred kids and to the imported Mamber cross. However, the average daily gain of the kids was lower than the expected gain, based on former information from crosses made in Israel, perhaps because of management problems.

The project duration was extended by 18 months. This was forced by low kids yield which was caused by two reasons: 1. Exceptional high mortality rate among the does in the herd, mainly during the first year. 2. A large number of uncontrolled kiddings, which were useless to the project. Not only that the kids without known sire could not be used for the analysis, but their mothers lost a season.

The small number of legitimate kids (kids with known ancestry) that reached slaughter resulted in the need for elaborate statistical analysis.

The small number of female kids that reached sexual maturity did not enable a proper investigation of the performance of F1 females. The only result that was found relate to the age of puberty, but nothing can be said on the effect of the cross on nursing abilities.

Two main reasons handicapped the project. The first one was that the IAAS campus was not the best location ecologically for goat breeding. The goat in general is an animal of dry environment and thrives better on pasture that include trees and bushes in addition to grass. Rampur area, basically swampy, was devoid of trees or bushes. This fact was not known in Israel at the planning stage and the Nepali collaborators were not aware of it. The cooperation of the IAAS authorities was limited and did not suffice to achieve maximum results from the project. This was most pronounced in the appointment of the principal investigator, who stopped to cooperate with the project before its completion.

FUTURE WORK

After the completion of the project, two imported bucks survived, one of each breed. The local scientists started a program of mating private local does with these bucks. Thus may give more information about the advantage of using the Damascus on the Khari, and perhaps encouraging the introduction of the technic.

TABLES

TABLE 1: TEMPERATURE IN RAMPUR (centigrades)

Average of three years.

	MAX	AVGMAX	MIN	AVGMIN
JAN	19.8	15.1	2.8	5.7
FEB	22.0	18.8	5.5	7.4
MAR	29.5	25.0	7.0	10.8
APR	35.0	30.4	11.5	15.9
MAY	35.5	31.5	16.3	20.2
JUN	34.3	31.2	18.8	22.4
JUL	34.0	29.3	19.5	22.8
AUG	36.0	30.5	15.3	21.1
SEP	37.3	27.7	15.0	21.1
OCT	30.0	26.8	11.5	17.0
NOV	26.7	23.1	7.0	10.1
DEC	20.7	17.9	4.5	6.4

TABLE 2: RAINFALL AND RELATIVE HUMIDITY IN RAMPUR

YEAR	1990		1991	
MONTH	RAIN	HUMIDITY	RAIN	HUMIDITY
1	0.0	96.3	18.1	97.6
2	28.6	91.2	8.6	83.4
3	41.4	72.0	43.7	70.4
4	28.5	52.5	19.3	60.9
5	265.8	70.0	109.6	69.0
6	319.8	82.2	343.2	81.6
7	592.5	88.0	564.7	87.3
8	632.9	86.5	546.2	94.1
9	288.6	86.9	347.9	89.2
10	60.2	84.7	0.0	83.9
11	0.0	88.0	0.0	87.3
12	1.0	95.5	59.5	94.0
ANNUAL	2259.3		2060.8	

Monthly average relative humidity percentage observed at 10am.

TABLE 3: DOE AVERAGE BODY WEIGHT (kg)

	1989	1990	1991
January		16.2	19.2
February		16.7	20.2
March		17.9	22.1
April		19.6	24.4
May		20.3	23.4
June		19.7	22.2
July		19.9	22.6
August		19.2	21.0
September		19.9	21.8
October	15.1	19.5	22.4
November	14.4	19.7	
December	15.5	20.2	

TABLE 4: SUMMARY OF MATING RESULTS

			METHOD											
			NATURAL			FRESHSEMEN			FROZENSEMEN			TOTALS		
BRE	BUC		+	-	T	+	-	T	+	-	T	+	-	T
K	13	N	68	104	172	5	1	6				73	105	178
		%	39.5%	60.5%		83.3%	16.7%					41.0%	59.0%	
D	5	N	24	37	61	23	27	50	9	45	54	56	109	165
		%	39.3%	60.7%		46.0%	54.0%		16.7%	83.3%		33.9%	66.1%	
M	3	N	24	39	63	27	35	62	10	32	42	61	106	167
		%	38.1%	61.9%		43.5%	56.5%		23.8%	76.2%		36.5%	63.5%	
ALL	21	N	116	180	296	55	63	118	19	77	96	190	320	510
		%	39.2%	60.8%		46.6%	53.4%		19.8%	80.2%		37.3%	62.7%	

TABLE 5: MATING RESULTS ACCORDING TO BREED, SEASON AND METHOD

		MAR-APR		MAY-JUN		JUL-AUG		OCT-NOV		BRETOTAL	
BRE	MET	+	-	+	-	+	-	+	-	+	-
K	NAT	11	12	20	11	5	10	23	31	59	64
	A.I.	5	1	0	0	0	0	0	0	5	1
		16	13	20	11	5	10	23	31	64	65
	%+	55.2%		64.5%		33.3%		42.6%		49.6%	
D	NAT	6	5	11	5	0	8	7	15	24	33
	A.I.	4	10	13	10	4	3	2	4	23	27
		10	15	24	15	4	11	9	19	47	60
	%+	40.0%		61.5%		26.7%		32.1%		43.9%	
M	NAT	5	8	9	7	1	4	9	16	24	35
	A.I.	11	11	8	8	1	6	7	10	27	35
		16	19	17	15	2	10	16	26	51	70
	%+	45.7%		53.1%		16.7%		38.1%		42.1%	
BRE	NAT	22	25	40	23	6	22	39	62	107	132
SEA	%+	46.8%		63.5%		21.4%		38.6%		44.8%	
TOT	A.I.	20	22	21	18	5	9	9	14	55	63
	%+	47.6%		53.8%		35.7%		39.1%		46.6%	
SEA		42	47	61	41	11	31	48	76	162	195
TOT	%+	47.2%		59.8%		26.2%		38.7%		45.4%	

SEASONS $X^2 = 17.14$ $p<0.001$

BREEDS $X^2 = 1.533$ $0.25<p<0.5$

TABLE 6: KID BIRTH WEIGHT ACCORDING TO SIRE BREED

		MALES			FEMALES			BOTH		
		SINGLES	TWINS	ALL	SINGLES	TWINS	ALL	SINGLES	TWINS	ALL
BREED										
K	N	26	8	33	21	13	34	46	21	67
	MEAN	1.75	1.46	1.68	1.67	1.27	1.52	1.71	1.34	1.60
	S.E.	0.07	0.11	0.06	0.08	0.08	0.07	0.05	0.07	0.05
D	N	17	15	32	20	7	27	37	22	59
	MEAN	1.99	1.57	1.79	1.8	1.13	1.63	1.89	1.43	1.72
	S.E.	0.08	0.07	0.06	0.09	0.09	0.09	0.06	0.07	0.06
M	N	20	15	35	22	5	27	42	20	62
	MEAN	1.75	1.44	1.59	1.73	1.14	1.59	1.74	1.36	1.59
	S.E.	0.07	0.08	0.06	0.07	0.14	0.08	0.05	0.07	0.05

TABLE 7: DOE MORTALITY

MONTH	1989	1990	1991	
JANUARY		7	0	
FEBRUARY		0	0	
MARCH		0	0	
APRIL		2	0	
MAY		1	2	
JUNE		2	2	
JULY		1	0	
AUGUST		7	3	
SEPTEMBER		1	0	
OCTOBER	58	5	1	
NOVEMBER	40	29	3	
DECEMBER	12	3	0	
ANNUAL	110	58	11	
TOTAL				179

TABLE 8: KID MORTALITY BY BREED

SIREBREED	D	K	M
ABORTION&STILLBIRTH	7	4	6
DIED	26	35	36
SURVIVED	33	34	21
TOTAL	66	73	63
RATE OF LOSS (%)	51.5	53.4	66.7

TABLE 9: MALE KID BODY WEIGHT BY AGE

BREED	D	K	M
AGE			
0	1.9	1.8	1.7
[illegible]	7.0	7.0	6.0
[illegible]3	8.7	8.3	7.1
179	12.1	10.2	9.4
326	19.5	16.8	15.9
ADG	0.054	0.045	0.042

TABLE 10: NUMBER OF KIDS SLAUGHTERED

BREED	9MONTHS	12MONTHS	BREEDTOTALS
D	10	11	21
K	8	9	17
M	6	10	16
TOTAL	24	30	54

TABLE 11: SLAUGHTER WEIGHT

	N	MEANAGE	STD	MEANLWT	STD	S.E.	CV
		NINE MONTHS					
D	10	272.1	16.30	15.05	2.75	0.870	18.3%
K	8	274.5	2.92	12.91	2.84	1.005	22.0%
M	6	276.8	3.72	12.17	2.01	0.822	16.6%
ALL	24	274.1		13.62	2.90	0.592	21.3%
		CNE YEAR					
D	11	360.5	8.54	21.77	4.86	1.465	22.3%
K	9	361.8	6.60	20.39	5.38	1.793	26.4%
M	10	354.0	13.47	17.05	4.72	1.494	27.7%
ALL	30	358.7		19.78	5.37	0.980	27.1%