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NUÑOA: A COMPUTER SIMULATOR OF INDIVIDUALS, FAMILIES,
AND EXTENDED FAMILIES OF THE HIGH-ALTITUDE QUECHUA

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ABSTRACT

C. C. BRANDT, D. A. WEINSTEIN, H. H. SHUGART, and B. SIMMONS.
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The Quechua Indians of the Peruvian Andes are an example of a human population which has developed special cultural adaptations to deal with hypocaloric stress imposed by a harsh environment. A highly detailed human ecosystem model, NUNOA, which simulates the yearly energy balance of individuals, families, and extended families in a hypothetical farming and herding Quechua community of the high Andes has been developed. Unlike most population models which use sets of differential equations in which individuals are aggregated into groups, this model considers the response of each individual to a stochastic environment. The model calculates the yearly energy demand for each family based on caloric requirements of its members. For each family, the model simulates the cultivation of seven different crops and the impact of precipitation, temperature, and disease on yield. Herding, slaughter, and market sales of three different animal species are also simulated. Any energy production in excess of the family's energy demand is placed into extended family storage for possible redistribution. A family failing to meet their annual energy demand may slaughter additional herd animals, temporarily migrate from the community, or borrow food from the extended family storage. The energy balance is used in determining births, deaths, marriages, and resource sharing in the Indian community. In addition, the model maintains a

record of each individual's ancestry as well as seven genetic traits for use in tracing lineage and gene flow. The model user has the opportunity to investigate the effect of changes in marriage patterns, resource sharing patterns, or subsistence activities on the ability of the human population to survive in the harsh Andean environment. In addition, the user may investigate the impact of external technology (improved medical facilities, agricultural aide, etc.) on the Indian culture.

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INTRODUCTION

In this paper, we present assumptions and simulation results from a detailed simulator of a hypothetical Quechua population in the Andes. The model is the product of two classes in Systems Ecology at the University of Tennessee, Knoxville, and represents the labors of some 25 students working on different parts of the model. The model is named NUÑO A after the town and district of Nuñoa in the Department of Puno in Peru. Much of the data has been drawn from the excellent synthesis of the US/IBP Human Adaptability Program (Little and Baker 1976) that summarizes the results of over a decade of multidisciplinary work in the Andes. Additional data has been obtained from the published works of, and personal communications with Dr. R. Brooke Thomas of the Department of Anthropology, University of Massachusetts (Thomas 1972, 1973, 1976).

Model Characteristics

Efforts to model population dynamics typically use the deterministic differential equation models developed by Pearl and Reed (1920), Verhulst (1838), Volterra (1926), or Lotka (1926) as a starting point for model development. These models have been roundly criticized by practitioners, but they form the basis of many extant population models. The principal criticism of these models and the frequently used Leslie-matrix models (Leslie 1945, 1948) is that these models do not consider the interaction of a population with the environment (and vice versa). Except for the Leslie (1945, 1948) models, there is also

an assumption of a stable age distribution. Wu and Botkin (1978) have recently proposed a population model that considers the life histories of the individuals in the modeled population. The model functions by considering the dynamic changes of each individual in the modeled population with birth and death operating as stochastic events in the population. This approach might be thought of as a generalization of the detailed forest succession modeling approach used by Botkin et al. (1972).

The NUÑO model uses the approach discussed by Wu and Botkin (1978) to model a human population, their crops, and their herds in a harsh high Andean environment. The model considers a hypothetical Quechua community and can compute the effects of different ecological factors on the explicit hierarchy of individual, nuclear family, extended family, and community. Although the NUÑO model is based upon data collected during a time when the hacienda system exerted considerable influence over the Quechua population, the model does not include this influence. The model keeps track of and allows dynamic changes in the composition of families and in the patterns of extended families. The model considers such praxeological constraints as marriage patterns and kinship relationships between community members. Further, it considers the success of eight different crops in the face of such environmental events as killing frosts, hailstorms, and droughts. Three different species of animals - llama, sheep, and alpaca - are herded and each family's herd is simulated by species and age class.

The Environment of Nuñoa

The district of Nuñoa is a region of some 950 km² located on the eastern range of the Andes in southeastern Peru. The region is in what is referred to as the altiplano and is over 4000 m in altitude. Since the region is in the tropics (~14°S, ~70°W), the temperature is relatively constant but cool. Most of the variation in temperature is diurnal with nighttime temperatures around freezing throughout the year. Crop killing frosts are associated with polar cold fronts and can occur in any season. Hail occurs most frequently during the transitional months between wet and dry seasons. Total precipitation during the rainy season (September through April) averages 83 cm. The area receives very little precipitation during the remainder of the year (Thomas and Winterhalder 1976).

The altiplano contains a continuum of moisture dependent vegetation zones (Troll 1968, Mann 1968, Cabrera 1968). The Nuñoa region lies within the moist zone (Fig. 1). The vegetation is in general herbaceous, perennial, dwarfed, and endemic with infrequent groves of a low-stunted (less than 3 m) tree (Polylepis), occurring below 4600 m. Frequently occurring vegetative formations (Hodge 1946, Weberbauer 1936, Thomas and Winterhalder 1976) are:

- (1) Packed mats of low herbs, cushion plants and rosettes alternating with bare ground.
- (2) Tussock grasses which cover most of the altiplano.
- (3) Mats of Distichia muscoides in wet places.
- (4) Rock vegetation with lichen, mosses, ferns and some taller herbs and tufted grasses.

ORNL-PHOTO 3164-78

Fig. 1. Panoramic photograph of the moist zone of the altiplano.

THE NUÑO A MODEL

The Family Submodel

The Quechua People

Indigenous populations have resided in the Nuñoa district for a considerable period of time presumably using similar adaptive strategies as they presently use. According to Escobar (1976), the area was well populated by 1000 AD. In 1653 there is a record of the Inca Topa losing a district (the province of Urcosuyo) that included Nuñoa to one of his sons in a dice game (Cobo 1956). This is the first historical reference to Nuñoa. Apparently the Nuñoa district was included in the kingdom of Colla which was incorporated into the Inca Empire by Inca Viracocha prior to 1438 (Escobar 1976). In 1630, Nuñoa was listed on tax rolls (Vasquez de Espinoza 1948) as 605 taxpayers (males age 20 to 50), 306 "old", 550 children and adolescents, and 1269 women (total 2730 people).

The Quechua people of Nuñoa (Fig. 2) are small in stature with disproportionately large chests. They grow and mature slowly (termination of growth at about 22 years in men and about 20 years in women)(Frisancho 1976), perhaps due to a combination of hypoxic stress, low nutritional levels, and genetic factors. They live in a region of low primary productivity where human ability to modify the environment is limited and where crop loss is not infrequent. They appear to persist by a combination of energy-optimizing strategies, notably (Fig. 3)(Thomas 1973, 1976):

ORNL-PHOTO 3163-78

Fig. 2. A typical rural Nuñoan residence with its occupants.

Fig. 3. Energy flow diagram of a typical Quechua family. Figure is adapted from Thomas (1973).

- (1) A spatially dispersed, multiple resource base of energetically efficient crops and domestic animals.
- (2) An interzonal exchange system whereby animal resources produced in the Nuñoa ecosystem are traded for high-energy foods from lower altitude regions.
- (3) A division of labor relying heavily on child labor.
- (4) An activity pattern in which much of the day is spent performing sedentary tasks.

We will discuss several additional aspects of the Quechua of Nunoa as we examine the model structure below. The reader should bear in mind that the model is designed to bring out the details of the Quechua culture as an ecologically adaptive strategy in a heterogeneous and unpredictable environment. In summarizing their work in the high Andes, Little and Baker (1976) wrote, "The ultimate objective in ecological studies is to develop predictive models of ecosystem dynamics and processes. Mathematical modeling and simulation of Andean ecosystems is a complex but logical next step for human investigations at high altitude." It is our belief that the model presented below is a preliminary step in this direction.

Table 1 summarizes the functions of the subroutines of the NUNOA model.

Description of the Submodel

The NUNOA model traces individuals as they contribute to the functioning of the family unit (Fig. 4). Basic activities are performed by each family as a whole, but differ between families with

Table 1. Subroutine list and description

Subroutine	Description
FAMILY	Births children; finds mates.
KILHUS	Kills selected husbands.
KILWIF	Kills selected wives.
KILCHL	Kills selected children.
UPDATE	Rearranges storage matrices to add new families; distributes surplus animals to families in need.
TRANS	Transfers children and animals of dissolved families to other families.
KIDMOV	Rearranges child matrix due to movement of children within the population.
INIT	Generates initial population.
OUTPUT	Outputs population structure, energy balance, and herd structure.
LAND	Selects plot size and crops to be planted.
AGRI	Calculates energy expenditure and energy gain of agricultural activities.
FSTKIL	Kills selected crops if frost occurs.
CRPKIL	Kills crops if hail occurs.
CLIMAT	Generates monthly weather conditions of frost, hail, and precipitation.
DEMAND	Calculates yearly energy demand of families.
MIGRATE	Calculates family energy savings if husband and sons temporarily migrate away.
HERD	Updates herd populations; calculates energy gained from butchering and market activities; reduces herds to carrying capacity.
DIST	Distributes surplus food to families in need.
RANDOM	Uniformly distributed random number generator.
RANSET	Initializes random number generator.
GAUSS	Normally distributed random number generator.

FAMILY SECTION: CALLED FROM MAIN ONCE A YEAR

Fig. 4. Flow diagram of the family submodel.

different compositions. For example, the number of acres planted or number of animals herded is directly dependent upon family size.

The Nuñoan society is based on a bilateral kinship structure (Lambert 1977). In a first attempt to model this kinship structure, we have assumed that Nuñoan families are organized into clans. Initially, the model randomly assigns each family to a clan. When young adults marry, the new family joins the clan of the wealthiest parent. Wealth of the parent family is determined by dividing the herd size by the family size. Clan members can also share resources in times of need. For example, a family which has not met its annual energy demand due to poor crop yield or insufficient herd size can get extra energy from the clan surplus (this will be discussed later).

Subroutine DEMAND calculates the total annual calories required by each family. Caloric requirements are calculated separately for each adult and each child in the family on the basis of sex and age (Thomas 1972), and these values are totalled for the family. The average amount of energy expended on farming and herding activities per family is included in the family energy requirement. If the actual energy expenditure differs from this average, the energy requirement is accordingly adjusted.

In the event that the family is in energy deficit, it is assumed that the father and any sons above the age of eighteen migrate away from the town for a short period of time (apparently an energy-saving mechanism in the Nuñoan population)(Thomas, personal communication). Subroutine MIGRATE reduces the family's energy demand to reflect each individual's absence.

Subroutine FAMILY is responsible for birth, death, and marriage and is called for each family once a year. First, the birth of children is considered. For a given family the probability that a baby will be born depends upon the family's energy balance and the wife's age (it is assumed that a woman will not have children after she reaches the age of 49) (Hoff and Abelson 1976). If the family is experiencing an energy deficit, the birth probability is reduced. A random number is selected and compared to the birth probability. If the number is less than or equal to this probability, an infant is added to the family. The sex of the newborn is randomly assigned, with a slightly greater probability that the child will be male. In addition, the newborn is assigned a unique number, an age of zero, and the clan designator of its father and mother.

Each year there is a certain probability that any member of the family may die. The probability depends upon the sex and age of the person (Baker and Dutt 1972) and the energy balance of the family. For example, if a family has an energy deficit the death probability for each member of the family is increased in proportion to the energy deficit. For every individual in each family, a random number is drawn and compared to the death probability. If this number is less than or equal to the death probability, the individual is removed from the population. In families which have lost both parents, an older child (16 years or older) may assume the duties of a parent. If no such child exists in the family, the children and assets will be given to a randomly chosen family within the clan.

The third step of subroutine FAMILY attempts to marry eligible members of the population. To be eligible for marriage, candidates must meet two criteria:

- (1) The candidate's age must be within a given number of years of the prospective mate's age.
- (2) The candidate must not be more closely related to the prospective mate than second cousin (or some other predetermined familial distance).

If the husband of a family is dead, the model attempts to find a new husband for the widow. First a search is made for a suitable widower. If the model finds one, there is a 75% chance that the marriage will take place. The search process is repeated until a marriage occurs or the pool of all eligible widowers is exhausted. Upon marriage the couple's animals and children are grouped to form a single family. If no suitable widower is found, the program searches for an eligible male child. An analogous procedure occurs to find mates for widowers.

The final portion of the subroutine attempts to marry eligible young people (at least 20 years old). The pool of female children is searched to find a mate for eligible male children of each family. When an eligible female candidate is found, there is a 50% chance that the marriage will take place. New families are given surplus animals from the wealthiest parent.

Functions NEWNUM and NRELTV give the model the capability of keeping a record of the parents of each individual and can be used to trace family genealogies. Each new individual is assigned a unique

number in function NEWNUM. The numbers of that individual's parents are then recorded in a file which can be searched by function NRELTV. Each individual can be assigned any number of independent Mendelian genotypes in order to trace the distribution and movement of these genes through the population. Adjustments could be easily made to expand this capability to cases of sex linked traits.

The Crop Submodel

Description of Agricultural Activities

The Nuñoan agricultural system is based on family fields averaging 1000 m² in size (Thomas 1972). The district consists of approximately 3.4 million m² of arable land which is apportioned yearly by community officials to families on the basis of family size.

Seven major crops (the two potato species are considered as one crop in the model) are grown in the district (Table 2). Families grow at least one tuber and at least one cereal. Of the tubers, 92% of the families raise potatoes in any one year, 18% raise oca, 9% ulluco, and 5% isano. Of the cereals, 98% of the families raise quinoa, 64% canihua, and 24% barley. In any one year, approximately one half of the land allotted to a family is planted in cereals and one half in tubers. Ideally agricultural land should be left fallow 8 to 12 years, but in crowded areas of the district it is left fallow as little as 2 years.

Crops are planted in September and October and harvested in March, April, and May. Food storage and preparation activities continue throughout the year. The energy required for food related activities for each month is given in Table 3. Certain activities are carried out

Table 2. Crops of the Quechua in the Nuñoa district (Amarga and dulce potatoes are lumped in the present version of NUNOA)

Cultigen	Percentage of families growing ^a	Energy ratio energy input: yield ^a	Reliance ^a	Environmental tolerance ^a	Altitude limit ^a	Planting time ^a	Harvest ^a	Ecology ^{b-f}
Quiñoa (<i>Chenopodium quinoa</i>) Chenopodiaceae (cereal)	98	1:22	High	High	4250 m	Sept.	April	Highly plastic species corresponding to a highly variable environment. Tall annual with few branches. Tolerant of light frost and scanty rainfall. Tolerant to insect attacks and diseases. "Cultivation characters" attributable to human selection indicate a great antiquity for the species as a cultigen. Protein content of 14-15% is higher than that of most grains.
Cañihua (<i>Chenopodium pallidicaule</i>) Chenopodiaceae (cereal)	64	1:15	High	High	4450 m	Sept.	March-April	Highly plastic species. Short, bushy, many branched annual. More tolerant of frost, scanty rainfall and hail than <i>C. quinoa</i> . Limited to the highlands of Bolivia and Peru, with the zone of most intensive cultivation centered on Nunoa and Ayaviri. Shorter growing season permits cultivation at higher altitudes than <i>C. quinoa</i> . Tolerant to insect attacks and diseases. Antiquity of cultivation apparently less than that for <i>C. quinoa</i> . Leaf ash, high in Ca, is used by coca chewers.
Barley (<i>Hordeum</i> sp. complex) Graminaeae (cereal)	24	1:8	Moderate	Low	4200 m	Sept.	April-May	Eurasia introduction. Less resistant to environmental conditions than cereals. Distribution generally restricted to a few well protected lower slopes.
Amarga potato (<i>Solanum curtilobum</i>) Solanaceae (tuber)	92	1:8	High	High	4450 m	Oct.	May	Limited to the Andean highlands of Bolivia and Peru. Withstands frosts of -5 to -6 C. Higher yielding than the dulce in this environment. More susceptible to disease than other tubers.
Dulce potato (<i>Solanum andigenum</i>) Solanaceae (tuber)	92	1:8	High	High	4250 m	Oct.	May	Widespread throughout South and Central America. Closely related to <i>Solanum tuberosum</i> . More susceptible to disease than other tubers.
Oca (<i>Oxalis crenata</i>) Oxalidaceae (tuber)	18	1:4	Low	Intermediate	4200 m	Oct.	May	Limited to the highlands of Colombia and Peru. Less hardy than <i>Solanum</i> sp. Contains calcium oxalate which must be removed by exposure to the sun for several days.
Isano (<i>Tropaeolum tuberosum</i>) Tropaeolaceae (tuber)	5	1:3	Low	Intermediate	4200 m	Oct.	May	Limited to the highlands of Colombia and Peru. Less hardy than <i>Solanum</i> sp. An important food source for the Incan Empire.
Ulluco (<i>Ullucus tuberosa</i>) Basellaceae (tuber)	9	1:3	Low	Intermediate	4200 m	Oct.	May	Limited to the highlands of Colombia and Peru. Less hardy than <i>Solanum</i> sp.

Sources

^aThomas 1973.^bThomas 1976.^cGade 1970.^dSimmonds 1964.^eSaver 1950.^fSchery 1972.

Table 3. Seasonal variation in energy cost of major subsistence activities^a

Activity complex	Energy Cost (1000 kcal/month)											
	Plant-shearing				Growing		Harvest			Post-harvest		
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
<u>Potatoes</u>												
Field prep., plt.		16.2										
Weed and ridge				0.5	0.5							
Harvest								5.1	5.1			
Food preparation										3.5	3.4	
<u>Cañihua</u>												
Field prep., plt.	1.4											
Harvest							14.4					
Food preparation	0.4	0.4	0.4	0.4	0.9	0.4	0.4	0.4	0.4	0.4	0.4	0.4
<u>Quiñoa</u>												
Field prep., plt.	0.7											0.7
Harvest							4.5	4.5				
Food preparation	0.3	0.3	0.3	0.3	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3
<u>Herd Animals</u>												
Daily herding	29.0	29.0	27.0	29.0	29.0	29.0	29.0	29.0	29.0	28.0	29.0	29.0
Shearing			12.3									
Slaughtering										5.0		
Change pasture				4.3						4.3		
Food preparation										2.3	2.2	
MONTHLY TOTAL	31.8	45.9	40.0	30.2	31.1	29.7	48.6	39.3	34.8	43.8	35.3	30.4
PERIOD TOTAL		117.7			91.0			122.7			109.5	

^aData from Thomas 1973.

by specific members of the family. For example, foot plowing requires such a large physical effort that only men or older male children normally perform the task.

Tubers must be fertilized for proper production. Dung is used as fertilizer and is usually obtained from the family's corral, but if the family has too few animals, dung will be carried in from the fields at an additional energy expense. The various crops have differing degrees of susceptibilities to the harsh climate of the altiplano (Table 2). Hail storms and frost occur most frequently during planting and harvest seasons. All crops can be destroyed by hail. Canihua alone is capable of surviving minor but not severe frost damage. Drought is common and will reduce crop yields, especially those of quinoa and barley. Drought can be particularly damaging if it occurs early in the growing season. Differences in susceptibility to disease and to snow damage also exist (Table 2).

Description of the Crop Submodel

The crop submodel calculates the energy expended for and energy obtained from crop production each year (Fig. 5). It is called once a year for each family.

Subroutine CLIMAT produces information for the eight-month growing season, September through April. It provides minimum temperature, total precipitation, total potential evapotranspiration on a monthly basis, and information on occurrences of frost and hail. Temperature and precipitation values are drawn from normal distributions with means and standard deviations calculated from weather data for the district

PLANT SECTION: CALLED FROM MAIN FOR EACH FAMILY ONCE A YEAR

Fig. 5. Flow diagram of the crop submodel.

(Thomas and Winterhalder 1976). The soil moisture conditions used in the calculation of crop yield are generated by comparing precipitation to evapotranspiration. A hail or frost event occurs if a random number falls below a selected frequency value for the particular month. The probability of hail and frost are larger in the transitional months between the wet and dry seasons (Thomas and Winterhalder 1976).

Arable land is apportioned to the family yearly on the basis of family size in subroutine LAND. Only 25% of the arable land is available for agriculture, the balance remaining fallow. A family will plant the entire parcel of allotted land only in the event that land is limiting to the total population. Generally the actual acreage planted depends on the number of children in the family.

One half of the land to be cultivated is planted in tubers and one half in cereals. For each crop a random number is selected and compared to the percentage of families planting the crop (Table 2). If the number is less than or equal to this percentage, the crop is planted. If no other tuber is selected, potatoes are planted. If more than one tuber is grown, the tuber acreage is evenly divided between crops. An analogous process occurs for cereals. If no other cereal is initially selected, quinoa will be planted.

Once the land is apportioned and the crops selected, subroutine AGRI calculates the energy expended in cultivation by multiplying the amount of energy required to perform a task on one unit of land by the number of units planted in that crop (Table 3). An additional energy expenditure is incurred by families having insufficient manpower or dung fertilizer.

Subroutine AGRI calculates energy expenditure for crop production activities in monthly units. Four different types of agricultural activities are performed: planting in September and October, maintenance throughout the growing period, harvesting in March, April, and May, and food preparation in June, July, and August (Table 3). Information on hail and frost events is generated by subroutine CLIMAT. Only one hail or frost is assumed probable in any one month. If a hail storm or a frost occurs in September, the cereals are replanted and the energy expenditure for that month is increased. A frost or hail storm in October will cause both tubers and cereals to be replanted, thereby increasing the October expenditure. From November through April the occurrence of a frost or hail event will cause all crops to be destroyed with the exception of cañihua. An expenditure of energy which has already occurred at the time of a post-October frost or hail remains as an energy loss, even though no energy is gained from those crops that year.

The amount of energy gained from each crop is equal to the amount of calories ideally obtained minus that lost to the deleterious effect of disease, snow, and drought. Information on drought is generated by subroutine CLIMAT and snow and disease effects are drawn from a probability distribution. The loss factor is calculated separately for each species based on its tolerance to weather conditions as given in Table 2.

The Herd Submodel

Description of herding activities

Herding is the most important subsistence activity of the Nunõa Quechua Indians in terms of energy expenditure and energy production. Thomas (1976) has calculated that during an average year herd-related activities account for 88% of the energy expended on subsistence tasks by a family of six. In the same paper Thomas calculates that 83% of the food energy ingested by a family of six is derived from the herd. However, consumption of meat contributes only about 10% of the yearly caloric intake of the Quechua (Picón-Reátegui 1976). Through the sale of low-energy animal goods such as meat, wool, and live animals the Quechua can obtain high-energy foods, clothing, and other goods. Herd animals are also the major source of transport (Webster 1973, Thomas 1972) and of fuel and fertilizer in the form of dung (Winterhalder et al. 1974).

The alpaca (Lama paces), llama (Lama glama) and sheep (Ovis aries) are the most important animals herded by the Quechua of Nunõa (Thomas 1972). Because of smaller size, lower waste, and market value, sheep are the preferred source of meat (Thomas 1972). Sheep wool is used for clothing, and the dung is important as fertilizer for the gardens (Winterhalder et al. 1974).

The primary use of the llama is as a pack animal. Adult male llamas are capable of carrying loads of 10 to 30 kg (Webster 1973). Llamas are used to carry seed and dung to the gardens, cereals and tubers to the family dwelling, and trade goods to and from the market

(Thomas 1972). Llama dung is important as fuel for cooking and heating (Winterhalder et al. 1974), and the wool is used to make heavy-duty fabric.

The alpaca is probably the most important component of the Quechua herds because of the international economic demand for its wool (Gade 1969, Webster 1973). Through the sale of alpaca wool and meat, the Quechua are able to purchase agricultural staples such as maize, wheat flour, and coca, and manufactured articles such as needles, agricultural tools, and ceramics (Thomas 1972). Without access to outside markets, it is doubtful whether the Quechua could meet their caloric requirements (Thomas 1972, Thomas 1976).

Description of the Herd Submodel

The submodel (Fig. 6) maintains an inventory of the alpacas, llamas, and sheep which each family owns. Each species is subdivided into three age classes: newborns (less than 1 year old), immatures (1 to 2 years old), and adults (more than 2 years old). Subroutines HERD and UPDATE control the herd population in each of the nine age-species classes.

Subroutine HERD is called from MAIN once a year for each family. The first step performed by HERD is to calculate the current herd size of the family. If the family has no animals, control is returned to MAIN. If the herd size is greater than zero, the subroutine proceeds to calculate population changes for each of the nine age-species classes.

ORNL-DWG 78-9310

SUBROUTINE HERD: CALLED FROM MAIN FOR EACH FAMILY ONCE A YEAR

Fig. 6. Flow diagram of the herd submodel.

Population changes due to births and natural mortality are calculated first. The animals in the newborn and immature age classes are transferred to the immature and adult age classes respectively for each species. Births are calculated by multiplying the number of adult animals by a species-specific birth rate. It is assumed that the ratio of male to female newborns is one. Mortality in each age-species class is calculated by multiplying the number of individuals in the class by a death rate. Death rates are drawn from an age-specific normally distributed function. Males and females within each age-species class are assumed to have an equal likelihood of dying.

The meat demand is satisfied through the consumption of animals dying from natural causes and the slaughter of adult sheep (Thomas 1972). In the model, the adult sheep population cannot be reduced by slaughter below a minimum size. The calories obtained from meat are subtracted from the family's total energy demand.

The model calculates an energy deficit which is the family's energy demand remaining after the consumption of crops and meat. The energy deficit is converted to a cash equivalent (market deficit) which is to be met by the sale of animal goods.

The contribution of wool sales to meeting this deficit is calculated by multiplying the number of animals in each age-species class by an age-species specific conversion factor. It is assumed that only immature and adult llamas and alpacas are sheared for their wool (Browman 1974). Immature animals are assumed to yield one-half the wool of adults (Browman 1974). The money gained from the sale of wool

is used to purchase food. If the energy gained from the sale of wool exceeds the family's deficit, the surplus is placed into a clan store for distribution to families of the clan in need.

If the energy gained from the sale of wool does not erase the deficit, herd animals may be sold. Animals are sold one at a time in a preferential manner. Alpacas are sold before sheep, sheep before llamas, and in all cases, adults before immature animals. It is assumed that no newborns are sold in the market. No age-species class can be reduced through sale below a minimum number. Cash obtained from the sale of live animals is used to buy food and reduce the energy deficit. Animals are sold until the energy deficit is removed or the family has no more animals available. If a deficit still exists after all available animals have been sold, the family must rely upon the clan store to satisfy their energy needs. If the sale of animals gives the family an energy surplus, the excess is placed in the clan store.

The ability of the family to maintain its herd places a constraint on the herd size. It is assumed that a family must have at least two children seven years or older to maintain a herd of more than 100 animals. If a family's herd is larger than 100 animals and if the family does not have the required number of children, all animals in excess of 100 are removed from the herd and placed into a clan store. The number of animals removed from each age-species class is proportional to the number of animals in excess of a lower limit set for each class. The lower limits are based on the average herd composition of a Quechua family (Thomas 1972).

The amount of dry season pasture places an upper limit on the number of animals that can survive in the district. The carrying capacity is expressed in sheep equivalents which is the number of sheep that one km^2 of pasture can support for one year. The district is estimated to have a carrying capacity of 375,000 sheep equivalents. A newborn llama or alpaca is considered equal to one sheep, an immature llama or alpaca equivalent to two sheep, and an adult llama or alpaca equivalent to three sheep (Browman 1974). Family herd size is converted to sheep equivalents by multiplying the number of animals in each age-species class by the appropriate conversion factor and summing the results.

The 375,000 sheep equivalents are distributed among the district families each year in proportion to family size. The family's herd is converted to sheep equivalents and compared to the family's allotted equivalents. If the herd exceeds the allotted equivalents, animals are removed from each age-species class in proportion to the number of sheep equivalents in the class and are placed into a clan surplus.

Subroutine DIST distributes surplus food to those families that fail to meet their energy demands through agriculture, herding, and trading. A family has access only to the surplus food of its clan. Subroutine UPDATE (Fig. 7) distributes surplus animals to families in need. Need is determined by calculating the number of sheep equivalents each family is entitled to and comparing this number to the actual herd size. If a family is entitled to more animals, the model determines which age-species classes of the family are deficient and attempts to add to these age-species classes from the clan store.

ORNL-DWG 78-9309R

SUBROUTINE UPDATE: CALLED FROM MAIN ONCE A YEAR

Fig. 7. Flow diagram of subrouting UPDATE.

Model Input and Output

Input information required by NUÑO[~]OA consists of:

1. NFAM = the initial number of families. (The present model is equipped to handle up to 1000).
2. CLANUM = the number of clans (up to 50).
3. NYR = the number of years of simulation time.
4. NTRAIT = the number of simple Mendelian traits to be followed by the model (the number of traits is equal to the number entered minus one since the first value in the record of each individual is the individual's unique number).
5. KDIST = a value indicating how closely related people can be and still be married (for example, KDIST = 2 means first cousins cannot marry but second cousins can, KDIST = 1 means siblings cannot marry but first cousins can).
6. ISEED = an initial seed value for the random number generator.
7. I01 = the logical device to which the output is to be sent.
8. KPRNT = the frequency of output.
9. PRINT1, PRINT2, PRINT3 = print switches for selecting the type of output desired.

Output from NUÑO[~]OA is a yearly summary consisting of one table of monthly weather conditions (PRINT1), one table of mortality statistics (PRINT3), and one table listing the following attributes for each family (PRINT2) (see Appendix):

- (1) The clan, sex, blood type, and age of all family members.
- (2) The family energy demand; energy gain through crop production, animal slaughter, and trading market activities; and net energy gain for the year.
- (3) The number of sheep, alpaca, and llama in the family's herd.

DISCUSSION

Many aspects of Nunoan life which may have implications for other human societies can be investigated by altering the input parameters. Clan structure is present in many primitive cultures, but its role in these cultures is unknown. Altering the number of families per clan may provide insight into the importance of sharing of resources within a superfamily to the maintenance of a stable population in a harsh environment. Further, the restrictions placed upon gene flow by clan structure and marriage patterns has an undefined impact on the population. The importance of population structure as a defense against the spread of a deleterious gene could be evaluated through observation of the flow of such a gene through the population under different structural rules and regulations.

The Nuñoan population is typical among primitive peoples of the world in that it is on the brink of experiencing the introduction of modern technology. The impact of this technology on other cultures has not always been favorable. An exciting potential of the model is the simulation of cultural dynamics in response to the introduction of changing medical practices or shipments of surplus food from outside

sources. It is quite possible that a previously unpredictable chain of repercussions might arise. For example, reduction of energy deficits might cause a lowered dependence on clan structure, leading to an increased susceptibility to the flow of deleterious genes. To our knowledge, no other model provides the capability of investigating the interactions of multilevel cultural interrelations so characteristic of human society.

REFERENCES

- Baker, P. T., and J. S. Dutt. 1972. Demographic variables as measures of biological adaptation: a case study of high altitude human populations. pp. 352-378. IN G. A. Harrison and A. J. Boyce (eds.), The structure of human populations. Clarendon Press, Oxford.
- Botkin, D. B., J. F. Janak, and J. R. Wallis. 1972. Some ecological consequences of a computer model of forest growth. J. Ecol. 60:849-873.
- Browman, D. L. 1974. Pastoral nomadism in the Andes. Curr. Anthropol. 15:188-196.
- Cabrera, A. L. 1968. Ecologia vegetal de la puna. IN C. Troll (ed.), Geoecology of the mountainous regions of the tropical Americas. Ferd. Dummlers Verlag, Bonn.
- Cobo, Bernabe de. 1956. Historia del Nuevo Mundo, Vol. 2. Biblioteca de Autores Espanoles 92, Madrid, Atlas.
- Escobar, M. G. 1976. Social and political structure of Nuñoa. pp. 60-84. IN P. T. Baker and M. A. Little (eds.), Man in the Andes. Dowden, Hutchinson, and Ross, Inc., Stroudsburg, Pennsylvania. 482 pp.
- Frisancho, A. R. 1976. Growth and morphology at high altitude. pp. 180-207. IN P. T. Baker and M. A. Little (eds.), Man in the Andes. Dowden, Hutchinson, and Ross, Inc., Stroudsburg, Pennsylvania. 482 pp.

- Gade, D. W. 1969. The llama, alpaca and vincuña: Fact vs fiction. J. Geog. 58:339-343.
- Gade, D. W. 1970. Ethnobotany of Canihua (Chenopodium pallidicaule), rustic seed crop of the Altiplano. Econ. Bot. 24:55-61.
- Hodge, W. H. 1946. Cushion plants of the Peruvian puna. J. N. Y. Bot. Garden 47(558):133-141.
- Hoff, C. J. and A. E. Albelson. 1976. Fertility. pp. 128-146. IN P. T. Baker and M. A. Little (eds.), Man in the Andes. Dowden, Hutchinson, and Ross, Inc., Stroudsburg, Pennsylvania. 482 pp.
- Lambert, B. 1977. Bilaterality in the Andes. pp. 1-76. IN R. Bolton and E. Mayr (eds.), Andean Kinship and Marriage. American Anthropological Association. Special publication no. 7.
- Leslie, P. 1945. The use of matrices in certain population mathematics. Biometrika 33:183-212.
- Leslie, P. 1948. Some further notes on the use of matrices in population mathematics. Biometrika 35:213-245.
- Little, M. A., and Baker, P. T. 1976. Environmental adaptations and perspectives. pp. 405-428. IN P. T. Baker and M. A. Little (eds.), Man in the Andes. Dowden, Hutchinson, and Ross, Inc., Stroudsburg, Pennsylvania. 482 pp.
- Lotka, A. 1926. Elements of Physical Biology. Williams and Wilkins, Baltimore, Maryland. Reprinted as Elements of Mathematical Biology by Dover Publ., New York.
- Mann, G. 1968. Okosysteme Sudamerikas. IN E. J. Fittkau et al. (eds.), Biogeography and ecology in South America. Dr. W. Junk, Publishers, The Hague.

- Pearl, R., and L. Reed. 1920. On the rate of growth of the population of the United States since 1790 and its mathematical representation, Proc. Natl. Acad. Sci. (Wash.), 6:275-288.
- Picón - Reátegui, E. 1976. Nutrition. p. 208-236. IN P. T. Baker and M. A. Little (eds.), Man in the Andes. Dowden, Hutchinson, and Ross, Inc., Stroudsburg, Pennsylvania. 482 pp.
- Saver, C. O. 1950. Cultivated plants of South and Central America. Smithsonian Inst. Bureau of Am. Ethno. Bull. 143:487-543.
- Schery, R. W. 1972. Plants for man. Second Edition. Prentice-Hall, Englewood Cliffs, New Jersey.
- Simmons, N. W. 1964. The grain chenopods of the tropical American highlands. Econ. Bot. 19:223-235.
- Thomas, R. B. 1972. Human adaptation to energy flow in a high Andes. Ph.D. Dissertation. Pennsylvania State University, University Park, Pennsylvania.
- Thomas, R. B. 1973. Human adaptation to a high Andean energy flow system. Occasional Papers in Anthropology 7. Department of Anthropology, Pennsylvania State University, University Park, Pennsylvania.
- Thomas, R. B. 1976. Energy flow at high altitude. pp. 379-404. IN P. T. Baker and M. A. Little (eds.), Man in the Andes. Dowden, Hutchinson, and Ross, Inc., Stroudsburg, Pennsylvania. 482 pp.
- Thomas, R. B., and B. S. Winterhalder. 1976. Physical and biotic environment of southern highland Peru. pp. 21-59. IN P. T. Baker and M. A. Little (eds.), Man in the Andes. Dowden, Hutchinson, and Ross, Inc., Stroudsburg, Pennsylvania. 482 pp.

- Troll, C. C. 1968. The Cordilleras of the tropical Americas; aspects of climate, phytogeographical and agrarian ecology. IN C. Troll (ed.), Geo-ecology of the Mountainous Regions of the Tropical Americas. Ferd. Dummlers Verlag, Bonn.
- Vasquez de Espinosa. 1948. Compendio y descripcion de las Indias Occidentales. Smithsonian Misc. Coll. 108.
- Verhulst, P. 1838. Notice sur la loi que la population suit dans son accroissement, Corresp. Math et Phys. 10:113-121.
- Volterra, V. 1926. Variations and fluctuations of the number of individuals in animal species living together. pp. 409-448. IN R. N. Chapman (ed.), Animal Ecology, McGraw-Hill Book Co. Inc., New York.
- Weberbauer, A. 1936. Phytogeography of the Peruvian Andes. IN J. F. MacBride (ed.), Flora of Peru: I. Field Museum of Natural History. Botanical Series, Publication 351, Vol. 13, Chicago.
- Webster, S. 1973. Native pastoralism in the south Andes. Ethnology 12:115-133.
- Winterhalder, B., R. Larsen, and R. B. Thomas. 1974. Dung as an essential resource in a highland Peruvian community. Hum. Ecol. 2:89-104.
- Wu, L. S., and D. B. Botkin. 1978. On population processes of long-lived species. pp. 245-254. IN H. H. Shugart (ed.), Time Series and Ecological Processes. Society of Industrial and Applied Mathematics Press, Philadelphia, Pennsylvania. 303 pp.

APPENDIX

COMPUTER LISTING AND TEST RUN OF NUNOA

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C*****
C*          NUNOA INDIAN MODEL                      *
C*          OAK RIDGE NATIONAL LABORATORY            *
C*          C.C. BRANDT, H.H. SHUGART, D.A. WEINSTEIN *
C*****
COMMON /ANIMAL/ NANIML(3,3,1000),NA(1000),NS(1000),NY(1000)      MAIN    0
COMMON /ATTR/ CHILD(5000,2)                                       MAIN    5
COMMON /CLAN/ CLNSR(50),ICLNAN(3,3,50),NUMCLN                    MAIN   10
COMMON /CROPS/ POTACR,OCAACR,OLLACR,ISNACR,QUNACR,CANACR,BARACR  MAIN   15
COMMON /DEATH/ DFACT                                              MAIN   20
COMMON /ENNET/ ENET(1000)                                         MAIN   25
COMMON /ENGAIN/ EGAINP(1000),EGAINA(1000),EGAINM(1000)           MAIN   30
COMMON /ENLOSS/ ELOSS(1000),ELOSSP(1000)                         MAIN   35
COMMON /FAMIL/ HUSB(1000),WIFE(1000),NCHILD(1000)               MAIN   40
COMMON /GENE/ NGENEH(1000,5),NGENEW(1000,5),NGENEC(5000,5)      MAIN   45
COMMON /GENEX/ KDIST,NTRAIT                                       MAIN   50
COMMON /IAGES/ IHUSB(1000),IWIFE(1000),ICHILD(5000)             MAIN   55
COMMON /ISEX/ KIDSEX(5000)                                        MAIN   60
COMMON /NEWFAM/ IYHUS(50,5),IYWIF(50,5),NYHUS(50,5),NYWIF(50,5), MAIN   65
> IYCLAN(50),IYANML(3,3,50),KNTY                                MAIN   70
COMMON /PRINT/ IO2,L1,L2,L3,L4,L5                                MAIN   75
COMMON /STATS/ NFAMI,KIDTOT,POPTOT,FAMPOP(1000),IDCLAN(1000)    MAIN   80
COMMON /SWITCH/ KKKKKK,LLLLLL                                    MAIN   85
COMMON /WETHER/ FROST(8),HAIL(8),DRTP,DRTP1                     MAIN   90
COMMON /CPARNT/ IROW,CPRNT,KOUNT                                 MAIN   95
COMMON /SEED/ USEED(45)                                          MAIN  100
DIMENSION TITLE(10)                                             MAIN  105
DIMENSION NZERO(20)                                              MAIN  110
DEFINE FILE 8(2000,80,U,IROW)                                   MAIN  115
INTEGER USED                                                    MAIN  120
INTEGER HUSB,FAMPOP,WIFE,CHILD,POPTOT,YEAR                     MAIN  125
C...
C... DESCRIPTION OF IMPORTANT COMMON BLOCK VARIABLES:          MAIN  135
C...
C... NFAMI=TOTAL NUMBER OF FAMILIES                             MAIN  140
C... KIDTOT=TOTAL NUMBER OF CHILDREN IN POPULATION              MAIN  145
C... POPTOT=TOTAL POPULATION SIZE                               MAIN  150
C... SEXRTO=RATIO OF FEMALE CHILDREN TO MALE CHILDREN          MAIN  155
C... NUMCLN=TOTAL NUMBER OF EXTENDED FAMILIES                  MAIN  160
C... CLNSR=TOTAL NUMBER OF SURPLUS ANIMALS IN CLAN STORAGE     MAIN  165
C... ICLNAN=NUMBER OF SURPLUS ANIMALS PER CLAN BY SPECIES      MAIN  170
C... AND AGE CLASS                                              MAIN  175
C... HUSB=CLAN NUMBER ASSIGNED TO HUSBAND                       MAIN  180
C... IHUSB=AGE OF HUSBAND                                        MAIN  185
C... WIFE=CLAN NUMBER ASSIGNED TO WIFE                           MAIN  190
C... IWIFE=AGE OF WIFE                                          MAIN  195
C... FAMPOP=NUMBER OF INDIVIDUALS IN A FAMILY UNIT              MAIN  200
C... IDCLAN=CLAN NUMBER ASSIGNED TO FAMILY                      MAIN  205
C... NCHILD=NUMBER OF CHILDREN IN FAMILY                         MAIN  210
C... CHILD(I,1)=CLAN NUMBER OF CHILD'S FATHER                  MAIN  215
C... CHILD(I,2)=CLAN NUMBER OF CHILD'S MOTHER                  MAIN  220
C... KIDSEX=SEX OF CHILD (-1=MALE, 1=FEMALE)                   MAIN  225
C... EGAINP=AMOUNT OF ENERGY GAINED FROM CROP ACTIVITIES     MAIN  230
C... EGAINA=AMOUNT OF ENERGY GAINED FROM HERDING ACTIVITIES  MAIN  235
C... EGAINM=AMOUNT OF ENERGY GAINED FROM MARKET ACTIVITIES  MAIN  240
C... ENET=ENERGY BALANCE FOR FAMILY                             MAIN  245

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APPENDIX (Continued)

C...	ELOSS=ENERGY DEMAND OF FAMILY	MAIN 255
C...	NANIML=NUMBER OF ANIMALS BY AGE CLASS AND SPECIES	MAIN 260
C...	OWNED BY FAMILY	MAIN 265
C...		MAIN 270
C...	READ TITLE INFORMATION	MAIN 275
C...		MAIN 280
	READ(5,9000) TITLE	MAIN 285
	WRITE(6,9001) TITLE	MAIN 290
C...		MAIN 295
C...	READ SEEDS FOR RANDOM NUMBER GENERATOR FOR VARIOUS STOCHASTIC	MAIN 300
C...	FUNCTIONS IN THE MODEL	MAIN 305
C...		MAIN 310
	READ(5,9002) (USEED(I),I=1,44)	MAIN 315
C...	THE FOLLOWING 12 CARDS OVERRIDE THE RANDOM NUMBER SEEDS	MAIN 320
C...	FOR CLIMATE AS A SIMPLE MEASURE FOR HOLDING CLIMATE CONSTANT	MAIN 325
C...	IN EACH OF THE SIMULATIONS.	MAIN 330
	USEED(34) = 73451	MAIN 335
	USEED(35) = 92631	MAIN 340
	USEED(23) = 13572	MAIN 345
	USEED(24) = 57912	MAIN 350
	USEED(26) = 64901	MAIN 355
	USEED(27) = 23517	MAIN 360
	USEED(12) = 78532	MAIN 365
	USEED(13) = 64379	MAIN 370
	USEED(28) = 34579	MAIN 375
	USEED(29) = 97542	MAIN 380
	USEED(14) = 13672	MAIN 385
	USEED(15) = 87431	MAIN 390
C...		MAIN 395
C...	SET OUTPUT DEVICE	MAIN 400
	IO2=6	MAIN 405
C...	SET THE PRINT SWITCHES	MAIN 410
C...		MAIN 415
C...	FOR WEATHER INFO OUTPUT L1>0	MAIN 420
	L1=0	MAIN 425
C...	FOR FAMILY INFO OUTPUT, L2>0	MAIN 430
	L2=1	MAIN 435
C...	FOR ENERGY INFO OUTPUT, L3>0	MAIN 440
	L3=1	MAIN 445
C...	FOR ANIMAL INFO OUTPUT, L4>0	MAIN 450
	L4 = 1	MAIN 455
C...	FOR DEATH INFO OUTPUT, L5>0	MAIN 460
	L5=0	MAIN 465
C...	INITIALIZE THE PRINT INTERVAL(KPRNT), NUMBER OF SIMULATION	MAIN 470
C...	YEARS(NYR), AND NUMBER OF REPLICATE RUNS(KTIMES).	MAIN 475
C...	INITIALIZE THE LEVEL OF RELATEDNESS PERMITTED FOR	MAIN 480
C...	MARRIAGE (KDIST), NUMBER OF GENETIC TRAITS TO BE FOLLOWED	MAIN 485
C...	(NTRAIT), THE NUMBER OF EXTENDED FAMILIES (NUMCLN),	MAIN 490
C...	AND THE NUMBER OF FAMILIES (IFAM).	MAIN 495
C...		MAIN 500
C...	NOTE: THE NTRAIT VALUE MUST BE 3 IF ONE	MAIN 505
C...	TRAIT IS BEING FOLLOWED, 5 FOR TWO TRAITS, ETC.	MAIN 510
C...	(THE FIRST POSITION OF NGENE ARRAYS IS INDIVIDUAL	MAIN 515
C...	NUMBER, THE SECOND THE MOTHER'S ALLELE, THE THIRD THE	MAIN 520
C...	FATHER'S, OF THE FIRST GENE).	MAIN 525
C...		MAIN 530
C..	*****	MAIN 535
	KPRNT = 1	MAIN 540

APPENDIX (Continued)

NYR = 5	MAIN 545
KTIMES = 1	MAIN 550
KDIST=2	MAIN 555
NTRAIT=3	MAIN 560
NUMCLN=20	MAIN 565
IFAM=100	MAIN 570
C...*****	MAIN 575
C...	MAIN 580
C... CALL THE INITIALIZATION SUBROUTINE	MAIN 585
C...	MAIN 590
KNTY=1	MAIN 595
DO 10 I=1,20	MAIN 600
NZERC(I)=0	MAIN 605
10 CONTINUE	MAIN 610
DO 80 IPOPUL=1,KTIMES	MAIN 615
NFAMI=IFAM	MAIN 617
WRITE(10) IPOPUL	MAIN 620
QFROST=0.0	MAIN 625
QHAIL=0.0	MAIN 630
TUBTOT=0.0	MAIN 635
CERTOT=0.0	MAIN 640
IROW = 1	MAIN 645
DO 20 I = 1,2000	MAIN 650
WRITE(8*IROW) NZERO	MAIN 655
20 CONTINUE	MAIN 660
CALL INIT	MAIN 665
C...	MAIN 670
C... START OF THE YEAR LOOP	MAIN 675
C...	MAIN 680
DO 70 I98=1,NYR	MAIN 685
YEAR=I98	MAIN 690
IDKNT=1	MAIN 695
WRITE(IO2,9003)	MAIN 700
WRITE(IO2,9004) YEAR	MAIN 705
C...	MAIN 710
C... GENERATE CLIMATE FOR THE YEAR	MAIN 715
C...	MAIN 720
KKKKKK=0	MAIN 725
LLLLLL=0	MAIN 730
CALL CLIMAT	MAIN 735
C...	MAIN 740
C... START OF THE FAMILY LOOP	MAIN 745
C...	MAIN 750
DO 50 I=1,NFAMI	MAIN 755
NFAM=I	MAIN 760
C...	MAIN 765
C... INCREMENT AGES OF INDIVIDUALS	MAIN 770
C...	MAIN 775
IF (IHUSB(I).GT.0) IHUSB(I)=IHUSB(I)+1	MAIN 780
IF (IWIFE(I).GT.0) IWIFE(I)=IWIFE(I)+1	MAIN 785
IF (NCHILD(I).EQ.0) GO TO 40	MAIN 790
IPT=IDKNT+NCHILD(I)-1	MAIN 795
DO 30 J=IDKNT,IPT	MAIN 800
IF (ICHILD(J).GE.0) ICHILD(J)=ICHILD(J)+1	MAIN 805
30 CONTINUE	MAIN 810
40 CONTINUE	MAIN 815
C...	MAIN 820
C... COMPUTE FAMILY ENERGY DEMAND	MAIN 825

APPENDIX (Continued)

C...		MAIN 830
	CALL DEMAND(NFAM, IDKNT)	MAIN 835
C...		MAIN 840
C...	COMPUTE FAMILY ENERGY GAINS FROM AGRICULTURE	MAIN 845
C...		MAIN 850
	CALL LAND(NFAM, TUBTOT, CERTOT)	MAIN 855
	CALL AGRI(NFAM, QFROST, QHAIL, IDKNT, TUBTOT, CERTOT)	MAIN 860
C...		MAIN 865
C...	ALLOW FAMILY TO SAVE ENERGY THROUGH MIGRATION	MAIN 870
	CALL MIGRAT(NFAM, IDKNT)	MAIN 875
C...		MAIN 880
C...	COMPUTE FAMILY ENERGY GAINS FROM HERD	MAIN 885
C...		MAIN 890
	CALL HERD(NFAM, IDKNT)	MAIN 895
	IDKNT=IDKNT+NCHILD(I)	MAIN 900
50	CONTINUE	MAIN 905
C...		MAIN 910
C...	DISTRIBUTE SURPLUS FOOD TO CLAN MEMBERS IN NEED	MAIN 915
C...		MAIN 920
	CALL DIST	MAIN 925
	IF ((YEAR/KPRNT)*KPRNT.EQ.YEAR) CALL OUTPUT(YEAR)	MAIN 930
	CALL FAMILY(YEAR)	MAIN 935
C...		MAIN 940
C...	UPDATE POPULATION STORAGE ARRAYS	MAIN 945
C...		MAIN 950
	CALL UPDATE	MAIN 955
C...		MAIN 960
C...	UPDATE POPULATION TOTALS	MAIN 965
C...		MAIN 970
	IF (NFAMI.EQ.1) GO TO 80	MAIN 975
	POPTOT=0	MAIN 980
	KIDTOT=0	MAIN 985
	DO 60 I=1, NFAMI	MAIN 990
	NH=0	MAIN 995
	NW=0	MAIN 1000
	IF (HUSB(I).GT.0) NH=1	MAIN 1005
	IF (WIFE(I).GT.0) NW=1	MAIN 1010
	FAMPOP(I)=NCHILD(I)+NH+NW	MAIN 1015
	POPTOT=POPTOT+FAMPOP(I)	MAIN 1020
	KIDTOT=KIDTOT+NCHILD(I)	MAIN 1025
60	CONTINUE	MAIN 1030
70	CONTINUE	MAIN 1035
80	CONTINUE	MAIN 1040
	STOP	MAIN 1045
9000	FORMAT(10A4)	MAIN 1050
9001	FORMAT(' ', 10A4/)	MAIN 1055
9002	FORMAT(16I5)	MAIN 1060
9003	FORMAT('0-----')	MAIN 1065
	>-----')	MAIN 1070
9004	FORMAT(' YEAR ', I3)	MAIN 1075
	END	MAIN 1080

APPENDIX (Continued)

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SUBROUTINE FAMILY(YEAR)
C...
C...   THIS SUBROUTINE BIRTHS, KILLS, AND MARRIES INDIVIDUALS.
C...   WHEN GAPS ARE FORMED IN THE ARRAYS, EITHER THROUGH
C...   DEATH OR MARRIAGE, THE LOCATIONS ARE FLAGGED
C...   WITH A -1, AND REMOVED AT THE END OF THE YEAR
C...   BY SUBROUTINE TRANS.
C...
COMMON /ANIMAL/ NANIML(3,3,1000), NA(1000), NS(1000), NY(1000)
COMMON /IAGES/ IHUSB(1000), IWIFE(1000), ICHILD(5000)
COMMON /GENE/ NGENEH(1000,5), NGENEW(1000,5), NGENEC(5000,5)
COMMON /ISEX/ KIDSEX(5000)
COMMON /ATTR/ CHILD(5000,2)
COMMON /CLAN/ CLNSR(50), ICLNAN(3,3,50), NUMCLN
COMMON /DEATH/ DFACT
COMMON /ENNET/ ENET(1000)
COMMON /ENLOSS/ ELOSS(1000), ELOSSP(1000)
COMMON /FAMIL/ HUSB(1000), WIFE(1000), NCHILD(1000)
COMMON /GENEX/ KDIST, NTRAIT
COMMON /NEWFAM/ IHUS(50,5), IWIF(50,5), NYHUS(50,5), NYWIF(50,5),
> IYCLAN(50), IYANML(3,3,50), KNTY
COMMON /PRINT/ IO2, L1, L2, L3, L4, L5
COMMON /STATS/ NFAMI, KIDTOT, POPTOT, FAMPOP(1000), IDCLAN(1000)
DIMENSION LOWLIM(3,3), EQUIV(9)
REAL KILNUM, KILSE
INTEGER TOTHRD, POPTOT
INTEGER HUSB, FAMPOP, WIFE, CHILD, SPECIE, AGE, YEAR, WELTHH, WELTHW
DATA EQUIV/1., 1., 1., 2., 1., 2., 3., 1., 3./
DATA LOWLIM/9, 9, 15, 9, 9, 15, 9, 9, 15/
IDKNT=1
DO 50 NFAM=1, NFAMI
  NNFAM=NFAM
C...
C...   COMPUTE BIRTHS IN THE FAMILY
C...
C...   NOTE: MALES ARE DESIGNATED BY A KIDSEX VALUE OF -1,
C...   FEMALES ARE DESIGNATED BY A KIDSEX VALUE OF 1
C...
C...   NOTE: CARDS COMMENTED OUT BY A "C1" MAY BE UNCOMMENTED
C...   IF THE USER DESIRES TO ALLOW INTERCLAN MARRIAGES ONLY
C...
C...   NOTE: ARRAY LOCATIONS THAT ARE NO LONGER FUNCTIONAL (DEAD
C...   ADULTS, DISSOLVED FAMILIES, MARRIED CHILDREN) ARE
C...   TEMPORARILY FLAGGED WITH A -1 UNTIL THE ARRAY CAN BE
C...   CLOSED BY SUBROUTINE TRANS.
C...
  BPROB=.25
  IF (WIFE(NFAM).EQ.0.OR.IWIFE(NFAM).GT.49) GO TO 20
  IF (ENET(NFAM).LT.0.0) BPROB=.12
  IF (HUSB(NFAM).LT.0) BPROB=BPROB*.1
  IF (RANDOM(1).GT.BPROB) GO TO 20
  IZ2=IDKNT
  KIDL=KIDTOT+1
  CHILD(KIDL,1)=HUSB(NFAM)
  IF (HUSB(NFAM).LE.0) CHILD(KIDL,1)=WIFE(NFAM)

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APPENDIX (Continued)

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      CHILD(KIDL,2)=WIFE(NFAM)                                FAMI 280
      KIDSEX(KIDL)=1                                          FAMI 285
      IF (RANDOM(2).GT..446) KIDSEX(KIDL)=-1                  FAMI 290
      ICHILD(KIDL)=0                                          FAMI 295
      NGENEC(KIDL,1)=NEWNUM(NGENEH(NFAM,1),NGENEH(NFAM,1))   FAMI 300
C...                                                         FAMI 305
C...   ASSIGN NEW CHILD GENETIC ALLELES FROM EACH PARENT      FAMI 310
C...                                                         FAMI 315
      DO 10 JJJ = 2,NTRAIT,2                                  FAMI 320
      NGENEC(KIDL,JJJ) = NGENEH(NFAM,JJJ)                    FAMI 325
      IF (RANDOM(43).GE.0.5) NGENEC(KIDL,JJJ) = NGENEH(NFAM,JJJ+1) FAMI 330
      NGENEC(KIDL,JJJ+1) = NGENEH(NFAM,JJJ)                  FAMI 335
      IF (RANDOM(38).GE.0.5) NGENEC(KIDL,JJJ+1) = NGENEH(NFAM,JJJ+1) FAMI 340
      1)                                                       FAMI 345
      IF (HUSB(NFAM).EQ.0) NGENEC(KIDL,JJJ)=NGENEH(KIDL,JJJ+1) FAMI 350
10    CONTINUE                                                FAMI 355
      KIDTCT=KIDTOT+1                                         FAMI 360
      NCHILD(NFAM)=NCHILD(NFAM)+1                             FAMI 365
      IF (IZ2.GE.KIDL) GO TO 20                                FAMI 370
C...                                                         FAMI 375
C...   INSERT NEW CHILDREN INTO ARRAYS                         FAMI 380
      CALL KIDMOV(IZ2,KIDL,1)                                  FAMI 385
20    CONTINUE                                                FAMI 390
C...                                                         FAMI 395
C...   CHECK FOR DEATHS IN FAMILY                             FAMI 400
C...                                                         FAMI 405
      IF (ELOSS(NNFAM).EQ.0.0) GO TO 30                      FAMI 410
      GO TO 40                                                  FAMI 415
30    WRITE(6,9000)                                           FAMI 420
      WRITE(6,9001) NNFAM                                       FAMI 425
      CALL OUTPUT                                              FAMI 430
40    CONTINUE                                                FAMI 435
C...                                                         FAMI 440
C...   ADJUST DEATH PROBABILITY BY THE FAMILY'S ENERGY DEFICIT FAMI 445
C...                                                         FAMI 450
      DFACT=EXP(ABS(ENET(NNFAM)/ELOSS(NNFAM))*4.6)           FAMI 455
C...                                                         FAMI 460
C...   SEARCH FOR POSSIBLE DEATH IN FAMILY                   FAMI 465
C...                                                         FAMI 470
      IF (HUSB(NNFAM).GT.0) CALL KILHUS(NNFAM)                FAMI 475
      IF (WIFE(NNFAM).GT.0) CALL KILWIF(NNFAM)                FAMI 480
      IF (NCHILD(NNFAM).GT.0) CALL KILCHL(IDKNT,NNFAM)         FAMI 485
      IDKNT=IDKNT+NCHILD(NFAM)                                 FAMI 490
50    CONTINUE                                                FAMI 495
C...                                                         FAMI 500
C...   CALCULATE FAMILY HERD TOTALS                           FAMI 505
C...                                                         FAMI 510
      DO 60 NFAM = 1,NFAMI                                     FAMI 515
      NY(NFAM) = 0                                             FAMI 520
      NS(NFAM) = 0                                             FAMI 525
      NA(NFAM) = 0                                             FAMI 530
      DO 60 AGE = 1,3                                          FAMI 535
      NY(NFAM) = NY(NFAM) + NANIML(AGE,1,NFAM)                FAMI 540
      NS(NFAM) = NS(NFAM) + NANIML(AGE,2,NFAM)                FAMI 545
      NA(NFAM) = NA(NFAM) + NANIML(AGE,3,NFAM)                FAMI 550
60    CONTINUE                                                FAMI 555
      IDKNT=1                                                  FAMI 560
      DO 420 NFAM=1,NFAMI                                     FAMI 565

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APPENDIX (Continued)

	IF (IDCLAN(NFAM).EQ.-1) GO TO 420	FAMI 570
C...		FAMI 575
C...	ATTEMPT TO MARRY ELIGIBLE MEMBERS OF THE FAMILY	FAMI 580
C...		FAMI 585
	IF (HUSB(NFAM).GT.0.AND.WIFE(NFAM).GT.0) GO TO 300	FAMI 590
	IF (WIFE(NFAM).EQ.0) GO TO 160	FAMI 595
C...		FAMI 600
C...	SEARCH FOR A HUSBAND FOR A WIDOW AMONG WIDOWERS	FAMI 605
C...	SELECT RANDOM STARTING LOCATION FOR SEARCH	FAMI 610
C...		FAMI 615
	NLIM = RANDOM(44)*NFAMI+1.0	FAMI 620
	NL=NLIM	FAMI 625
	NU=NFAMI	FAMI 630
70	DO 80 IU=NL,NU	FAMI 635
	IF (IDCLAN(IU).EQ.-1) GO TO 80	FAMI 640
	IF (HUSB(IU).EQ.0.OR.WIFE(IU).GT.0) GO TO 80	FAMI 645
C...		FAMI 650
C...	WIDOW MUST MARRY OUTSIDE OF HER CLAN	FAMI 655
C...		FAMI 660
C1	IF(HUSB(IU).EQ.WIFE(NFAM)) GO TO 100	FAMI 665
C...		FAMI 670
C...	AGES MUST BE WITHIN 10 YEARS	FAMI 675
C...		FAMI 680
	IF (IABS(IHUSB(IU)-IWIFE(NFAM)).GT.10) GO TO 80	FAMI 685
C...		FAMI 690
C...	CHECK RELATEDNESS	FAMI 695
C...		FAMI 700
	KIN=NRELTV(NGENEH(IU,1),NGENEH(NFAM,1),KDIST)	FAMI 705
	IF (KIN.GT.0) GO TO 80	FAMI 710
C...		FAMI 715
C...	ADD AN ELEMENT OF CHANCE	FAMI 720
C...		FAMI 725
	IF (RANDOM(3).GT..75) GO TO 80	FAMI 730
C.....		FAMI 735
C.....	CLAN NUMBER BASED ON WEALTH (# OF ANIMALS OF RESPECTIVE FAMILY)	FAMI 740
C.....		FAMI 745
	WELTHW=NA(NFAM)+NS(NFAM)+NY(NFAM)	FAMI 750
	WELTHH=NA(IU)+NS(IU)+NY(IU)	FAMI 755
	IDCLAN(NFAM)=HUSB(IU)	FAMI 760
	IF (WELTHW.GT.WELTHH) IDCLAN(NFAM)=WIFE(NFAM)	FAMI 765
	GO TO 260	FAMI 770
80	CONTINUE	FAMI 775
	IF (NL.EQ.1) GO TO 90	FAMI 780
	NL = 1	FAMI 785
	NU = NLIM-1	FAMI 790
	GO TO 70	FAMI 795
C...		FAMI 800
C...	SEARCH FOR A POSSIBLE MATE FOR WIDOW AMONG CHILDREN	FAMI 805
C...	AGES MUST BE WITHIN 3 YEARS	FAMI 810
C...	RANDOMLY SELECT A STARTING POINT FOR SEARCH	FAMI 815
C...		FAMI 820
90	KIDTI=KIDTOT	FAMI 825
	NLIM = RANDOM(44)*KIDTI+1.0	FAMI 830
	NL=NLIM	FAMI 835
	NU=KIDTI	FAMI 840
100	DO 140 KL=NL,NU	FAMI 845
	IF (CHILD(KL,1).EQ.-1) GO TO 140	FAMI 850
C1	IF(CHILD(KL,1).EQ.WIFE(NFAM)) GO TO 140	FAMI 855

APPENDIX (Continued)

	I HGF=IABS (ICHILD (KL) -IWIFE (NFAM))	FAMI 860
	IF (KIDSEX (KL) .GT.0.OR.I HGF.GT.3) GO TO 140	FAMI 865
C...		FAMI 870
C...	CHECK RELATEDNESS	FAMI 875
C...		FAMI 880
	KIN=NRELTV (NGENEC (KL, 1) ,NGENEW (NFAM, 1) ,KDIST)	FAMI 885
	IF (KIN.GT.0) GO TO 140	FAMI 890
	IF (RANDOM (4) .GT..5) GO TO 140	FAMI 895
C...		FAMI 900
C...	MARRY COUPLE	FAMI 905
C...		FAMI 910
	NZ=1	FAMI 915
	DO 110 KM=1,NFAMI	FAMI 920
	NZ=NZ+NCHILD (KM)	FAMI 925
	IF (NZ.GT.KL) GO TO 120	FAMI 930
110	CONTINUE	FAMI 935
120	HUSB (NFAM)=CHILD (KL, 1)	FAMI 940
	I HUSB (NFAM)=ICHILD (KL)	FAMI 945
	IDCLAN (NFAM)=WIFE (NFAM)	FAMI 950
	CHILD (KL, 1) = -1	FAMI 955
	DC 130 I=1, NTRAIT	FAMI 960
	NGENEH (NFAM, I) =NGENEC (KL, I)	FAMI 965
130	CONTINUE	FAMI 970
	GO TO 300	FAMI 975
140	CONTINUE	FAMI 980
	IF (NL.EQ.1) GO TO 150	FAMI 985
	NL = 1	FAMI 990
	NU = NLIM-1	FAMI 995
	GO TO 100	FAMI1000
150	GO TO 300	FAMI1005
160	IF (HUSB (NFAM) .EQ.0) GO TO 300	FAMI1010
C...		FAMI1015
C...	SEARCH FOR A WIFE FOR A WIDOWER AMONG WIDOW POOL	FAMI1020
C...	RANDOMLY SELECT A STARTING POINT FOR SEARCH	FAMI1025
C...		FAMI1030
	NLIM = RANDOM (44) *NFAMI+1.0	FAMI1035
	NL=NLM	FAMI1040
	NU=NFAMI	FAMI1045
170	DO 180 IU=NL,NU	FAMI1050
	IF (IDCLAN (IU) .EQ.-1) GO TO 180	FAMI1055
	IF (WIFE (IU) .EQ.0.OR.HUSB (IU) .GT.0) GO TO 180	FAMI1060
C...		FAMI1065
C...	WIDOWER MUST MARRY OUTSIDE OF HIS CLAN	FAMI1070
C...		FAMI1075
C1	IF (WIFE (IU) .EQ.HUSB (NFAM))	FAMI1080
C...	GO TO 190	FAMI1085
C...	AGES MUST BE WITHIN 10 YEARS	FAMI1090
C...		FAMI1095
	IF (IABS (IWIFE (IU) -I HUSB (NFAM)) .GT.10) GO TO 180	FAMI1100
C...		FAMI1105
C...	CHECK RELATEDNESS	FAMI1110
C...		FAMI1115
	KIN=NRELTV (NGENEH (NFAM, 1) ,NGENEW (IU, 1) ,KDIST)	FAMI1120
	IF (KIN.GT.0) GO TO 180	FAMI1125
C...		FAMI1130
C...	ADD AN ELEMENT OF CHANCE	FAMI1135
C...		FAMI1140
	IF (RANDOM (5) .GT..75) GO TO 180	FAMI1145

APPENDIX (Continued)

C.....		FAMI1150
C.....	CLAN NUMBER BASED ON WEALTH (# OF ANIMALS OF RESPECTIVE FAMILY)	FAMI1155
C.....		FAMI1160
	WELTHW=NA(IU)+NS(IU)+NY(IU)	FAMI1165
	WELTHH=NA(NFAM)+NS(NFAM)+NY(NFAM)	FAMI1170
	IDCLAN(NFAM)=HUSB(NFAM)	FAMI1175
	IF (WELTHW.GT.WELTHH) IDCLAN(NFAM)=WIFE(IU)	FAMI1180
	GO TO 260	FAMI1185
180	CONTINUE	FAMI1190
	IF (NL.EQ.1) GO TO 190	FAMI1195
	NL = 1	FAMI1200
	NU = NLIM-1	FAMI1205
	GO TO 170	FAMI1210
C...		FAMI1215
C...	SEARCH FOR POSSIBLE MATE FOR WIDOWER AMONG CHILDREN	FAMI1220
C...	AGES MUST BE WITHIN 3 YEARS	FAMI1225
C...	RANDOMLY SELECT A STARTING POINT FOR SEARCH	FAMI1230
C...		FAMI1235
C...		FAMI1240
190	KIDTI=KIDTOT	FAMI1245
	NLIM = RANDOM(44)*KIDTI+1.0	FAMI1250
	NL=NLIM	FAMI1255
	NU=KIDTI	FAMI1260
200	DO 240 KLO=NL,NU	FAMI1265
	IF (CHILD(KLO,1).EQ.-1) GO TO 240	FAMI1270
C...		FAMI1275
C...	MARRY ONLY OUTSIDE CLAN	FAMI1280
C...		FAMI1285
C1	IF(CHILD(KLO,1).EQ.HUSB(NFAM)) GO TO 230	FAMI1290
	IUTY=IABS(ICHILD(KLO)-IHUSB(NFAM))	FAMI1295
	IF (KIDSEX(KLO).LT.0.OR.IUTY.GT.3) GO TO 240	FAMI1300
C...		FAMI1305
C...	CHECK RELATEDNESS	FAMI1310
C...		FAMI1315
	KIN=NRELTV(NGENEH(NFAM,1),NGENEC(KLO,1),KDIST)	FAMI1320
	IF (KIN.GT.0) GO TO 240	FAMI1325
	IF (RANDOM(6).GT..5) GO TO 240	FAMI1330
C...		FAMI1335
C...	MARRY COUPLE	FAMI1340
C...		FAMI1345
	NZ=1	FAMI1350
	DO 210 KM=1,NFAM	FAMI1355
	NZ=NZ+NCHILD(KM)	FAMI1360
	IF (NZ.GT.KLO) GO TO 220	FAMI1365
210	CONTINUE	FAMI1370
220	WIFE(NFAM)=CHILD(KLO,1)	FAMI1375
	IWIFE(NFAM)=ICHILD(KLO)	FAMI1380
	CHILD(KLO,1) = -1	FAMI1385
	DO 230 I=1,NTRAIT	FAMI1390
	NGENEW(NFAM,I)=NGENEC(KLO,I)	FAMI1395
230	CONTINUE	FAMI1400
	GO TO 300	FAMI1405
240	CONTINUE	FAMI1410
	IF (NL.EQ.1) GO TO 250	FAMI1415
	NL = 1	FAMI1420
	NU = NLIM-1	FAMI1425
	GO TO 200	FAMI1430
250	GO TO 300	FAMI1435

APPENDIX (Continued)

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260      IF (NCHILD(IU).EQ.0) GO TO 290
          KNTNK = 1
          I1=IU-1
          IF (I1.EQ.0) GO TO 280
          DO 270 IUY = 1,I1
              KNTNK=KNTNK+NCHILD(IUY)
270      CONTINUE
C...
C...  AS FAMILIES ARE MERGED REARRANGE CHILD ARRAYS.
C...
280      CALL KIDMOV(IDKNT,KNTNK,NCHILD(IU))
290      NFFAM=NFAM
C...
C...  SUBROUTINE TRANS IS CALLED AT THIS POINT TO
C...  MERGE FAMILY ATTRIBUTES AND REMOVE DEAD CHILDREN
C...
          CALL TRANS(NFFAM,IU,1,IDKNT)
          CALL TRANS(NFFAM,IU,2,IDKNT)
300      CONTINUE
C...
C...  ATTEMPT TO MARRY CHILDREN TO ONE ANOTHER
C...
          IF (NCHILD(NFAM).EQ.0) GO TO 410
          MMQ=IDKNT+NCHILD(NFAM)-1
          MKID = 0
          DO 320 MOP=IDKNT,MMQ
              IF (CHILD(MOP,1).EQ.-1) GO TO 320
C...
C...  SEARCH FOR A MALE CHILD OF APPROPRIATE AGE
C...
          IF (KIDSEX(MOP).GT.0.OR.ICHILD(MOP).LT.20) GO TO 320
          IF (MKID.EQ.0) GO TO 310
          IF (ICHILD(MOP).LE.ICHILD(MKID)) GO TO 320
310      MKID = MOP
320      CONTINUE
          IF (MKID.EQ.0) GO TO 410
          MOP = MKID
C...
C...  MALE CHILD(MOP) OF FAMILY(NFAM) IS ELIGIBLE TO MARRY THIS YEAR
C...  SEARCH FOR A FEMALE WITHIN 3 YEARS OF HIS AGE AND OUTSIDE
C...  OF HIS CLAN
C...
          DO 330 KL=1,KIDTOT
              IF (CHILD(KL,1).EQ.-1) GO TO 330
              IUYHG=IABS(ICHILD(KL)-ICHILD(MOP))
              IF (KIDSEX(KL).LT.0.OR.IUYHG.GT.3) GO TO 330
C1      IF (CHILD(MOP,1).EQ.CHILD(KL,1)) GO TO 270
C1      IF (CHILD(MOP,2).EQ.CHILD(KL,2)) GO TO 270
C1      IF (CHILD(MOP,1).EQ.CHILD(KL,2)) GO TO 270
C1      IF (CHILD(MOP,2).EQ.CHILD(KL,1)) GO TO 270
C...
C...  CHECK RELATEDNESS
C...
          KIN=NRELTV(NGENEC(MOP,1),NGENEC(KL,1),KDIST)
          IF (KIN.GT.0) GO TO 330
          IF (RANDOM(7).GT..5) GO TO 340
330      CONTINUE
          GO TO 410

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FAMI1440
FAMI1445
FAMI1450
FAMI1455
FAMI1460
FAMI1465
FAMI1470
FAMI1475
FAMI1480
FAMI1485
FAMI1490
FAMI1495
FAMI1500
FAMI1505
FAMI1510
FAMI1515
FAMI1520
FAMI1525
FAMI1530
FAMI1535
FAMI1540
FAMI1545
FAMI1550
FAMI1555
FAMI1560
FAMI1565
FAMI1570
FAMI1575
FAMI1580
FAMI1585
FAMI1590
FAMI1595
FAMI1600
FAMI1605
FAMI1610
FAMI1615
FAMI1620
FAMI1625
FAMI1630
FAMI1635
FAMI1640
FAMI1645
FAMI1650
FAMI1655
FAMI1660
FAMI1665
FAMI1670
FAMI1675
FAMI1680
FAMI1685
FAMI1690
FAMI1695
FAMI1700
FAMI1705
FAMI1710
FAMI1715
FAMI1720
FAMI1725

APPENDIX (Continued)

C...		FAMI1730
C...	CHILD (KL) IS TO BE WIFE OF CHILD(MOP)	FAMI1735
C...		FAMI1740
C...	IYHUS (I,2) IS THE CLAN NUMBER OF THE NEW HUSBAND	FAMI1745
C...	IYWIF (I,2) IS THE CLAN NUMBER OF THE NEW WIFE	FAMI1750
C...		FAMI1755
C...	STORE NEW FAMILY IN TEMPORARY ARRAYS	FAMI1760
C...		FAMI1765
340	IYHUS(KNTY,2)=CHILD (MOP,1)	FAMI1770
	IYHUS(KNTY,1)=ICHILD (MOP)	FAMI1775
	IYWIF (KNTY,2)=CHILD (KL,1)	FAMI1780
	IYWIF (KNTY,1)=ICHILD (KL)	FAMI1785
	DO 350 I=1,NTRAIT	FAMI1790
	NYHUS (KNTY,I)=NGENEC (MOP,I)	FAMI1795
	NYWIF (KNTY,I)=NGENEC (KL,I)	FAMI1800
350	CONTINUE	FAMI1805
C...		FAMI1810
C...	FIND LOCATION OF THESE FAMILIES'S CHILDREN IN CHILD ARRAY AND	FAMI1815
C...	CALCULATE TOTAL NUMBER OF KIDS IN RESPECTIVE FAMILY.	FAMI1820
C...		FAMI1825
	NTOTAL=0	FAMI1830
	DO 360 I=1,NFAMI	FAMI1835
	NTOTAL=NTOTAL+NCHILD (I)	FAMI1840
	IF (KL.LE.NTOTAL) GO TO 370	FAMI1845
360	CONTINUE	FAMI1850
370	ITOTAL = NTOTAL - NCHILD (I) + 1	FAMI1855
C.....		FAMI1860
C.....	CLAN NUMBER BASED ON WEALTH (# OF ANIMALS OF RESPECTIVE FAMILY)	FAMI1865
C.....		FAMI1870
	WELTHW = NA (I) + NS (I) + NY (I)	FAMI1875
	WELTHH=NA (NFAM)+NS (NFAM)+NY (NFAM)	FAMI1880
	IYCLAN (KNTY)=IYHUS (KNTY,2)	FAMI1885
	IF (WELTHW.GT.WELTHH) IYCLAN (KNTY)=IYWIF (KNTY,2)	FAMI1890
	IPOPI = 0	FAMI1895
	DO 380 II = ITOTAL,NTOTAL	FAMI1900
	IF (CHILD (II,1).EQ.-1) GO TO 380	FAMI1905
	IPOPI = IPOPI + 1	FAMI1910
380	CONTINUE	FAMI1915
	IF (IHUSB (I).GT.0) IPOPI = IPOPI + 1	FAMI1920
	IF (IWIFE (I).GT.0) IPOPI = IPOPI + 1	FAMI1925
	IPOINT = IDKNT + NCHILD (NFAM) - 1	FAMI1930
	IPOPNI = 0	FAMI1935
	DO 390 II = IDKNT,IPOINT	FAMI1940
	IF (CHILD (II,1).EQ.-1) GO TO 390	FAMI1945
	IPOPNI = IPOPNI + 1	FAMI1950
390	CONTINUE	FAMI1955
	IF (IHUSB (NFAM).GT.0) IPOPNI = IPOPNI + 1	FAMI1960
	IF (IWIFE (NFAM).GT.0) IPOPNI = IPOPNI + 1	FAMI1965
C...		FAMI1970
C...	GIVE NEW FAMILY ANIMALS BASED ON TOTAL NUMBER OF PEOPLE	FAMI1975
C...	IN DONATING FAMILY	FAMI1980
C...		FAMI1985
	DO 400 AGE = 1,3	FAMI1990
	DC 400 SPECIE = 1,3	FAMI1995
	IYANML (AGE,SPECIE,KNTY) = (NANIML (AGE,SPECIE,I)/IPOPI) +	FAMI2000
>	(NANIML (AGE,SPECIE,NFAM)/IPOPNI)	FAMI2005
	NANIML (AGE,SPECIE,I) = NANIML (AGE,SPECIE,I) -	FAMI2010
>	(NANIML (AGE,SPECIE,I)/IPOPI)	FAMI2015

APPENDIX (Continued)

	NANIML (AGE, SPECIE, NFAM) = NANIML (AGE, SPECIE, NFAM) -	FAMI2020
	(NANIML (AGE, SPECIE, NFAM) / IPOPN)	FAMI2025
400	CONTINUE	FAMI2030
	CHILD(MOP, 1) = -1	FAMI2035
	CHILD(KL, 1) = -1	FAMI2040
	KNTY = KNTY+1	FAMI2045
410	CONTINUE	FAMI2050
	IDKNT=IDKNT+NCHILD (NFAM)	FAMI2055
420	CONTINUE	FAMI2060
C...		FAMI2065
C...	CALL TRANS TO REARRANGE CHILD ARRAYS AND FAMILY ARRAYS	FAMI2070
C...		FAMI2075
	CALL TRANS (NFFAM, IU, 2, IDKNT)	FAMI2080
	CALL TRANS (NFFAM, IU, 3, IDKNT)	FAMI2085
	IDKNT = 1	FAMI2090
	DO 530 NFAM = 1, NFAMI	FAMI2095
	TOTHRD = 0	FAMI2100
	DO 430 SPECIE = 1, 3	FAMI2105
	DO 430 AGE=1, 3	FAMI2110
	TOTHRD=TOTHRD+NANIML (AGE, SPECIE, NFAM)	FAMI2115
430	CONTINUE	FAMI2120
C...		FAMI2125
C...	REMOVE ALL INDIVIDUALS FROM THE HERD BEYOND THE NUMBER	FAMI2130
C...	HERDERS CAN WATCH	FAMI2135
C...		FAMI2140
	NKIDT=0	FAMI2145
	NN=IDKNT+NCHILD (NFAM) - 1	FAMI2150
	DO 440 JN=IDKNT, NN	FAMI2155
	IF (KIDSEX (JN) .LT. 0. AND. ICHILD (JN) .GE. 7) NKIDT=NKIDT+1	FAMI2160
440	CONTINUE	FAMI2165
	IF (NKIDT.GT. 2) GO TO 450	FAMI2170
	KFAM=100	FAMI2175
	GO TO 460	FAMI2180
450	KFAM=100+ (NKIDT-2) *25	FAMI2185
460	CONTINUE	FAMI2190
	KILNUM=TOTHRD-KFAM	FAMI2195
	IF (KILNUM.LE. 0) GO TO 490	FAMI2200
C...		FAMI2205
C...	REMOVE ANIMALS FROM HERD BASED ON THEIR % ABUNDANCE	FAMI2210
C...	IN EACH AGE CLASS	FAMI2215
C...		FAMI2220
	TOTEX=0.0	FAMI2225
	DO 470 AGE=1, 3	FAMI2230
	DO 470 SPECIE=1, 3	FAMI2235
	EX=NANIML (AGE, SPECIE, NFAM) -LOWLIN (AGE, SPECIE)	FAMI2240
	IF (EX.LE. 0.0) GO TO 470	FAMI2245
	TOTEX=TOTEX+EX	FAMI2250
470	CONTINUE	FAMI2255
	DO 480 AGE=1, 3	FAMI2260
	DO 480 SPECIE=1, 3	FAMI2265
	EX=NANIML (AGE, SPECIE, NFAM) -LOWLIN (AGE, SPECIE)	FAMI2270
	IF (EX.LE. 0.0) GO TO 480	FAMI2275
	KILL= (EX*KILNUM) /TOTEX+.5)	FAMI2280
	ICLNAN (AGE, SPECIE, IDCLAN (NFAM)) =ICLNAN (AGE, SPECIE,	FAMI2285
	IDCLAN (NFAM)) +KILL	FAMI2290
	NANIML (AGE, SPECIE, NFAM) =NANIML (AGE, SPECIE, NFAM) -KILL	FAMI2295
480	CONTINUE	FAMI2300
490	CONTINUE	FAMI2305

APPENDIX (Continued)

C...		FAMI2310
C...	ADJUST HERD SIZE BASED ON CARRYING CAPACITY OF NUNOA	FAMI2315
C...		FAMI2320
	TOTPOP=POPTOT	FAMI2325
	POPFAM=FAMPOP(NFAM)	FAMI2330
	I=0	FAMI2335
	FAMKL=(30000./TOTPOP)*POPFAM	FAMI2340
	HERDSE=(NANIML(3,1,NFAM)+NANIML(3,3,NFAM))*3+ (NANIML(2,1,NFAM)	FAMI2345
>	+NANIML(2,3,NFAM))*2+ NANIML(1,1,NFAM)+NANIML(1,3,NFAM)+	FAMI2350
>	NANIML(1,2,NFAM)+ NANIML(2,2,NFAM)+NANIML(3,2,NFAM)	FAMI2355
	IF ((HERDSE-FAMKL).LE.0.0) GO TO 510	FAMI2360
	KILSE=(HERDSE-FAMKL)	FAMI2365
	DO 500 AGE=1,3	FAMI2370
	DO 500 SPECIE=1,3	FAMI2375
	I=I+1	FAMI2380
	ANIMAL=NANIML(AGE,SPECIE,NFAM)	FAMI2385
	SHPEQ=ANIMAL*EQUIV(I)	FAMI2390
	IF (SHPEQ.LE.0.0) GO TO 500	FAMI2395
	KILL=(((SHPEQ*KILSE)/HERDSE)/EQUIV(I))+.5)	FAMI2400
	NANIML(AGE,SPECIE,NFAM)=NANIML(AGE,SPECIE,NFAM)-KILL	FAMI2405
	ICLNAN(AGE,SPECIE,IDCLAN(NFAM))=ICLNAN(AGE,SPECIE,	FAMI2410
>	IDCLAN(NFAM)) +KILL	FAMI2415
500	CONTINUE	FAMI2420
510	CONTINUE	FAMI2425
C...		FAMI2430
C...	RECALCULATE HERD SIZES	FAMI2435
C...		FAMI2440
	NY(NFAM)=0	FAMI2445
	NA(NFAM)=0	FAMI2450
	NS(NFAM)=0	FAMI2455
	DO 520 AGE=1,3	FAMI2460
	NY(NFAM)=NY(NFAM)+NANIML(AGE,1,NFAM)	FAMI2465
	NS(NFAM)=NS(NFAM)+NANIML(AGE,2,NFAM)	FAMI2470
520	NA(NFAM)=NA(NFAM)+NANIML(AGE,3,NFAM)	FAMI2475
	IDKNT = IDKNT + NCHILD(NFAM)	FAMI2480
530	CONTINUE	FAMI2485
	RETURN	FAMI2490
9000	FORMAT(1X,' ERROR IN FAMILY,CALL OUTPUT')	FAMI2495
9001	FORMAT(1X,' FAMILY',1X,I3,' CAUSED ERROR')	FAMI2500
	END	FAMI2505

APPENDIX (Continued)

SUBROUTINE KILHUS(NFAM)	KILH	0
COMMON /DEATH/ DFACT	KILH	5
COMMON /ENNET/ ENET(1000)	KILH	10
COMMON /FAMIL/ HUSB(1000),WIFE(1000),NCHILD(1000)	KILH	15
COMMON /GENE/ NGENEH(1000,5),NGENEW(1000,5),NGENEC(5000,5)	KILH	20
COMMON /GENEX/ KDIST,NTRAIT	KILH	25
COMMON /IAGES/ IHUSB(1000),IWIFE(1000),ICHILD(5000)	KILH	30
COMMON /PRINT/ IO2,L1,L2,L3,L4,L5	KILH	35
DIMENSION WHATGN(3,3)	KILH	40
DATA WHATGN/'AA','AB','AO','AB','BB','BO','AO','BO','OO'/	KILH	45
DATA AB/'AB'/	KILH	50
INTEGER HUSB	KILH	55
C...	KILH	60
C... THIS SUBROUTINE KILLS THE HUSBAND ACCORDING TO AGE-PROBABILITY	KILH	65
C... TABLES AND ZEROS APPROPRIATE ARRAYS. THESE VACANCIES	KILH	70
C... ARE LATER CLOSED BY SUBROUTINE TRANS.	KILH	75
C...	KILH	80
DPROB=.007	KILH	85
IF (IHUSB(NFAM).GT.20) DPROB=.010	KILH	90
IF (IHUSB(NFAM).GT.40) DPROB=.017	KILH	95
IF (IHUSB(NFAM).GT.65) DPROB=.052	KILH	100
IF (IHUSB(NFAM).GT.70) DPROB=.500	KILH	105
IF (ENET(NFAM).LT.0) DPROB=DFACT*DPROB	KILH	110
IF (WHATGN(NGENEH(NFAM,2),NGENEH(NFAM,3)).EQ.AB) DPROB=1.0	KILH	115
IF (RANDOM(8).GT.DPROB) GO TO 20	KILH	120
HUSB(NFAM)=0	KILH	125
IHUSB(NFAM)=0	KILH	130
DO 10 I=1,NTRAIT	KILH	135
NGENEH(NFAM,I)=0	KILH	140
10 CONTINUE	KILH	145
IF (L5.IT.1) GO TO 20	KILH	150
WRITE(IO2,9000) NFAM	KILH	155
20 RETURN	KILH	160
9000 FORMAT(' HUSBAND OF FAMILY',I4,' IS DEAD')	KILH	165
END	KILH	170

APPENDIX (Continued)

SUBROUTINE KILWIF(NFAM)	KILW	0
COMMON /DEATH/ DFACT	KILW	5
COMMON /ENNET/ ENET(1000)	KILW	10
COMMON /FAMIL/ HUSB(1000),WIFE(1000),NCHILD(1000)	KILW	15
COMMON /GENE/ NGENEH(1000,5),NGENEW(1000,5),NGENEC(5000,5)	KILW	20
COMMON /GENEX/ KDIST,NTRAIT	KILW	25
COMMON /IAGES/ IHUSB(1000),IWIFE(1000),ICHILD(5000)	KILW	30
COMMON /PRINT/ IO2,L1,L2,L3,L4,L5	KILW	35
DIMENSION WHATGN(3,3)	KILW	40
DATA WHATGN/'AA','AB','AO','AB','BB','BO','AO','BO','OO'/	KILW	45
DATA AB/'AB'/	KILW	50
INTEGER WIFE	KILW	55
C... THIS SUBROUTINE KILLS THE WIFE ACCORDING TO AGE-PROBABILITY	KILW	60
C... TABLES AND ZEROS APPROPRIATE ARRAYS. THESE VACANCIES	KILW	65
C... ARE LATER CLOSED BY SUBROUTINE TRANS.	KILW	70
C...	KILW	75
DPROB=.008	KILW	80
IF (IWIFE(NFAM).GT.20) DPROB=.011	KILW	85
IF (IWIFE(NFAM).GT.40) DPROB=.014	KILW	90
IF (IWIFE(NFAM).GT.65) DPROB=.057	KILW	95
IF (IWIFE(NFAM).GT.70) DPROB=.500	KILW	100
IF (ENET(NFAM).LT.0) DPROB=DFACT*DPROB	KILW	105
IF (WHATGN(NGENEW(NFAM,2),NGENEW(NFAM,3)).EQ.AB) DPROB=1.0	KILW	110
IF (RANDOM(9).GT.DPROB) GO TO 20	KILW	115
WIFE(NFAM)=0	KILW	120
IWIFE(NFAM)=0	KILW	125
DO 10 I=1,NTRAIT	KILW	130
NGENEW(NFAM,I)=0	KILW	135
10 CONTINUE	KILW	140
IF (L5.LT.1) GO TO 20	KILW	145
WRITE(IC2,9000) NFAM	KILW	150
20 RETURN	KILW	155
9000 FORMAT(' WIFE OF FAMILY',I3,' IS DEAD')	KILW	160
END	KILW	165
	KILW	170

APPENDIX (Continued)

SUBROUTINE KILCHL(I,NFAM)	KILC	0
COMMON /ATTR/ CHILD(5000,2)	KILC	5
COMMON /DEATH/ DFACT	KILC	10
COMMON /ENNET/ ENET(1000)	KILC	15
COMMON /FAMIL/ HUSB(1000),WIFE(1000),NCHILD(1000)	KILC	20
COMMON /GENE/ NGENEH(1000,5),NGENEW(1000,5),NGENEC(5000,5)	KILC	25
COMMON /GENEX/ KDIST,NTRAIT	KILC	30
COMMON /IAGES/ IHUSB(1000),IWIFE(1000),ICHILD(5000)	KILC	35
COMMON /ISEX/ KIDSEX(5000)	KILC	40
COMMON /PRINT/ IO2,L1,L2,L3,L4,L5	KILC	45
DIMENSION WHATGN(3,3)	KILC	50
DATA WHATGN/'AA','AB','AO','AB','BB','BO','AO','BO','OO'/	KILC	55
DATA AB/'AB'/	KILC	60
INTEGER CHILD	KILC	65
C... THIS SUBROUTINE KILLS THE CHILD ACCORDING TO AGE-SEX-PROBABILITY	KILC	70
C... TABLES AND ZEROS APPROPRIATE ARRAYS. THESE VACANCIES	KILC	75
C... ARE LATER CLOSED BY SUBROUTINE TRANS.	KILC	80
C...	KILC	85
C...	KILC	90
C...	KILC	95
C... NOTE: MALES ARE DESIGNATED BY A KIDSEX VALUE OF -1,	KILC	100
C... FEMALES ARE DESIGNATED BY A KIDSEX VALUE OF 1	KILC	105
C...	KILC	110
J=I+NCHILD(NFAM)-1	KILC	115
DO 40 L=I,J	KILC	120
IF (KIDSEX(L).GT.0) GO TO 10	KILC	125
DPROB=.171	KILC	130
IF (ICHILD(L).GT.1) DPROB=.0205	KILC	135
IF (ICHILD(L).GT.5) DPROB=.005	KILC	140
IF (ICHILD(L).GT.10) DPROB=.0025	KILC	145
IF (ICHILD(L).GT.15) DPROB=.0075	KILC	150
IF (ICHILD(L).GT.20) DPROB=.011	KILC	155
IF (ICHILD(L).GT.40) DPROB=.014	KILC	160
IF (ICHILD(L).GT.65) DPROB=.057	KILC	165
IF (ICHILD(L).GT.70) DPROB=.500	KILC	170
GO TO 20	KILC	175
10 DPROB=.192	KILC	180
IF (ICHILD(L).GT.1) DPROB=.021	KILC	185
IF (ICHILD(L).GT.5) DPROB=.0065	KILC	190
IF (ICHILD(L).GT.10) DPROB=.003	KILC	195
IF (ICHILD(L).GT.15) DPROB=.007	KILC	200
IF (ICHILD(L).GT.20) DPROB=.009	KILC	205
IF (ICHILD(L).GT.40) DPROB=.017	KILC	210
IF (ICHILD(L).GT.65) DPROB=.052	KILC	215
IF (ICHILD(L).GT.70) DPROB=.500	KILC	220
20 IF (ENET(NFAM).LT.0.0) DPROB=DPROB*DFACT	KILC	225
IF (WHATGN(NGENEC(L,2),NGENEC(L,3)).EQ.AB) DPROB=1.0	KILC	230
IF (RANDOM(10).GT.DPROB) GO TO 40	KILC	235
IF (I5.LT.1) GO TO 30	KILC	240
WRITE(IO2,9000) ICHILD(L),NFAM	KILC	245
30 CHILD(L,1) = -1	KILC	250
40 CONTINUE	KILC	255
RETURN	KILC	260
9000 FORMAT(1X,I3,' YEAR OLD CHILD OF FAMILY',I4,' IS DEAD')	KILC	265
END	KILC	270

APPENDIX (Continued)

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SUBROUTINE UPDATE
COMMON /ANIMAL/ NANIML(3,3,1000),NA(1000),NS(1000),NY(1000)
COMMON /ATTR/ CHILD(5000,2)
COMMON /CLAN/ CLNSR(50),ICLNAN(3,3,50),NUMCLN
COMMON /FAMIL/ HUSB(1000),WIFE(1000),NCHILD(1000)
COMMON /GENE/ NGENEH(1000,5),NGENEW(1000,5),NGENEC(5000,5)
COMMON /GENEX/ KDIST,NTRAIT
COMMON /IAGES/ IHUSB(1000),IWIFE(1000),ICHILD(5000)
COMMON /ISEX/ KIDSEX(5000)
COMMON /NEWFAM/ IYHUS(50,5),IYWIF(50,5),NYHUS(50,5),NYWIF(50,5),
> IYCLAN(50),IYANML(3,3,50),KNTY
COMMON /PRINT/ IO2,L1,L2,L3,L4,L5
COMMON /STATS/ NFAMI,KIDTOT,POPTOT,FAMPOP(1000),IDCLAN(1000)
DIMENSION EQUIV(9),PERSHP(9),LOWLIM(3,3),PER(9)
INTEGER SPECIE,AGE,PASS,TOTHRD
INTEGER HUSB,FAMPOP,WIFE,CHILD,POPTOT
DATA EQUIV/1.,1.,1.,2.,1.,2.,3.,1.,3./
DATA PERSHP/.0454,.0454,.0454,.0909,.0454,.0909,.2727,.0909,
> .2727/
DATA LOWLIM/9,9,15,9,9,15,9,9,15/
DATA PER/.05,.1,.1,.05,.1,.1,.2,.2/
C...
C... THIS SUBROUTINE ADDS NEW FAMILIES AND TAKES CARE OF ORPHANED
C... FAMILIES.
C...
C... ADD NEW FAMILIES TO COMPUTATIONAL ARRAYS
C...
IFAM=NFAMI
IF (KNTY.LE.1) GO TO 50
I9=KNTY-1
DO 40 IH=1,I9
  NFAMI=NFAMI+1
  HUSB(NFAMI)=IYHUS(IH,2)
  IDCLAN(NFAMI)=IYCLAN(IH)
  WIFE(NFAMI)=IYWIF(IH,2)
  IHUSB(NFAMI)=IYHUS(IH,1)
  IWIFE(NFAMI)=IYWIF(IH,1)
  DO 10 I=1,NTRAIT
    NGENEH(NFAMI,I)=NYHUS(IH,I)
    NGENEW(NFAMI,I)=NYWIF(IH,I)
10  CONTINUE
  NCHILD(NFAMI)=0
C...
C... IF NEW FAMILY HAS INSUFFICIENT NUMBER OF ANIMALS
C... GIVE IT MORE ANIMALS FROM CLAN SURPLUS
C... UP TO LOWER LIMIT (LOWLIM).
C...
DO 30 AGE=1,3
  DO 30 SPECIE=1,3
    NANIML(AGE,SPECIE,NFAMI) = IYANML(AGE,SPECIE,IH)
    IF (ICLNAN(AGE,SPECIE,IDCLAN(NFAMI)).LE.0) GO TO 30
    IF (NANIML(AGE,SPECIE,NFAMI).GT.LOWLIM(AGE,SPECIE)) GO
    > TO 30
    NADD = LOWLIM(AGE,SPECIE) - NANIML(AGE,SPECIE,NFAMI)
    IF (ICLNAN(AGE,SPECIE,IDCLAN(NFAMI)).LT.NADD) GO TO 20
    NANIML(AGE,SPECIE,NFAMI) = NANIML(AGE,SPECIE,NFAMI) +
UPDA 0
UPDA 5
UPDA 10
UPDA 15
UPDA 20
UPDA 25
UPDA 30
UPDA 35
UPDA 40
UPDA 45
UPDA 50
UPDA 55
UPDA 60
UPDA 65
UPDA 70
UPDA 75
UPDA 80
UPDA 85
UPDA 90
UPDA 95
UPDA 100
UPDA 105
UPDA 110
UPDA 115
UPDA 120
UPDA 125
UPDA 130
UPDA 135
UPDA 140
UPDA 145
UPDA 150
UPDA 155
UPDA 160
UPDA 165
UPDA 170
UPDA 175
UPDA 180
UPDA 185
UPDA 190
UPDA 195
UPDA 200
UPDA 205
UPDA 210
UPDA 215
UPDA 220
UPDA 225
UPDA 230
UPDA 235
UPDA 240
UPDA 245
UPDA 250
UPDA 255
UPDA 260
UPDA 265
UPDA 270
UPDA 275

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APPENDIX (Continued)

>	NADD	UPDA 280
	ICLNAN(AGE,SPECIE,IDCLAN(NFAMI)) = ICLNAN(AGE,SPECIE,	UPDA 285
>	IDCLAN(NFAMI)) - NADD	UPDA 290
	GO TO 30	UPDA 295
20	NANIML(AGE,SPECIE,NFAMI) = NANIML(AGE,SPECIE,NFAMI) +	UPDA 300
>	ICLNAN(AGE,SPECIE,IDCLAN(NFAMI))	UPDA 305
	ICLNAN(AGE,SPECIE,IDCLAN(NFAMI)) = 0	UPDA 310
30	CONTINUE	UPDA 315
40	CONTINUE	UPDA 320
	KNTY=1	UPDA 325
50	CONTINUE	UPDA 330
C...		UPDA 335
C...	THIS SECTION CHECKS FOR DEAD HUSBAND AND WIFE,	UPDA 340
C...	SEARCHES FOR CHILD CAPABLE OF BECOMING HEAD OF HOUSEHOLD.	UPDA 345
C...	FAILING THIS, IT MOVES THE CHILDREN AND ANIMALS	UPDA 350
C...	OF A DISSOLVED FAMILY TO SOME OTHER FAMILY SELECTED	UPDA 355
C...	AT RANDOM.	UPDA 360
C...		UPDA 365
C...	FIRST CHECK FOR DEAD HUSBAND AND WIFE	UPDA 370
C...		UPDA 375
	IDKNT = 1	UPDA 380
	DO 200 IK = 1,NFAMI	UPDA 385
	IF (HUSB(IK).GT.0.OR.WIFE(IK).GT.0) GO TO 190	UPDA 390
C...		UPDA 395
C...	SEARCH FOR OLDEST CHILD IN FAMILY	UPDA 400
C...	(MUST BE OLDER THAN 16)	UPDA 405
C...		UPDA 410
	IF (NCHILD(IK).EQ.0) GO TO 120	UPDA 415
	IPOINT = IDKNT + NCHILD(IK) - 1	UPDA 420
	MKID = 0	UPDA 425
	DO 70 M = IDKNT,IPOINT	UPDA 430
	IF (ICHILD(M).LT.16) GO TO 70	UPDA 435
	IF (MKID.EQ.0) GO TO 60	UPDA 440
	IF (ICHILD(M).LE.ICHILD(MKID)) GO TO 70	UPDA 445
60	MKID = M	UPDA 450
70	CONTINUE	UPDA 455
	IF (MKID.EQ.0) GO TO 120	UPDA 460
	M = MKID	UPDA 465
	IF (KIDSEX(M).GT.0) GO TO 90	UPDA 470
	HUSB(IK)=CHILD(M,1)	UPDA 475
	IHUSB(IK)=ICHILD(M)	UPDA 480
	CHILD(M,1) = -1	UPDA 485
	DO 80 I=1,NTRAIT	UPDA 490
	NGENEH(IK,I)=NGENEC(M,I)	UPDA 495
80	CONTINUE	UPDA 500
	GO TC 110	UPDA 505
90	WIFE(IK)=CHILD(M,1)	UPDA 510
	IWIFE(IK)=ICHILD(M)	UPDA 515
	CHILD(M,1) = -1	UPDA 520
	DO 100 I=1,NTRAIT	UPDA 525
	NGENEH(IK,I)=NGENEC(M,I)	UPDA 530
100	CONTINUE	UPDA 535
110	CONTINUE	UPDA 540
	GO TC 180	UPDA 545
C...		UPDA 550
C...	IF THERE IS NO CHILD CAPABLE OF BECOMING HEAD OF HOUSEHOLD	UPDA 555
C...	SELECT A FAMILY TO GET THE FORMER FAMILY'S ATTRIBUTES	UPDA 560
C...		UPDA 565

APPENDIX (Continued)

120	PASS=0	UPDA 570
130	LOT=RANDOM(11)*FLOAT(NFAMI)+1.	UPDA 575
	IF (IOT.EQ.IK.OR.LOT.LE.0.OR.LOT.GT.NFAMI) GO TO 130	UPDA 580
	IF (IDCLAN(LOT).EQ.-1) GO TO 130	UPDA 585
	PASS=PASS+1	UPDA 590
	IF (PASS.GT.NFAMI*2) GO TO 140	UPDA 595
	IF (HUSB(LOT).EQ.0.AND.WIFE(LOT).EQ.0) GO TO 130	UPDA 600
	IF (NCHILD(LOT).GT.3) GO TO 130	UPDA 605
140	KNTNK = 1	UPDA 610
	IF (NCHILD(LOT).EQ.0) GO TO 170	UPDA 615
	I1 = LOT - 1	UPDA 620
	IF (I1.EQ.0) GO TO 160	UPDA 625
	DO 150 I = 1,I1	UPDA 630
	KNTNK = KNTNK + NCHILD(I)	UPDA 635
150	CONTINUE	UPDA 640
C...		UPDA 645
C...	CALL KIDMOV TO INSERT CHILDREN OF MERGED FAMILIES INTO	UPDA 650
C...	THE PROPER POSITION OF THE CHILD ARRAYS.	UPDA 655
160	CALL KIDMOV(IDKNT,KNTNK,NCHILD(LOT))	UPDA 660
170	IDCLAN(IK) = IDCLAN(LOT)	UPDA 665
C...		UPDA 670
C...	CALL TRANS TO COMBINE ATTRIBUTES OF	UPDA 675
C...	MERGED FAMILIES.	UPDA 680
	CALL TRANS(IK,LOT,1,IDKNT)	UPDA 685
180	CALL TRANS(LOT,IK,2,IDKNT)	UPDA 690
190	IDKNT = IDKNT + NCHILD(IK)	UPDA 695
200	CONTINUE	UPDA 700
C...		UPDA 705
C...	THIS SECTION UPDATES HERD ACCORDING TO NEW CARRYING	UPDA 710
C...	CAPACITIES.	UPDA 715
C...		UPDA 720
	IDKNT=1	UPDA 725
	DO 270 NFAM=1,NFAMI	UPDA 730
	TOTHRD=0	UPDA 735
	DO 210 SPECIE=1,3	UPDA 740
	DO 210 AGE=1,3	UPDA 745
210	TOTHRD=TOTHRD+NANIML(AGE,SPECIE,NFAM)	UPDA 750
	NKIDT=0	UPDA 755
	NN=IDKNT+NCHILD(NFAM)-1	UPDA 760
	DO 220 JN=IDKNT,NN	UPDA 765
	IF (KIDSEX(JN).LT.0.AND.ICHILD(JN).GE.7) NKIDT=NKIDT+1	UPDA 770
220	CCNTINUE	UPDA 775
	IF (NKIDT.GT.2) GO TO 230	UPDA 780
	KFAM=100	UPDA 785
	GO TO 240	UPDA 790
230	KFAM=100+(NKIDT-2)*25	UPDA 795
240	CONTINUE	UPDA 800
	ADNUM=KFAM-TOTHRD	UPDA 805
	IF (ADNUM.LE.0) GO TO 270	UPDA 810
	TOTPOP=POPTOT	UPDA 815
	POPFAM=FAMPOP(NFAM)	UPDA 820
	FAMKL=(30000./TOTPOP)*POPFAM	UPDA 825
	HERDSE=(NANIML(3,1,NFAM)+NANIML(3,3,NFAM))*3+ (NANIML(2,1,NFAM)	UPDA 830
>	+NANIML(2,3,NFAM))*2+ NANIML(1,1,NFAM)+NANIML(1,3,NFAM)+	UPDA 835
>	NANIML(1,2,NFAM)+ NANIML(2,2,NFAM)+NANIML(3,2,NFAM)	UPDA 840
	IF ((HERDSE-FAMKL).GE.0.0) GO TO 270	UPDA 845
	I=0	UPDA 850
	DO 260 AGE=1,3	UPDA 855

APPENDIX (Continued)

DO 260 SPECIE=1,3	UPDA 860
I=I+1	UPDA 865
IF (ICLNAN(AGE,SPECIE,IDCLAN(NFAM)).EQ.0) GO TO 260	UPDA 870
NADNUM=PER(I)*ADNUM	UPDA 875
NUMAN=FAMKL*PERSHP(I)*EQUIV(I)	UPDA 880
IF (NUMAN.GT.NADNUM) NUMAN=NADNUM	UPDA 885
IF (NANIML(AGE,SPECIE,NFAM).GE.NUMAN) GO TO 260	UPDA 890
IF (NUMAN.GT.ICLNAN(AGE,SPECIE,IDCLAN(NFAM))) GO TO 250	UPDA 895
NANIML(AGE,SPECIE,NFAM)=NANIML(AGE,SPECIE,NFAM)+NUMAN	UPDA 900
ICLNAN(AGE,SPECIE,IDCLAN(NFAM))=ICLNAN(AGE,SPECIE,	UPDA 905
> IDCLAN(NFAM))-NUMAN	UPDA 910
GO TO 260	UPDA 915
250 NANIML(AGE,SPECIE,NFAM)=NANIML(AGE,SPECIE,NFAM)+	UPDA 920
> ICLNAN(AGE, SPECIE,IDCLAN(NFAM))	UPDA 925
ICLNAN(AGE,SPECIE,IDCLAN(NFAM))=0	UPDA 930
260 CONTINUE	UPDA 935
270 CONTINUE	UPDA 940
C... ZERO CLAN STORAGE AT THE END OF EACH YEAR	UPDA 945
C... DO 280 ID=1,50	UPDA 950
DO 280 AGE=1,3	UPDA 955
DO 280 SPECIE=1,3	UPDA 960
ICLNAN(AGE,SPECIE,ID)=0	UPDA 965
CONTINUE	UPDA 970
280 CONTINUE	UPDA 975
C...CALL TRANS TO REMOVE NOEXISTANT FAMILIES	UPDA 980
CALL TRANS(ILOW,IHIGH,3,IDKNT)	UPDA 985
RETURN	UPDA 990
END	UPDA 995
	UPDA1000

APPENDIX (Continued)

SUBROUTINE TRANS(ILOW,IHIGH,NPATH,IDKNT)	TRAN	0
COMMON /ANIMAL/ NANIML(3,3,1000),NA(1000),NS(1000),NY(1000)	TRAN	5
COMMON /FAMIL/ HUSB(1000),WIFE(1000),NCHILD(1000)	TRAN	10
COMMON /GENE/ NGENEH(1000,5),NGENEW(1000,5),NGENEC(5000,5)	TRAN	15
COMMON /GENEX/ KDIST,NTRAIT	TRAN	20
COMMON /IAGES/ IHUSB(1000),IWIFE(1000),ICHILD(1000)	TRAN	25
COMMON /ISEX/ KIDSEX(5000)	TRAN	30
COMMON /ATTR/ CHILD(5000,2)	TRAN	35
COMMON /STATS/ NFAMI,KIDTOT,POPTOT,FAMPOP(1000),IDCLAN(1000)	TRAN	40
INTEGER HUSB,WIFE	TRAN	45
INTEGER CHILD	TRAN	50
INTEGER SPECIE,AGE	TRAN	55
C... SUBROUTINE TRANS IS A GENERAL BOOKKEEPING	TRAN	60
C... ROUTINE THAT COMBINES ATTRIBUTES OF MERGED	TRAN	65
C... FAMILIES (SECTION 1), ELIMINATES DEAD CHILDREN OR	TRAN	70
C... THOSE THAT HAVE MARRIED (SECTION 2), AND ELIMINATES	TRAN	75
C... NONEXISTANT FAMILIES (SECTION 3).	TRAN	80
C...	TRAN	85
C... NOTE: "DEAD" HUSBANDS, WIVES, OF CHILDREN HAVE	TRAN	90
C... BEEN FLAGGED FOR REMOVAL BY A -1.	TRAN	95
C...	TRAN	100
GO TO (10,40,110),NPATH	TRAN	105
C...	TRAN	110
C... SECTION 1	TRAN	115
C...	TRAN	120
10 CONTINUE	TRAN	125
C...	TRAN	130
C... TRANSFER VALUES TO NEW ARRAY POSITION	TRAN	135
C...	TRAN	140
HUSB(ILOW)=HUSB(ILOW)+HUSB(IHIGH)	TRAN	145
WIFE(ILOW)=WIFE(ILOW)+WIFE(IHIGH)	TRAN	150
NCHILD(ILOW)=NCHILD(ILOW)+NCHILD(IHIGH)	TRAN	155
IHUSB(ILOW)=IHUSB(ILOW)+IHUSB(IHIGH)	TRAN	160
IWIFE(ILOW)=IWIFE(ILOW)+IWIFE(IHIGH)	TRAN	165
IDCLAN(IHIGH) = -1	TRAN	170
DO 20 I=1,NTRAIT	TRAN	175
NGENEH(ILOW,I)=NGENEH(ILOW,I)+NGENEH(IHIGH,I)	TRAN	180
NGENEW(ILOW,I)=NGENEW(ILOW,I)+NGENEW(IHIGH,I)	TRAN	185
20 CONTINUE	TRAN	190
DO 30 SPECIE=1,3	TRAN	195
DO 30 AGE=1,3	TRAN	200
NANIML(AGE,SPECIE,ILOW)=NANIML(AGE,SPECIE,ILOW)+NANIML(AGE,	TRAN	205
> SPECIE,IHIGH)	TRAN	210
30 CCNTINUE	TRAN	215
NY(ILOW) = NY(ILOW) + NY(IHIGH)	TRAN	220
NS(ILOW) = NS(ILOW) + NS(IHIGH)	TRAN	225
NA(ILOW) = NA(ILOW) + NA(IHIGH)	TRAN	230
RETURN	TRAN	235
C...	TRAN	240
C... SECTION 2	TRAN	245
C...	TRAN	250
40 CONTINUE	TRAN	255
NL = 1	TRAN	260
IJ = 0	TRAN	265
IDSAVE = IDKNT	TRAN	270
DO 80 I=1,NFAMI	TRAN	275

APPENDIX (Continued)

IF (NCHILD(I).EQ.0) GO TO 80	TRAN 290
NU = NL+NCHILD(I)-1	TRAN 285
DO 70 IJ1 = NL,NU	TRAN 290
IF (CHILD(IJ1,1).EQ.-1) GO TO 60	TRAN 295
IJ = IJ+1	TRAN 300
CHILD(IJ,1) = CHILD(IJ1,1)	TRAN 305
CHILD(IJ,2)=CHILD(IJ1,2)	TRAN 310
ICHILD(IJ)=ICHILD(IJ1)	TRAN 315
KIDSEX(IJ)=KIDSEX(IJ1)	TRAN 320
DO 50 K=1,NTRAIT	TRAN 325
NGENEC(IJ,K) = NGENEC(IJ1,K)	TRAN 330
50 CONTINUE	TRAN 335
GO TO 70	TRAN 340
60 NCHILD(I) = NCHILD(I)-1	TRAN 345
IF (IJ1.LT.IDSAVE) IDKNT = IDKNT-1	TRAN 350
70 CONTINUE	TRAN 355
NL = NU+1	TRAN 360
80 CONTINUE	TRAN 365
IJ1 = IJ+1	TRAN 370
DO 100 I=IJ1,KIDTOT	TRAN 375
CHILD(I,1) = 0	TRAN 380
CHILD(I,2) = 0	TRAN 385
ICHILD(I) = 0	TRAN 390
KIDSEX(I) = 0	TRAN 395
DO 90 K=1,NTRAIT	TRAN 400
90 NGENEC(I,K) = 0	TRAN 405
100 CONTINUE	TRAN 410
KIDTOT = IJ	TRAN 415
RETURN	TRAN 420
C... SECTION 3	TRAN 425
C... 110 CONTINUE	TRAN 430
C... REMOVE GAP IN ARRAY	TRAN 435
C... I = 0	TRAN 440
DO 140 I1=1,NFAMI	TRAN 445
IF (IDCLAN(I1).LT.0) GO TO 140	TRAN 450
I = I+1	TRAN 455
HUSB(I)=HUSB(I1)	TRAN 460
WIFE(I)=WIFE(I1)	TRAN 465
IDCLAN(I)=IDCLAN(I1)	TRAN 470
NCHILD(I)=NCHILD(I1)	TRAN 475
IHUSB(I)=IHUSB(I1)	TRAN 480
IWIFE(I)=IWIFE(I1)	TRAN 485
DO 120 J=1,NTRAIT	TRAN 490
NGENEW(I,J) = NGENEW(I1,J)	TRAN 495
NGENEH(I,J) = NGENEH(I1,J)	TRAN 500
120 CONTINUE	TRAN 505
DO 130 SPECIE=1,3	TRAN 510
DC 130 AGE=1,3	TRAN 515
NANIML(AGE,SPECIE,I)=NANIML(AGE,SPECIE,I1)	TRAN 520
130 CONTINUE	TRAN 525
NY(I) = NY(I1)	TRAN 530
NS(I) = NS(I1)	TRAN 535
NA(I) = NA(I1)	TRAN 540
140 CONTINUE	TRAN 545
	TRAN 550
	TRAN 555
	TRAN 560
	TRAN 565

APPENDIX (Continued)

```
      NUP = NFAMI
      NFAMI = I
      I1 = I+1
      DO 160 I=I1,NUP
        HUSB(I)=0
        WIFE(I)=0
        IDCLAN(I)=0
        NCHILD(I)=0
        IHUSB(I)=0
        IWIFE(I)=0
        DO 150 J=1,NTRAIT
          NGENEW(I,J) =0
          NGENEH(I,J) =0
150      CONTINUE
160      CONTINUE
      RETURN
      END
```

```
TRAN 570
TRAN 575
TRAN 580
TRAN 585
TRAN 590
TRAN 595
TRAN 600
TRAN 605
TRAN 610
TRAN 615
TRAN 620
TRAN 625
TRAN 630
TRAN 635
TRAN 640
TRAN 645
TRAN 650
```

APPENDIX (Continued)

	SUBROUTINE KIDMOV(ITO,J,N1)	KIDM 0
	COMMON /ATTR/ CHILD(5000,2)	KIDM 5
	COMMON /GPNE/ NGENEH(1000,5),NGENEW(1000,5),NGENEC(5000,5)	KIDM 10
	COMMON /GENEX/ KDIST,NTRAIT	KIDM 15
	COMMON /IAGES/ IHUSB(1000),IWIFE(1000),ICHILD(5000)	KIDM 20
	COMMON /ISEX/ KIDSEX(5000)	KIDM 25
	COMMON /STATS/ NFAMI,KIDTOT,POPTOT,FAMPOP(1000),IDCLAN(1000)	KIDM 30
	INTEGER CHILD,Z1(50),Z2(50),ZGENE(50,5),IC(50),KDX(50)	KIDM 35
C...		KIDM 40
C...	THIS SUBROUTINE INSERTS CHILDREN INTO PROPER LOCATION	KIDM 45
C...	IN CHILD ARRAYS	KIDM 50
C...		KIDM 55
C...	NOTE: CHILDREN ARE ORDERED IN THESE ARRAYS BY FAMILY.	KIDM 60
C...		KIDM 65
	IF (N1.GT.50) GO TO 70	KIDM 70
	I = ITO	KIDM 75
	M = J+N1-1	KIDM 80
	L = 0	KIDM 85
	DO 20 K=J,M	KIDM 90
	L = L+1	KIDM 95
	Z1(L) = CHILD(K,1)	KIDM 100
	Z2(L) = CHILD(K,2)	KIDM 105
	CHILD(K,1) = -1	KIDM 110
	DO 10 IJ=1,NTRAIT	KIDM 115
	ZGENE(L,IJ) = NGENEC(K,IJ)	KIDM 120
10	CONTINUE	KIDM 125
	IC(L) = ICHILD(K)	KIDM 130
	KDX(L) = KIDSEX(K)	KIDM 135
20	CONTINUE	KIDM 140
	KNT = KIDTOT+N1	KIDM 145
	DO 40 J=I,KIDTOT	KIDM 150
	CHILD(KNT,1) = CHILD(KNT-N1,1)	KIDM 155
	CHILD(KNT,2) = CHILD(KNT-N1,2)	KIDM 160
	ICHILD(KNT) = ICHILD(KNT-N1)	KIDM 165
	KIDSEX(KNT) = KIDSEX(KNT-N1)	KIDM 170
	DO 30 IJ = 1,NTRAIT	KIDM 175
	NGENEC(KNT,IJ) = NGENEC(KNT-N1,IJ)	KIDM 180
30	CONTINUE	KIDM 185
	KNT = KNT-1	KIDM 190
40	CONTINUE	KIDM 195
	DO 60 J=1,N1	KIDM 200
	CHILD(I,1) = Z1(J)	KIDM 205
	CHILD(I,2) = Z2(J)	KIDM 210
	DO 50 IJ = 1,NTRAIT	KIDM 215
	NGENEC(I,IJ) = ZGENE(J,IJ)	KIDM 220
50	CONTINUE	KIDM 225
	ICHILD(I) = IC(J)	KIDM 230
	KIDSEX(I) = KDX(J)	KIDM 235
	I = I+1	KIDM 240
60	CONTINUE	KIDM 245
	RETURN	KIDM 250
70	WRITE(6,9000)	KIDM 255
	STOP	KIDM 260
9000	FORMAT('1 FAMILY HAS MORE THAN 50 KIDS')	KIDM 265
	END	KIDM 270

APPENDIX (Continued)

	SUBROUTINE INIT	INIT 0
	COMMON /ANIMAL/ NANIML(3,3,1000), NA(1000), NS(1000), NY(1000)	INIT 5
	COMMON /ATTR/ CHILD(5000,2)	INIT 10
	COMMON /CLAN/ CLNSR(50), ICLNAN(3,3,50), NUMCLN	INIT 15
	COMMON /ENNET/ ENET(1000)	INIT 20
	COMMON /ENGAIN/ EGAINP(1000), EGAINA(1000), EGAINM(1000)	INIT 25
	COMMON /ENLOSS/ ELOSS(1000), ELOSSP(1000)	INIT 30
	COMMON /FAMIL/ HUSB(1000), WIFE(1000), NCHILD(1000)	INIT 35
	COMMON /GENE/ NGENEH(1000,5), NGENEW(1000,5), NGENEC(5000,5)	INIT 40
	COMMON /GENEX/ KDIST, NTRAIT	INIT 45
	COMMON /IAGES/ IHUSB(1000), IWIFE(1000), ICHILD(5000)	INIT 50
	COMMON /ISEX/ KIDSEX(5000)	INIT 55
	COMMON /PRINT/ IO2, L1, L2, L3, L4, L5	INIT 60
	COMMON /STATS/ NFAMI, KIDTOT, POPTOT, FAMPOP(1000), IDCLAN(1000)	INIT 65
	DIMENSION PROB(2), UPLIM(3), LWLIM(3)	INIT 70
	INTEGER UPLIM	INIT 75
	DIMENSION Y(9), Z(2)	INIT 80
	INTEGER HUSB, FAMPOP, WIFE, CHILD, SPECIE, AGE, POPTOT	INIT 85
	DATA PROB/.167, .417/	INIT 90
	DATA UPLIM/80, 64, 39/, LWLIM/65, 40, 20/	INIT 95
C...		INIT 100
C...	THIS SUBROUTINE ZEROS ARRAYS, SETS UP INITIAL POPULATION	INIT 105
C...	AND DISTRIBUTES ANIMALS AMONG FAMILIES	INIT 110
C...		INIT 115
C...	ZERO ARRAYS	INIT 120
C...		INIT 125
	AAA=NEWNUM(-1,-1)	INIT 130
	DO 10 I=1, 50	INIT 135
	CLNSR(I)=0.0	INIT 140
	DO 10 J=1, 3	INIT 145
	DO 10 K=1, 3	INIT 150
	ICLNAN(K, J, I)=0	INIT 155
10	CONTINUE	INIT 160
	DO 30 I=1, 1000	INIT 165
	HUSB(I)=0	INIT 170
	WIFE(I)=0	INIT 175
	NCHILD(I)=0	INIT 180
	IHUSB(I)=0	INIT 185
	IWIFE(I)=0	INIT 190
	DO 20 J=1, NTRAIT	INIT 195
	NGENEH(I, J)=0	INIT 200
	NGENEW(I, J)=0	INIT 205
20	CONTINUE	INIT 210
	ELOSS(I)=0.0	INIT 215
	ELOSSP(I)=0.0	INIT 220
	EGAINP(I)=0.0	INIT 225
	EGAINA(I)=0.0	INIT 230
	EGAINM(I)=0.0	INIT 235
	ENET(I)=0.0	INIT 240
	NY(I)=0	INIT 245
	NA(I)=0	INIT 250
	NS(I)=0	INIT 255
	FAMPOP(I)=0	INIT 260
	DO 30 AGE=1, 3	INIT 265
	DO 30 SPECIE=1, 3	INIT 270
	NANIML(AGE, SPECIE, I)=0	INIT 275

APPENDIX (Continued)

30	CONTINUE	INIT 280
DO 50 I=1,5000		INIT 285
ICHILD(I)=0		INIT 290
KIDSEX(I)=0		INIT 295
DO 40 J=1,NTRAIT		INIT 300
NGENEC(I,J)=0		INIT 305
40	CCONTINUE	INIT 310
DO 50 J=1,2		INIT 315
CHILD(I,J)=0		INIT 320
50	CONTINUE	INIT 325
POPTOT=0		INIT 330
JJ=1		INIT 335
KIDTOT=0		INIT 340
C...		INIT 345
C...	ASSIGN CLAN NUMBER FROM UNIFORM RANDOM DISTRIBUTION	INIT 350
C...		INIT 355
DO 130 NFAM=1,NFAMI		INIT 360
60	CONTINUE	INIT 365
IDCLAN(NFAM)=(RANDOM(12)*NUMCLN)+.5)		INIT 370
IF (IDCLAN(NFAM).LE.0) GO TO 60		INIT 375
HUSB(NFAM)=IDCLAN(NFAM)		INIT 380
WIFE(NFAM)=IDCLAN(NFAM)		INIT 385
C...		INIT 390
C..	ASSIGN AGES OF PARENTS BASED ON TYPICAL POPULATION	INIT 395
C...	PYRAMID	INIT 400
C...		INIT 405
DO 70 LL=1,2		INIT 410
IF (RANDOM(13).LT.PROB(LL)) GO TO 80		INIT 415
70	CONTINUE	INIT 420
LL=3		INIT 425
80	IHUSB(NFAM) = RANDOM(39) * (UPLIM(LL)-LWLIM(LL)) +LWLIM(LL) +.5	INIT 430
	IWIFE(NFAM) = RANDOM(39) * (UPLIM(LL)-LWLIM(LL)) +LWLIM(LL) +.5	INIT 435
	KIDLIM = IWIFE(NFAM) - 20	INIT 440
	IF (KIDLIM.GT.20) KIDLIM = 20	INIT 445
C...		INIT 450
C...	ASSIGN INITIAL GENETICS	INIT 455
C...		INIT 460
	NGENEH(NFAM,2) = 3	INIT 465
	NGENEH(NFAM,3) = 3	INIT 470
	IF (RANDOM(40).GT.0.873.AND.RANDOM(40).LE.0.970) NGENEH(NFAM,2)	INIT 475
>	=1	INIT 480
	IF (RANDOM(40).GT.0.970) NGENEH(NFAM,2)=2	INIT 485
	NGENEH(NFAM,2) = 3	INIT 490
	NGENEH(NFAM,3) = 3	INIT 495
	IF (RANDOM(40).GT.0.873.AND.RANDOM(40).LE.0.970) NGENEH(NFAM,2)	INIT 500
>	=1	INIT 505
	IF (RANDOM(40).GT.0.970) NGENEH(NFAM,2)=2	INIT 510
C...		INIT 515
C...	ASSIGN NUMBER OF CHILDREN (BASED ON AGE OF WIFE)	INIT 520
C...	AND AGES OF CHILDREN (BASED ON UNIFORM DISTRIBUTION	INIT 525
C...	FROM 1 TO 20) AND SEX (BASED ON 50/50 PROBABILITY)	INIT 530
C...		INIT 535
	FERT=IWIFE(NFAM)-20	INIT 540
	IF (FERT.GT.32.) FERT=32.	INIT 545
	MKID=FERT*.2	INIT 550
	NCHILD(NFAM)=MKID+(.5*MKID*Z(2))	INIT 555
	IF (NCHILD(NFAM).LT.0) NCHILD(NFAM)=0	INIT 560
	IF (NCHILD(NFAM).EQ.0) GO TO 110	INIT 565

APPENDIX (Continued)

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      KK=JJ+NCHILD(NFAM)-1                                INIT 570
      DO 100 J=JJ, KK                                     INIT 575
        CHILD(J,1)=HUSB(NFAM)                             INIT 580
        CHILD(J,2)=WIFE(NFAM)                             INIT 585
        SEX=(RANDOM(14)-.5)                                INIT 590
        KIDSEX(J)=1                                        INIT 595
        IF (SEX.GT.0) KIDSEX(J)=-1                        INIT 600
        ICHILD(J) = RANDOM(39) * KIDLIM + .5              INIT 605
C...                                                    INIT 610
C...  ASSIGN NEW CHILD GENETIC ALLELES FROM EACH PARENT  INIT 615
C...                                                    INIT 620
      DO 90 JJJ = 2, NTRAIT, 2                             INIT 625
        NGENEC(J, JJJ) = NGENEH(NFAM, JJJ)               INIT 630
        IF (RANDOM(41).GE.0.5) NGENEC(J, JJJ) = NGENEH(NFAM, JJJ+1) INIT 635
        NGENEC(J, JJJ+1) = NGENEW(NFAM, JJJ)             INIT 640
        IF (RANDOM(42).GE.0.5) NGENEC(J, JJJ+1) = NGENEW(NFAM, JJJ+1) INIT 645
      1)                                                    INIT 650
      90 CONTINUE                                           INIT 655
      100 CONTINUE                                           INIT 660
      JJ=JJ+NCHILD(NFAM)                                    INIT 665
      110 FAMPCP(NFAM)=NCHILD(NFAM)+2                      INIT 670
C...                                                    INIT 675
C...  NUMBER OF ALPACAS, LLAMAS, AND SHEEP IN EACH OF THE THREE AGE  INIT 680
C...  CLASSES FOR EACH FAMILY                             INIT 685
C...                                                    INIT 690
      DO 120 J=1, 9                                         INIT 695
        Y(J)=0                                              INIT 700
        CALL GGNORD(28, 29, Z)                             INIT 705
        Y(J)=Z(1)                                           INIT 710
      120 CONTINUE                                           INIT 715
        NANIML(1,1,NFAM)=20+(2*Y(1))                     INIT 720
        NANIML(2,1,NFAM)=20+(2*Y(2))                     INIT 725
        NANIML(3,1,NFAM)=30+(2*Y(3))                     INIT 730
        NANIML(1,2,NFAM)=30+(2*Y(4))                     INIT 735
        NANIML(2,2,NFAM)=30+(2*Y(5))                     INIT 740
        NANIML(3,2,NFAM)=50+(2*Y(6))                     INIT 745
        NANIML(1,3,NFAM)=30+(2*Y(7))                     INIT 750
        NANIML(2,3,NFAM)=30+(2*Y(8))                     INIT 755
        NANIML(3,3,NFAM)=50+(2*Y(9))                     INIT 760
      130 CONTINUE                                           INIT 765
C...                                                    INIT 770
C...  WRITE OUT INITIAL CONDITIONS                         INIT 775
C...                                                    INIT 780
      DO 150 NFAM=1, NFAMI                                  INIT 785
        NGENEH(NFAM,1)=NEWNUM(0,0)                        INIT 790
        NGENEW(NFAM,1)=NEWNUM(0,0)                        INIT 795
        JJ=1                                                INIT 800
        KK=JJ+NCHILD(NFAM)-1                              INIT 805
        DO 140 J=JJ, KK                                    INIT 810
          NGENEC(J,1)=NEWNUM(NGENEH(NFAM,1), NGENEW(NFAM,1)) INIT 815
          CONTINUE                                           INIT 820
          JJ=JJ+NCHILD(NFAM)                                INIT 825
          NY(NFAM)=NANIML(1,1,NFAM)+NANIML(2,1,NFAM)+NANIML(3,1,NFAM) INIT 830
          NA(NFAM)=NANIML(1,3,NFAM)+NANIML(2,3,NFAM)+NANIML(3,3,NFAM) INIT 835
          NS(NFAM)=NANIML(1,2,NFAM)+NANIML(2,2,NFAM)+NANIML(3,2,NFAM) INIT 840
          KIDTOT=KIDTOT+NCHILD(NFAM)                      INIT 845
          POPTOT=POPTOT+FAMPCP(NFAM)                      INIT 850
      150 CONTINUE                                           INIT 855

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APPENDIX (Continued)

```

WRITE(102,9000)
WRITE(102,9001)
TOTM=0.0
TOTF=0.0
IFAKE=1
DO 190 NFAM=1,NFAMI
  JFAKE=IFAKE+NCHILD(NFAM)-1
  IF (NCHILD(NFAM).EQ.0) GO TO 170
  NMALE=0
  NFMALF=0
  DO 160 NM=IFAKE,JFAKE
    IF (KIDSEX(NM).LT.0) NMALE=NMALE+1
    IF (KIDSEX(NM).GT.0) NFMALF=NFMALF+1
160  CONTINUE
  TOTM=TOTM+NMALE
  TOTF=TOTF+NFMALF
  WRITE(102,9002) NFAM, IDCLAN(NFAM), IHUSB(NFAM), IWIFE(NFAM),
    > NMALE, NFMALF, (NCHILD(J), KIDSEX(J), J=IFAKE, JFAKE)
  GO TO 180
170  WRITE(102,9002) NFAM, IDCLAN(NFAM), IHUSB(NFAM), IWIFE(NFAM),
    > NCHILD(NFAM)
180  IFAKE=IFAKE+NCHILD(NFAM)
190  CONTINUE
  SEXRTO=TOTF/TOTM
  WRITE(102,9003) NFAMI, KIDTOT, SEXRTO
  WRITE(102,9004)
  NUMSHP=0
  NUMLLM=0
  NUMALP=0
  NUMEQ=0
  DO 200 I=1,NFAMI
    NUMEQ=(NANIML(3,1,I)+NANIML(3,3,I))*3+ (NANIML(2,1,I)+NANIML(2,
    > 3,I))*2+ NANIML(1,1,I)+NANIML(1,3,I)+NANIML(1,2,I)+ NANIML(2,
    > 2,I)+NANIML(3,2,I)+NUMEQ
    WRITE(102,9005) I, NY(I), NS(I), NA(I)
    DO 200 AGE=1,3
      NUMSHP=NUMSHP+NANIML(AGE,2,I)
      NUMLLM=NUMLLM+NANIML(AGE,1,I)
      NUMALP=NUMALP+NANIML(AGE,3,I)
200  CONTINUE
  WRITE(102,9006) NUMEQ
  WRITE(102,9007) NUMSHP, NUMLLM, NUMALP
  RETURN
9000 FORMAT(1H0,'INITIAL CONDITIONS')
9001 FORMAT(1H0,'FAMILY CLAN HUSBAND WIFE CHILDREN
    > CHILD AGES AND SEXES')
9002 FORMAT(1X,I4,4X,I3,5X,I3,4X,I3,4X,I2,'/',I2,4X,I4(I3,',',I2))
9003 FORMAT(1X,'TOTAL FAMILIES =',I4,' TOTAL CHILDREN = ',I5,
    > ' SEX RATIO (F/M) =',F4.1)
9004 FORMAT(1H0,'FAMILY LLAMAS SHEEP ALPACAS')
9005 FORMAT(1X,I4,7X,I5,5X,I5,5X,I5)
9006 FORMAT(1X,'TOTAL SHEEP EQUIVALENTS =',I8)
9007 FORMAT(1X,'TOTAL SHEEP =',I5,2X,'TOTAL LLAMA =',I5,2X,
    > 'TOTAL ALPACA =',I5)
END

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```

INIT 860
INIT 865
INIT 870
INIT 875
INIT 880
INIT 885
INIT 890
INIT 895
INIT 900
INIT 905
INIT 910
INIT 915
INIT 920
INIT 925
INIT 930
INIT 935
INIT 940
INIT 945
INIT 950
INIT 955
INIT 960
INIT 965
INIT 970
INIT 975
INIT 980
INIT 985
INIT 990
INIT 995
INIT1000
INIT1005
INIT1010
INIT1015
INIT1020
INIT1025
INIT1030
INIT1035
INIT1040
INIT1045
INIT1050
INIT1055
INIT1060
INIT1065
INIT1070
INIT1075
INIT1080
INIT1085
INIT1090
INIT1095
INIT1100
INIT1105
INIT1110
INIT1115
INIT1120
INIT1125
INIT1130

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APPENDIX (Continued)

SUBROUTINE OUTPUT (YEAR)		OUTP	0
COMMON /ANIMAL/ NANIML(3,3,1000),NA(1000),NS(1000),NY(1000)		OUTP	5
COMMON /ATTR/ CHILD(5000,2)		OUTP	10
COMMON /CLAN/ CLNSR(50),ICLNAN(3,3,50),NUMCLN		OUTP	15
COMMON /ENNET/ ENET(1000)		OUTP	20
COMMON /ENGAIN/ EGAINP(1000),EGAINA(1000),EGAINM(1000)		OUTP	25
COMMON /ENLOSS/ ELOSS(1000),ELOSSP(1000)		OUTP	30
COMMON /FAMIL/ HUSB(1000),WIFE(1000),NCHILD(1000)		OUTP	35
COMMON /GENE/ NGENEH(1000,5),NGENEW(1000,5),NGENEC(5000,5)		OUTP	40
COMMON /GENEX/ KDIST,NTRAIT		OUTP	45
COMMON /IAGES/ IHUSB(1000),IWIFE(1000),ICHILD(5000)		OUTP	50
COMMON /ISEX/ KIDSEX(5000)		OUTP	55
COMMON /PRINT/ IO2,L1,L2,L3,L4,L5		OUTP	60
COMMON /STATS/ NFAMI,KIDTOT,POPTOT,FAMPOP(1000),IDCLAN(1000)		OUTP	65
INTEGER HUSB,FAMPOP,WIFE,CHILD,POPTOT,AGE		OUTP	70
DIMENSION WHATGN(3,4),BTYPE(3,3)		OUTP	75
DATA WHATGN/'AA','AB','AO','AB','BB','BO','AO','BO','OO',' ' /		OUTP	80
INTEGER YEAR		OUTP	85
C...	THIS SUBROUTINE PRINTS SUMMARY STATISTICS AT AN INTERVAL	OUTP	90
C...	ASSIGNED IN MAIN PROGRAM (VARIABLE "KPRNT")	OUTP	95
C...		OUTP	100
C...	THIS SECTIONS PRINTS TO THE DEVICE ASSIGNED BY VARIABLE "IO2"	OUTP	105
C...	IN MAIN PROGRAM (USUALLY ASSIGNED TO LINE PRINTER DEVICE)	OUTP	110
	DO 10 IJ=1,3	OUTP	115
	DO 10 JI=1,3	OUTP	120
	BTYPE(IJ,JI)=0	OUTP	125
10	CONTINUE	OUTP	130
	IF (L2.EQ.0) GO TO 20	OUTP	135
	WRITE(IO2,9000)	OUTP	140
20	TOTM=0.0	OUTP	145
	TOTF=0.0	OUTP	150
	IFAKE=1	OUTP	155
	DO 60 I=1,NFAMI	OUTP	160
	JFAKE=IFAKE+NCHILD(I)-1	OUTP	165
	IF (NCHILD(I).EQ.0) GO TO 40	OUTP	170
	NMALE=0	OUTP	175
	NFMALE=0	OUTP	180
	DO 30 NM=IFAKE,JFAKE	OUTP	185
	IF (KIDSEX(NM).LT.0) NMALE=NMALE+1	OUTP	190
	IF (KIDSEX(NM).GT.0) NFMALE=NFMALE+1	OUTP	195
30	CONTINUE	OUTP	200
	TOTM=TOTM+NMALE	OUTP	205
	TOTF=TOTF+NFMALE	OUTP	210
	IF (L2.EQ.0) GO TO 50	OUTP	215
	WRITE(IO2,9002) I,IDCLAN(I),IHUSB(I),IWIFE(I),NFMALE,NMALE,	OUTP	220
>	(ICHILD(J),KIDSEX(J),J=IFAKE,JFAKE)	OUTP	225
	GO TO 50	OUTP	230
40	IF (L2.EQ.0) GO TO 50	OUTP	235
	WRITE(IO2,9002) I,IDCLAN(I),IHUSB(I),IWIFE(I),NCHILD(I)	OUTP	240
50	IFAKE=IFAKE+NCHILD(I)	OUTP	245
60	CONTINUE	OUTP	250
	SEXRT0 = 999.	OUTP	255
	IF (TOTM.NE.0) SEXRT0 = TOTF/TOTM	OUTP	260
	WRITE(IO2,9003) POPTOT	OUTP	265
	WRITE(IO2,9004) NFAMI,KIDTOT,SEXRT0	OUTP	270
	WRITE(IO2,9001)	OUTP	275

APPENDIX (Continued)

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70 TOTM=0.0
TOTF=0.0
IFAKE=1
IF (L2.EQ.0) GO TO 130
DO 110 I=1,NFAMI
  JFAKE=IFAKE+NCHILD(I)-1
  IH2=NGENEH(I,2)
  IH3=NGENEH(I,3)
  IW2=NGENEW(I,2)
  IW3=NGENEW(I,3)
  IF (NGENEH(I,2).EQ.0) IH2=1
  IF (NGENEH(I,3).EQ.0) IH3=4
  IF (NGENEW(I,2).EQ.0) IW2=1
  IF (NGENEW(I,3).EQ.0) IW3=4
  IF (NGENEH(I,2).NE.0) BTYPE(NGENEH(I,2),NGENEH(I,3)) =
> BTYPE(NGENEH(I,2),NGENEH(I,3))+1
  IF (NGENEW(I,2).NE.0) BTYPE(NGENEW(I,2),NGENEW(I,3)) =
> BTYPE(NGENEW(I,2),NGENEW(I,3))+1
  IF (NCHILD(I).EQ.0) GO TO 90
  NMALE = 0
  NFMAL = 0
  DO 80 NM=IFAKE,JFAKE
    IF (KIDSEX(NM).LT.0) NMALE = NMALE+1
    IF (KIDSEX(NM).GT.0) NFMAL = NFMAL+1
    BTYPE(NGENEC(NM,2),NGENEC(NM,3)) = BTYPE(NGENEC(NM,2),
> NGENEC(NM,3))+1
80 CONTINUE
  WRITE(IO2,9015) I,IDCLAN(I),WHATGN(IH2,IH3),WHATGN(IW2,IW3),
> NFMAL,NMALE,(ICHILD(J),WHATGN(NGENEC(J,2),NGENEC(J,3)),J=
> IFAKE,JFAKE)
  GO TO 100
90 CONTINUE
  WRITE(IO2,9015) I,IDCLAN(I),WHATGN(IH2,IH3),WHATGN(IW2,IW3)
100 IFAKE=IFAKE+NCHILD(I)
110 CONTINUE
  DO 120 IJ=1,3
    DO 120 JI=1,3
      BTYPE(IJ,JI) = (BTYPE(IJ,JI)/POPTOT)*100
120 CONTINUE
  BTYPE(2,1)=BTYPE(2,1)+BTYPE(1,2)
  BTYPE(3,1)=BTYPE(3,1)+BTYPE(1,3)
  BTYPE(3,2)=BTYPE(3,2)+BTYPE(2,3)
  WRITE(IO2,9014) BTYPE(3,3),BTYPE(3,1),BTYPE(3,2),BTYPE(1,1),
> BTYPE(2,2),BTYPE(2,1)
130 CONTINUE
  IF (L3.EQ.0) GO TO 150
  WRITE(IO2,9005)
  WRITE(IO2,9006)
  DO 140 NFAM=1,NFAMI
    WRITE(IO2,9007) NFAM,ELOSS(NFAM),EGAINP(NFAM),EGAINA(NFAM),
> EGAINM(NFAM),ENET(NFAM)
140 CONTINUE
150 IF (L4.NE.0) WRITE(IO2,9008)
  NUMSHP=0
  NUMLLM=0
  NUMALP=0
  NUMEQ=0
  DO 170 I=1,NFAMI

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      OUTP 280
      OUTP 285
      OUTP 290
      OUTP 295
      OUTP 300
      OUTP 305
      OUTP 310
      OUTP 315
      OUTP 320
      OUTP 325
      OUTP 330
      OUTP 335
      OUTP 340
      OUTP 345
      OUTP 350
      OUTP 355
      OUTP 360
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      OUTP 390
      OUTP 395
      OUTP 400
      OUTP 405
      OUTP 410
      OUTP 415
      OUTP 420
      OUTP 425
      OUTP 430
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      OUTP 455
      OUTP 460
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      OUTP 470
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      OUTP 490
      OUTP 495
      OUTP 500
      OUTP 505
      OUTP 510
      OUTP 515
      OUTP 520
      OUTP 525
      OUTP 530
      OUTP 535
      OUTP 540
      OUTP 545
      OUTP 550
      OUTP 555
      OUTP 560
      OUTP 565

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APPENDIX (Continued)

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      NY(I)=0                                OUTP 570
      NS(I)=0                                OUTP 575
      NA(I)=0                                OUTP 580
      NUMEQ=(NANIML(3,1,I)+NANIML(3,3,I))*3+ (NANIML(2,1,I)+NANIML(2,
> 3,I))*2+ NANIML(1,1,I)+NANIML(1,3,I)+NANIML(1,2,I)+ NANIML(2,
> 2,I)+NANIML(3,2,I)+NUMEQ                                OUTP 595
      DO 160 AGE=1,3                                OUTP 600
        NUMSHP=NUMSHP+NANIML(AGE,2,I)                OUTP 605
        NUMLLM=NUMLLM+NANIML(AGE,1,I)                OUTP 610
        NUMALP=NUMALP+NANIML(AGE,3,I)                OUTP 615
        NY(I)=NY(I)+NANIML(AGE,1,I)                  OUTP 620
        NS(I)=NS(I)+NANIML(AGE,2,I)                  OUTP 625
        NA(I)=NA(I)+NANIML(AGE,3,I)                  OUTP 630
160      CONTINUE                                OUTP 635
      IF (I4.NE.0) WRITE(IO2,9009) I,NY(I),NS(I),NA(I) OUTP 640
170      CONTINUE                                OUTP 645
      WRITE(IO2,9011) NUMEQ                          OUTP 650
      WRITE(IO2,9010) NUMSHP,NUMLLM,NUMALP            OUTP 655
C...                                           OUTP 660
C... THIS SECTION STORES DATA ON A PERMANENT DEVICE DESIGNATED OUTP 665
C... BY UNIT 10 FOR LATER RETRIEVAL                OUTP 670
C... NOTE: ONLY "PERTINENT POOP" (THARP) VARIABLES ARE OUTP 675
C... DEALT WITH IN THIS SECTION.                  OUTP 680
      WRITE(10) YEAR,NFAMI,KIDTOT,POPTOT,SEXRT0,NUMCLN OUTP 685
      WRITE(10) ((CLNSR(K),ICLNAN(I,J,K),I=1,3),J=1,3),K=1,NUMCLN) OUTP 690
      WRITE(10) (HUSB(I),IHUSB(I),WIFE(I),IWIFE(I),FAMPOP(I),IDCLAN(I),
> NCHILD(I),I=1,NFAMI)                                OUTP 700
      WRITE(10) (CHILD(I,1),CHILD(I,2),ICHILD(I),KIDSEX(I),I=1,KIDTOT) OUTP 705
      WRITE(10) (EGAINP(I),EGAINA(I),EGAINM(I),ENET(I),ELOSS(I),
> ELOSSP(I),I=1,NFAMI)                                OUTP 715
      WRITE(10) (((NANIML(I,J,K),I=1,3),J=1,3),K=1,NFAMI) OUTP 720
      RETURN                                          OUTP 725
9000 FORMAT(1H0,'FAMILY CLAN HUSBAND WIFE CHILDREN OUTP 730
>CHILD AGES AND SEXES')                                OUTP 735
9001 FORMAT(1H0,'FAMILY CLAN HUSBAND WIFE CHILDREN OUTP 740
>CHILD AGES AND BLOOD TYPES')                          OUTP 745
9002 FORMAT(1X,I4,4X,I3,5X,I3,4X,I3,4X,I2,'/',I2,4X,I4(I3,',',I2)) OUTP 750
9003 FORMAT(1X,'TOTAL POPULATION =',I6)                OUTP 755
9004 FORMAT(1X,'TOTAL FAMILIES =',I4,' TOTAL CHILDREN = ',I5, OUTP 760
> ' SEX RATIO (F/M) =',F4.1)                            OUTP 765
9005 FORMAT(1H0,' ENERGY ENERGY GAINS OUTP 770
> NET')                                                  OUTP 775
9006 FORMAT(1X,'FAMILY DEMAND PLANT ANIMAL MARKET OUTP 780
> ENERGY')                                              OUTP 785
9007 FORMAT(1X,I4,2X,F10.0,2X,F10.0,2X,F10.0,2X,F10.0,2X,F10.0) OUTP 790
9008 FORMAT(1H0,'FAMILY LLAMAS SHEEP ALPACAS')          OUTP 795
9009 FORMAT(1X,I4,7X,I5,5X,I5,5X,I5)                    OUTP 800
9010 FORMAT(1X,'TOTAL SHEEP =',I5,2X,'TOTAL LLAMA =',I5,2X, OUTP 805
> 'TOTAL ALPACA =',I5)                                OUTP 810
9011 FORMAT(1X,'TOTAL SHEEP EQUIVALENTS =',I8)          OUTP 815
9012 FORMAT(1H0,'CLAN',10X,'LLAMAS',14X,'SHEEP',15X,'ALPACAS') OUTP 820
9013 FORMAT(2X,I2,5X,3(I4,2X,I4,2X,I4,4X))              OUTP 825
9014 FORMAT('0','BLOOD TYPE PERCENTAGES: OO = ',F5.2,'% AO = ',F5.2, OUTP 830
> '% BO = ',F5.2,'% AA = ',F5.2,'% BB = ',F5.2,'% AB = ',F5.2, OUTP 835
> '%')                                                  OUTP 840
9015 FORMAT(1X,I4,4X,I3,5X,A3,4X,A3,4X,I2,'/',I2,4X,I4(I3,',',A2)) OUTP 845
      END                                            OUTP 850

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APPENDIX (Continued)

SUBROUTINE LAND(NFAM,TUBTOT,CERTOT)	LAND	0
COMMON /CROPS/ POTACR,OCAACR,OLLACR,ISNACR,QUNACR,CANACR,BARACR	LAND	5
COMMON /FAMIL/ HUSB(1000),WIFE(1000),NCHILD(1000)	LAND	10
COMMON /STATS/ NFAMI,KIDTOT,POPTOT,FAMPOP(1000),IDCLAN(1000)	LAND	15
DIMENSION TOTACR(1000),Z(2)	LAND	20
INTEGER POTATO,OCA,OLLUCO,QUINOA,BARLEY,CANHUA,FAMPOP,POPTOT	LAND	25
REAL ISNACR	LAND	30
DATA NCT/0/	LAND	35
C... THIS SUBROUTINE DISTRIBUTES LAND AND DECIDES QUANTITIES	LAND	40
C... OF CROPS PLANTED FOR EACH FAMILY.	LAND	45
C...	LAND	50
C...	LAND	55
C... CALCULATE THE NUMBER OF 500 M**2 PLOTS AVAILABLE TO THE FAMILY	LAND	60
C...	LAND	65
TOTACR(NFAM)=0.0	LAND	70
PERACR=3400000./POPTOT	LAND	75
NCT = NCT + 1	LAND	80
IF (NCT.EQ.2) GO TO 10	LAND	85
CALL GGNORD(30,31,Z)	LAND	90
GO TO 20	LAND	95
10 Z(1) = Z(2)	LAND	100
NCT = 0	LAND	105
20 TOTACR(NFAM)=PERACR*(FAMPOP(NFAM)+Z(1)*2)	LAND	110
IF (TOTACR(NFAM).LE.0.0) TOTACR(NFAM)=PERACR*FAMPOP(NFAM)	LAND	115
PLOTS=TOTACR(NFAM)/500.	LAND	120
C... CALCULATE THE NUMBER OF 500 M**2 PLOTS AVAILABLE FOR PLANTING.	LAND	125
C... (ASSUME A 2 YEAR ACTIVE, 6 YEAR FALLOW CYCLE)	LAND	130
C	LAND	135
AVAIL=PLOTS/4.	LAND	140
POTATO=0	LAND	145
OCA=0	LAND	150
OLLUCO=0	LAND	155
ISANO=0	LAND	160
QUINOA=0	LAND	165
CANHUA=0	LAND	170
BARLEY=0	LAND	175
POTACR=0.0	LAND	180
OCAACR=0.0	LAND	185
OLLACR=0.0	LAND	190
ISNACR=0.0	LAND	195
QUNACR=0.0	LAND	200
CANACR=0.0	LAND	205
BARACR=0.0	LAND	210
PLTNUM=2.0	LAND	215
IF (NCHILD(NFAM).GT.4) PLTNUM=3.0	LAND	220
IF (NCHILD(NFAM).GT.7) PLTNUM=4.0	LAND	225
IF (PLTNUM.GT.AVAIL) PLTNUM=AVAIL	LAND	230
C... DETERMINE THE NUMBER OF PLOTS OF EACH CROP TO BE PLANTED.	LAND	235
C... (AT LEAST ONE TUBER AND ONE GRAIN WILL BE PLANTED)	LAND	240
C...	LAND	245
IF (RANDOM(16).LE..92) POTATO=1	LAND	250
IF (RANDOM(17).LE..18) OCA=1	LAND	255
IF (RANDOM(18).LE..09) OLLUCO=1	LAND	260
	LAND	265
	LAND	270
	LAND	275

APPENDIX (Continued)

IF (RANDOM(19).LE..05) ISANO=1	LAND 280
TUBTOT=POTATO+OCA+OLLUCO+ISANO	LAND 285
IF (TUBTOT.GT..5) GO TO 30	LAND 290
POTATO=1	LAND 295
TUBTOT=1.0	LAND 300
30 CONTINUE	LAND 305
RPLOT=PITNUM/2.0	LAND 310
IF (POTATO.GT..5) POTACR=RPLOT/TUBTOT	LAND 315
IF (OCA.GT..5) OCAACR=RPLOT/TUBTOT	LAND 320
IF (OLLUCO.GT..5) OLLACR=RPLOT/TUBTOT	LAND 325
IF (ISANO.GT..5) ISNACR=RPLOT/TUBTOT	LAND 330
IF (RANDOM(20).LE..98) QUINOA=1	LAND 335
IF (RANDOM(21).LE..64) CANHUA=1	LAND 340
IF (RANDOM(22).LE..24) BARLEY=1	LAND 345
CERTOT=QUINOA+CANHUA+BARLEY	LAND 350
IF (CERTOT.GT..5) GO TO 40	LAND 355
QUINOA=1	LAND 360
CERTOT=1.0	LAND 365
40 CONTINUE	LAND 370
IF (QUINOA.GT..5) QUNACR=RPLOT/CERTOT	LAND 375
IF (CANHUA.GT..5) CANACR=RPLOT/CERTOT	LAND 380
IF (BARLEY.GT..5) BARACR=RPLOT/CERTOT	LAND 385
RETURN	LAND 390
END	LAND 395

APPENDIX (Continued)

SUBROUTINE AGRI (NFAM, QFROST, QHAIL, IDKMT, TUBTOT, CERTOT)	AGRI 0
COMMON /ANIMAL/ NANIML(3,3,1000), NA(1000), NS(1000), NY(1000)	AGRI 5
COMMON /CROPS/ POTACR, OCAACR, OLLACR, ISNACR, QUNACR, CANACR, BARACR	AGRI 10
COMMON /ENNET/ ENET(1000)	AGRI 15
COMMON /EGAIN/ EGAINP(1000), EGAINA(1000), EGAINM(1000)	AGRI 20
COMMON /ENLOSS/ ELOSS(1000), ELOSSP(1000)	AGRI 25
COMMON /FAMIL/ HUSB(1000), WIFE(1000), NCHILD(1000)	AGRI 30
COMMON /IAGES/ IHUSB(1000), IWIFE(1000), ICHILD(5000)	AGRI 35
COMMON /ISEX/ KIDSEX(5000)	AGRI 40
COMMON /WETHER/ FROST(8), HAIL(8), DRTP, DRTP1	AGRI 45
DIMENSION Z(2)	AGRI 50
INTEGER HUSB, WIFE, AGE	AGRI 55
REAL ISNACR	AGRI 60
C... THIS SUBROUTINE ASSESSES THE WORK ABILITY OF THE FAMILY,	AGRI 65
C... CALCULATES THE YEARLY ENERGY EXPENDITURES OF THE FAMILY	AGRI 70
C... FOR AGRICULTURAL ACTIVITIES, CALCULATES THE ENERGY	AGRI 75
C... OBTAINED FROM THE CROPS.	AGRI 80
C... SEPARATE FAMILY MEMBERS BASED ON THEIR WORK ABILITY	AGRI 85
C... ABLE = 0	AGRI 90
ABLET=0	AGRI 95
ELOSSP(NFAM)=0.0	AGRI 100
IF (NCHILD(NFAM).EQ.0) GO TO 20	AGRI 105
NN=IDKMT+NCHILD(NFAM)-1	AGRI 110
DO 10 J=IDKMT, NN	AGRI 115
IF (KIDSEX(J).LT.0.AND.ICHILD(J).GT.18) ABLE=1	AGRI 120
ABLET=ABLET+ABLE	AGRI 125
10 CONTINUE	AGRI 130
20 CONTINUE	AGRI 135
IF (HUSB(NFAM).GT.0.AND.WIFE(NFAM).GT.0.AND.ABLET.GT.0.0) GO TO 30	AGRI 140
IF (HUSB(NFAM).LT.1.AND.WIFE(NFAM).GT.0.AND.ABLET.GT.1.0) GO TO 30	AGRI 145
C... IF THERE IS NO CHILD (MALE) OLDER THAN 18, PLOWING COSTS MORE	AGRI 150
C... ENERGY	AGRI 155
C... ELOSSP(NFAM)=16185.9*3*TUBTOT+1380.3*3*CERTOT	AGRI 160
30 CONTINUE	AGRI 165
SHEEP=0.0	AGRI 170
DO 40 AGE=1,3	AGRI 175
SHEEP=SHEEP+NANIML(AGE,2,NFAM)	AGRI 180
40 CONTINUE	AGRI 185
DUNGND=TUBTOT*900.0	AGRI 190
IF (SHEEP*39.42.GT.DUNGND) GO TO 50	AGRI 195
ELOSSP(NFAM)=ELOSSP(NFAM)+23250.0	AGRI 200
50 CONTINUE	AGRI 205
DUNGPT=1	AGRI 210
C... ZERO STORAGE VARIABLES	AGRI 215
C... TEQN=0.0	AGRI 220
C... TECN=0.0	AGRI 225
C... TEBR=0.0	AGRI 230
C... TEPT=0.0	AGRI 235
	AGRI 240
	AGRI 245
	AGRI 250
	AGRI 255
	AGRI 260
	AGRI 265
	AGRI 270
	AGRI 275

APPENDIX (Continued)

TEOC=0.0	AGRI 280
TEOL=0.0	AGRI 285
TEIN=0.0	AGRI 290
C... ENERGY EXPENDITURES OF PLANTING	AGRI 295
C... EQUINPL=1380.3*QUNACR	AGRI 300
ECANPL=1380.3*CANACR	AGRI 305
EBARPL=1380.3*BARACR	AGRI 310
EPOTPL=16185.9*POTACR	AGRI 315
EOCAPL=16185.9*OCAACR	AGRI 320
EOLLPL=16285.9*OLLACR	AGRI 325
EISNPL=16185.9*ISNACR	AGRI 330
C... ENERGY EXPENDITURES OF PERIODIC CROP MAINTAINANCE	AGRI 335
C... ESQNPP=300.0*QUNACR	AGRI 340
ESCNPP=400.0*CANACR	AGRI 345
ESBRPP=300.0*BARACR	AGRI 350
ESPTWP=500.0*POTACR	AGRI 355
ESOCWP=500.0*OCAACR	AGPI 360
ESOLWP=500.0*OLLACR	AGRI 365
ESINWP=500.0*ISNACR	AGRI 370
C... CALCULATE TOTAL ENERGY EXPENDITURES OF AGRICULTURAL	AGRI 375
C... ACTIVITIES PFR MONTH.	AGRI 380
C... SEPTEMBER	AGRI 385
C... TEQN=ESQNPP+EQUINPL+TEQN	AGRI 390
TECN=ESCNPP+ECANPL+TECN	AGRI 395
TEBR=ESBRPP+EBARPL+TEBR	AGPI 400
C... ALLOW FOR REPLANTING IF FROST OR HAIL OCCURS IN SEPTEMBER.	AGRI 405
C... IF (FROST(1).LT.1.0.AND.HAIL(1).LT.1.0) GO TO 60	AGRI 410
TEQN=TEQN+EQUINPL	AGRI 415
TECN=TECN+ECANPL	AGRI 420
TEBR=TEBR+EBARPL	AGRI 425
C... OCTOBER	AGRI 430
C... 60 CONTINUE	AGRI 435
TEPT=TEPT+EPOTPL	AGRI 440
TEOC=TEOC+EOCAPL	AGRI 445
TEOL=TEOL+EOLLPL	AGRI 450
TEIN=TEIN+EISNPL	AGRI 455
TEQN=TEQN+ESQNPP	AGRI 460
TECN=TECN+ESCNPP	AGRI 465
TEBR=TEBR+ESBRPP	AGRI 470
C... ALLOW FOR REPLANTING IF FROST OR HAIL OCCURS IN OCTOBER.	AGRI 475
C... IF (FROST(2).LT.1.0.AND.HAIL(2).LT.1.0) GO TO 70	AGRI 480
TEPT=TEPT+EPOTPL	AGRI 485
TEOC=TEOC+EOCAPL	AGRI 490
TEOL=TEOL+EOLLPL	AGRI 495
TEIN=TEIN+EISNPL	AGRI 500
	AGRI 505
	AGRI 510
	AGRI 515
	AGRI 520
	AGRI 525
	AGRI 530
	AGRI 535
	AGRI 540
	AGRI 545
	AGRI 550
	AGRI 555
	AGRI 560
	AGRI 565

APPENDIX (Continued)

TEQN=TEQN+EQUINPL	AGRI 570
TECN=TECN+ECANPL	AGRI 575
TEBR=TEBR+EBARPL	AGRI 580
70 CONTINUE	AGRI 585
C... NOVEMBER	AGRI 590
C... IF (FROST(3).GT.0.0) CALL FSTKIL(ESPTWP,ESQNPP, ESOCWP,ESOLWP,	AGRI 595
> ESISWP)	AGRI 600
IF (HAIL(3).GT.0.0) CALL CRPKIL(ESPTWP,ESQNPP, ESCNPP,ESBRPP,	AGRI 605
> ESOCWP,ESOLWP,ESISWP)	AGRI 610
TEQN=TEQN+ESQNPP	AGRI 615
TECN=TECN+ESCNPP	AGRI 620
TEBR=TEBR+ESBRPP	AGRI 625
C... DECEMBER	AGRI 630
C... IF (FROST(4).GT.0.0) CALL FSTKIL(ESPTWP,ESQNPP, ESBRPP,ESOCWP,	AGRI 635
> ESOLWP,ESISWP)	AGRI 640
IF (HAIL(4).GT.0.0) CALL CRPKIL(ESPTWP,ESQNPP, ESCNPP,ESBRPP,	AGRI 645
> ESOCWP,ESOLWP,ESISWP)	AGRI 650
TEQN=ESQNPP+TEQN	AGRI 655
TECN=ESCNPP+TECN	AGRI 660
TEBR=ESBRPP+TEBR	AGRI 665
TEPT=TEPT+ESPTWP	AGRI 670
TEOC=TEOC+ESOCWP	AGRI 675
TEOL=TEOL+ESOLWP	AGRI 680
TEIN=TEIN+ESINWP	AGRI 685
C... JANUARY	AGRI 690
C... IF (FROST(5).GT.0.0) CALL FSTKIL(ESPTWP,ESQNPP, ESBRPP,ESOCWP,	AGRI 695
> ESOLWP,ESISWP)	AGRI 700
IF (HAIL(5).GT.0.0) CALL CRPKIL(ESPTWP,ESQNPP, ESCNPP,ESBRPP,	AGRI 705
> ESOCWP,ESOLWP,ESISWP)	AGRI 710
IF (ESQNPP.GT.0.0) TEQN=ESQNPP+TEQN+400.0*QUNACR	AGRI 715
IF (ESCNPP.GT.0.0) TECN=TECN+ESCNPP+500.0*CANACR	AGRI 720
IF (ESBRPP.GT.0.0) TEBR=TEBR+ESBRPP+400.0*BARACR	AGRI 725
TEPT=TEPT+ESPTWP	AGRI 730
TEOC=TEOC+ESOCWP	AGRI 735
TEOL=TEOL+ESOLWP	AGRI 740
TEIN=TEIN+ESINWP	AGRI 745
C... FEBRUARY	AGRI 750
C... IF (FROST(6).GT.0.0) CALL FSTKIL(ESPTWP,ESQNPP, ESBRPP,ESOCWP,	AGRI 755
> ESOLWP,ESISWP)	AGRI 760
IF (HAIL(6).GT.0.0) CALL CRPKIL(ESPTWP,ESQNPP, ESCNPP,ESBRPP,	AGRI 765
> ESOCWP,ESOLWP,ESISWP)	AGRI 770
TEQN=TEQN+ESQNPP	AGRI 775
TECN=TECN+ESCNPP	AGRI 780
TEBR=TEBR+ESBRPP	AGRI 785
C... MARCH	AGRI 790
C... IF (FROST(7).GT.0.0) CALL FSTKIL(ESPTWP,ESQNPP, ESBRPP,ESOCWP,	AGRI 795
> ESOLWP,ESISWP)	AGRI 800
IF (HAIL(7).GT.0.0) CALL CRPKIL(ESPTWP,ESQNPP, ESCNPP,ESBRPP,	AGRI 805
	AGRI 810
	AGRI 815
	AGRI 820
	AGRI 825
	AGRI 830
	AGRI 835
	AGRI 840
	AGRI 845
	AGRI 850
	AGRI 855

APPENDIX (Continued)

```

      > ESOCWP,ESOLWP,ESISWP)
      IF (ESQNPP.GT.0.0) TEQN=TEQN+4500.0*QUNACR+ESQNPP
      IF (ESCNPP.GT.0.0) TECN=TECN+14400.0*CANACR+ESCNPP
      IF (ESBRPP.GT.0.0) TEBR=TEBR+14400.0*BARACR+ESBRPP
C...
C...   APRIL
C...
      IF (FROST(8).GT.0.0) CALL FSTKIL(ESPTWP,ESQNPP,ESBRPP,ESOCWP,
      > ESOLWP,ESISWP)
      IF (HAIL(8).GT.0.0) CALL CRPKIL(ESPTWP,ESQNPP,ESCNPP,ESBRPP,
      > ESOCWP,ESOLWP,ESISWP)
      IF (ESQNPP.GT.0.0) TEQN=TEQN+ESQNPP+4500.0*QUNACR
      TECN=TECN+ESCNPP
      TEBR=TEBR+ESBRPP
      IF (ESPTWP.GT.0.0) TEPT=TEPT+5100.0*POTACR
      IF (ESOCWP.GT.0.0) TEOC=TEOC+5100.0*OCAACR
      IF (ESOLWP.GT.0.0) TEOL=TEOL+5100.0*OLLACR
      IF (ESINWP.GT.0.0) TEIN=TEIN+5100.0*ISNACR
C...
C...   MAY
C...
      TEQN=TEQN+ESQNPP
      TECN=TECN+ESCNPP
      TEBR=TEBR+ESBRPP
      IF (ESPTWP.GT.0.0) TEPT=5100.0*POTACR+TEPT
      IF (ESOCWP.GT.0.0) TEOC=TEOC+5100.0*OCAACR
      IF (ESOLWP.GT.0.0) TEOL=TEOL+5100.0*OLLACR
      IF (ESINWP.GT.0.0) TEIN=TEIN+5100.0*ISNACR
C...
C...   JUNE
C...
      TEQN=TEQN+ESQNPP
      TECN=TECN+ESCNPP
      TEBR=TEBR+ESBRPP
      IF (ESPTWP.GT.0.0) TEPT=TEPT+3500.0*POTACR
      IF (ESOCWP.GT.0.0) TEOC=TEOC+3500.0*OCAACR
      IF (ESOLWP.GT.0.0) TEOL=TEOL+3500.0*OLLACR
      IF (ESINWP.GT.0.0) TEIN=TEIN+3500.0*ISNACR
C...
C...   JULY
C...
      TEQN=TEQN+ESQNPP
      TECN=TECN+ESCNPP
      TEBR=TEBR+ESBRPP
      IF (ESPTWP.GT.0.0) TEPT=TEPT+3400.0*POTACR
      IF (ESOCWP.GT.0.0) TEOC=TEOC+3400.0*OCAACR
      IF (ESOLWP.GT.0.0) TEOL=TEOL+3400.0*OLLACR
      IF (ESINWP.GT.0.0) TEIN=TEIN+3400.0*ISNACR
C...
C...   AUGUST
C...
      TEQN=TEQN+ESQNPP+700.0*QUNACR
      TECN=TECN+ESCNPP
      TEBR=TEBR+ESBRPP
      ELOSSP(NFAM)=ELOSSP(NFAM)+TEQN+TECN+TEBR+TEPT+TEOC+TEOL+TEIN
C...
C...   THIS SECTION CALCULATES ENERGY OBTAINED FROM CROPS GROWN
C...   THIS YEAR

```

AGRI 860
 AGRI 865
 AGRI 870
 AGRI 875
 AGRI 880
 AGRI 885
 AGRI 890
 AGRI 895
 AGRI 900
 AGRI 905
 AGRI 910
 AGRI 915
 AGRI 920
 AGRI 925
 AGRI 930
 AGRI 935
 AGRI 940
 AGRI 945
 AGRI 950
 AGRI 955
 AGRI 960
 AGRI 965
 AGRI 970
 AGRI 975
 AGRI 980
 AGRI 985
 AGRI 990
 AGRI 995
 AGRI 1000
 AGRI 1005
 AGRI 1010
 AGRI 1015
 AGRI 1020
 AGRI 1025
 AGRI 1030
 AGRI 1035
 AGRI 1040
 AGRI 1045
 AGRI 1050
 AGRI 1055
 AGRI 1060
 AGRI 1065
 AGRI 1070
 AGRI 1075
 AGRI 1080
 AGRI 1085
 AGRI 1090
 AGRI 1095
 AGRI 1100
 AGRI 1105
 AGRI 1110
 AGRI 1115
 AGRI 1120
 AGRI 1125
 AGRI 1130
 AGRI 1135
 AGRI 1140
 AGRI 1145

APPENDIX (Continued)

C...	CALCAN=0.0	AGRI1150
	CALPOT=0.0	AGRI1155
	CALOCA=0.0	AGRI1160
	CALOLL=0.0	AGRI1165
	CALISN=0.0	AGRI1170
	CALQNU=0.0	AGRI1175
	CALBAR=0.0	AGRI1180
C...		AGRI1185
C...	IF QHAIL IS ZERO THERE WAS A HAIL AFTER OCTOBER AND NO CROPS	AGRI1190
C...	HAVE BEEN HARVESTED	AGRI1195
C...		AGRI1200
	QHAIL=ESCNPP+ESQNPP+ESBRPP	AGRI1205
	IF (QHAIL.LE.0.0) GO TO 90	AGRI1210
	CALL GGNORD(32,33,Z)	AGRI1215
C...		AGRI1220
C...	CALCULATE THE EFFECT OF SNOW, DISEASE, AND RAINFALL CONDITIONS	AGRI1225
C...	THIS YEAR BY GENERATING FACTORS (NUMBERS FROM ZERO TO ONE)	AGRI1230
C...	WHICH ARE MULTIPLIED BY THE AGFICULTURAL YIELD TO REDUCE	AGRI1235
C...	THE ENERGY OBTAINED FROM THE CROPS. THE EFFECTS ARE	AGRI1240
C...	SPECIES SPECIFIC.	AGRI1245
C...		AGRI1250
C...	SNOW EFFECT	AGRI1255
C...		AGRI1260
	SNOW=1.0-(ABS(Z(1))*0.1)	AGRI1265
C...		AGRI1270
C...	DISEASE EFFECT	AGRI1275
C...		AGRI1280
	DISEAS=1.0-(ABS(Z(2))*0.2)	AGRI1285
C...		AGRI1290
C...	PRECIPITATION EFFECT	AGRI1295
C...		AGRI1300
	IF (DRTP.LE.12) PPTEFT=1	AGRI1305
	IF (DRTP.GT.12.AND.DRTP.LE.14) PPTEFT=.8	AGRI1310
	IF (DRTE.GT.14.AND.DRTP.LE.16) PPTEFT=.6	AGRI1315
	IF (DRTE.GT.16.AND.DRTP.LE.20) PPTEFT=.4	AGRI1320
	IF (DRTE.GT.20.AND.DRTP.LE.24) PPTEFT=.2	AGRI1325
	IF (DRTE.GT.24) PPTEFT=0	AGRI1330
	IF (DRTEI.GT.6.AND.DRTPI.LT.8) PPTEFT=PPTEFT*0.75	AGRI1335
	IF (DRTEI.GE.8) PPTEFT=PPTEFT*0.5	AGRI1340
C...		AGRI1345
C...	CALCULATE TOTAL ENVIRONMENTAL EFFECT FOR EACH SPECIES	AGRI1350
C...		AGRI1355
	ENVLSS=SNOW*PPTEFT*DISEAS	AGRI1360
	ENVLPT=(PPTEFT+.2)*(DISEAS-.15)	AGRI1365
	ENVLQN=PPTEFT*(DISEAS+.2)*SNOW	AGRI1370
	ENVLCN=(PPTEFT+.2)*(DISEAS+.1)	AGRI1375
	ENVLBR=(PPTEFT-.1)*(DISEAS-.1)*SNOW	AGRI1380
C...		AGRI1385
C...	PREVENT EFFECT FROM EXCEEDING ONE.	AGRI1390
C...		AGRI1395
	IF (ENVLPT.GT.1) ENVLPT=1	AGRI1400
	IF (ENVLQN.GT.1) ENVLQN=1	AGRI1405
	IF (ENVLCN.GT.1) ENVLCN=1	AGRI1410
	IF (ENVLBR.LT.0.0) ENVLBR=0.0	AGRI1415
C...		AGRI1420
C...	IF QFROST IS ZERO THERE WAS A FROST AFTER OCTOBER AND ONLY	AGRI1425
C...	HARVESTED	AGRI1430
		AGRI1435

APPENDIX (Continued)

C...	QFROST=ESPTWP+ESOCWP+ESOLWP+ESINWP	AGRI1440
	IF (QFROST.LE.0.0) GO TO 80	AGRI1445
C..		AGRI1450
C...	APPLY MULTIPLIERS TO ENERGY TOTALS	AGRI1455
C...		AGRI1460
	CALPOT=198000.0*POTACR*DUNGPT*ENVLPT	AGRI1465
	CALOCA=137000.0*OCAACR*DUNGPT*ENVLSS	AGRI1470
	CALOLL=103000.0*OLLACR*DUNGPT*ENVLSS	AGRI1475
	CALISN=103000.0*ISNACR*DUNGPT*ENVLSS	AGRI1480
	CALQNU=307800.0*QNNACR*ENVLPT	AGRI1485
	CALBAR=138700.0*BARACR*ENVLBR	AGRI1490
80	CALCAN=307800.0*CANACR*ENVLPT	AGRI1495
C...		AGRI1500
C...	CALCULATE GROSS ENERGY GAIN THROUGH CROP ACTIVITIES	AGRI1505
90	EGAINP(NFAM)=CALPOT+CALOCA+CALOLL+CALISN+CALQNU+CALCAN+CALBAR	AGRI1510
C...		AGRI1515
C...	ADJUST ENERGY DEMAND AFTER NET GAIN FROM CROP ACTIVITIES	AGRI1520
	ENET(NFAM)= -(ELOSS(NFAM)+ELOSSP(NFAM)) +EGAINP(NFAM)	AGRI1525
	RETURN	AGRI1530
	END	AGRI1535
		AGRI1540

APPENDIX (Continued)

	SUBROUTINE FSTKIL(ESPTWP,ESQNPP,ESBRPP,ESOCWP,ESOLWP,ESISWP)	FSTK	0
	COMMON /PRINT/ IO2,L1,L2,L3,L4,L5	FSTK	5
	COMMON /SWITCH/ KKKKKK,LLLLLL	FSTK	10
C...		FSTK	15
C...	KILL ALL CROPS BY FROST EXCEPT CANIHUA	FSTK	20
C...		FSTK	25
	ESPTWP=0.0	FSTK	30
	ESQNPP=0.0	FSTK	35
	ESBRPP=0.0	FSTK	40
	ESOCWP=0.0	FSTK	45
	ESOLWP=0.0	FSTK	50
	ESISWP=0.0	FSTK	55
	IF (KKKKKK.LT.1.AND.LLLLLL.LT.1) WRITE(IO2,9000)	FSTK	60
	KKKKKK=1	FSTK	65
	RETURN	FSTK	70
9000	FORMAT(' ALL CROPS HAVE BEEN KILLED BY FROST EXCEPT CANIHUA.')	FSTK	75
	END	FSTK	80

APPENDIX (Continued)

	SUBROUTINE CRPKIL(ESPTWP,ESQNPP,ESCNPP,ESBRPP, ESOCWP,ESOLWP,	CRPK	0
	> ESISWP)	CRPK	5
	COMMON /PRINT/ IO2,L1,L2,L3,L4,L5	CRPK	10
	COMMON /SWITCH/ KKKKKK,LLLLLL	CRPK	15
C...		CRPK	20
C...	KILL ALL CROPS BY HAIL	CRPK	25
C...		CRPK	30
	ESPTWP=0.0	CRPK	35
	ESQNPP=0.0	CRPK	40
	ESCNPP=0.0	CRPK	45
	ESBRPP=0.0	CRPK	50
	ESOCWP=0.0	CRPK	55
	ESOLWP=0.0	CRPK	60
	ESISWP=0.0	CRPK	65
	IF (LLLLLL.LT.1) WRITE(IO2,9000)	CRPK	70
	LLLLLL=1	CRPK	75
	RETURN	CRPK	80
9000	FORMAT(' ALL CROPS HAVE BEEN DESTROYED BY HAIL.')	CRPK	85
	END	CRPK	90

APPENDIX (Continued)

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SUBROUTINE CLIMAT
COMMON /PRINT/ IO2,L1,L2,L3,L4,L5
COMMON /WETHER/ FROST(8),HAIL(8),DRTP,DRTP1
DIMENSION POTEVP(8),PRECP(8),FTEMP(8),TMPSD(8),PRCPSD(8)
DIMENSION PREP(8),TFRST(8),FHAIL(8),Z(2)
DATA POTEVP/75.0,85.0,75.0,60.0,65.0,60.0,64.0,56.0/
DATA PRECP/40.0,37.0,80.0,95.0,150.0,90.0,133.0,43.0/
DATA FTEMP/32.0,33.0,32.5,35.0,36.5,35.0,35.5,36.0/
DATA TMPSD/1.75,2.5,0.75,1.5,2.25,1.5,1.75,2.0/
DATA PRCPSD/5.0,8.0,20.0,30.0,37.0,35.0,60.0,21.0/
DATA FHAIL/0.03,0.07,0.03,0.02,0.01,0.01,0.02,0.03/

C...
C...   THIS SUBROUTINE CALCULATES THE WEATHER TO BE USED IN
C...   SUBROUTINE AGRI.
C...
C...   CLIMATE LEGEND:   1=HUMID,2=RATHER DRY,3=DRY,4=ARID
C...
DRTP=0.0
DRTP1=0.0

C...
C...   THE FOLLOWING ARE MULTIPLIERS WHICH WIDEN THE NORMAL
C...   DISTRIBUTIONS OF MONTHLY TEMPERATURE (F) AND PRECIPITATION (G)
C...
G=1.5
F=1.5
DO 20 I=1,8
  HAIL(I)=0.0
  CLIM=0.0
  FROST(I)=0.0
  TFRST(I)=0.0

C...
C...   WAS THERE A DROUGHT THIS YEAR (BASED ON A RANDOM DRAWING OF
C...   PRECIPITATION FROM MONTHLY NORMALLY DISTRIBUTED DATA) ??
C...
  CALL GGNORD(34,35,Z)
  PREP(I)=(G*Z(1)*PRCPSD(I))+PRECP(I)
  IF (POTEVP(I).LT.PREP(I)) CLIM=1.0
  PREP3=PREP(I)*3.0
  PREP6=PREP(I)*6.0
  IF (POTEVP(I).GE.PREP(I).AND.POTEVP(I).LT.PREP3) CLIM=2.0
  IF (POTEVP(I).GE.PREP3.AND.POTEVP(I).LT.PREP6) CLIM=3.0
  IF (POTEVP(I).GE.PREP6) CLIM=4.0
  DRTP=DRTP+CLIM
  IF (I.NE.3) GO TO 10

C...   WAS THERE AN EARLY SEASON DROUGHT?
DRTP1=DRTP
10  CONTINUE

C...
C...   WAS THERE A HAIL STORM (BASED ON A UNIFORM RANDOM PROBABILITY
C...   AS COMPARED TO A TYPICAL MONTHLY FREQUENCY) ??
C...
  IF (RANDOM(23).LT.FHAIL(I)) HAIL(I)=1.0

C...
C...   WAS THERE A FROST (A PERIOD OF 4 DEGREE-HOURS BELOW 32 DEGREES F
C...   DURING ANY MONTH) ??
C...

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CLIM  0
CLIM  5
CLIM 10
CLIM 15
CLIM 20
CLIM 25
CLIM 30
CLIM 35
CLIM 40
CLIM 45
CLIM 50
CLIM 55
CLIM 60
CLIM 65
CLIM 70
CLIM 75
CLIM 80
CLIM 85
CLIM 90
CLIM 95
CLIM 100
CLIM 105
CLIM 110
CLIM 115
CLIM 120
CLIM 125
CLIM 130
CLIM 135
CLIM 140
CLIM 145
CLIM 150
CLIM 155
CLIM 160
CLIM 165
CLIM 170
CLIM 175
CLIM 180
CLIM 185
CLIM 190
CLIM 195
CLIM 200
CLIM 205
CLIM 210
CLIM 215
CLIM 220
CLIM 225
CLIM 230
CLIM 235
CLIM 240
CLIM 245
CLIM 250
CLIM 255
CLIM 260
CLIM 265
CLIM 270
CLIM 275

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APPENDIX (Continued)

	TFRST(I)=(32.0-(Z(2)*F*TMPSD(I)+FTEMP(I)))*5.0*RANDOM(24)	CLIM 280
	IF (TFRST(I).GE.4.0) FROST(I)=1.0	CLIM 285
20	CONTINUE	CLIM 290
	IF (L1.EQ.0) GO TO 40	CLIM 295
C...:		CLIM 300
C...:	WRITE OUT WEATHER CONDITIONS FOR THIS YEAR.	CLIM 305
C...:		CLIM 310
	WRITE(IC2,9000)	CLIM 315
	WRITE(IO2,9001)	CLIM 320
	WRITE(IC2,9002)	CLIM 325
	DO 30 I=1,8	CLIM 330
	WRITE(IO2,9003)I,FROST(I),I,HAIL(I)	CLIM 335
30	CONTINUE	CLIM 340
	IF (DRTP.LE.12) WRITE(IO2,9004)	CLIM 345
	IF (DRTP.GT.12.AND.DRTP.LE.14) WRITE(IO2,9005)	CLIM 350
	IF (DRTP.GT.14.AND.DRTP.LE.16) WRITE(IO2,9006)	CLIM 355
	IF (DRTP.GT.16.AND.DRTP.LE.20) WRITE(IO2,9007)	CLIM 360
	IF (DRTP.GT.20.AND.DRTP.LE.24) WRITE(IO2,9008)	CLIM 365
	IF (DRTP.GT.24) WRITE(IO2,9009)	CLIM 370
	IF (DRTP.GT.6) WRITE(IO2,9010)	CLIM 375
40	CONTINUE	CLIM 380
	RETURN	CLIM 385
9000	FORMAT(1H0,'THIS SEASONS WEATHER:')	CLIM 390
9001	FORMAT(1H0,' FROST AND HAIL CODE:')	CLIM 395
9002	FORMAT(1H0,' STORM TYPE(MONTH)=(0=NO EVENT,1=EVENT)')	CLIM 400
9003	FORMAT(' FROST',I1,'=',F8.2,3X,'HAIL',I1,'=',F8.2)	CLIM 405
9004	FORMAT(' PRECIPITATION CONDITIONS THIS YEAR WERE HUMID.')	CLIM 410
9005	FORMAT(' PRECIPITATION CONDITIONS THIS YEAR WERE SUBHUMID.')	CLIM 415
9006	FORMAT(' PRECIPITATION CONDITIONS THIS YEAR WERE DRY.')	CLIM 420
9007	FORMAT(' PRECIPITATION CONDITIONS THIS YEAR WERE ARID.')	CLIM 425
9008	FORMAT(' PRECIPITATION CONDITIONS THIS YEAR WERE XERIC.')	CLIM 430
9009	FORMAT(' PRECIPITATION CONDITIONS THIS YEAR WERE RAINLESS.')	CLIM 435
9010	FORMAT(' THERE HAS BEEN AN EARLY SEASON DROUGHT.')	CLIM 440
	END	CLIM 445

APPENDIX (Continued)

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SUBROUTINE DEMAND(NFAM, IDKNT)
COMMON /ENLOSS/ ELOSS(1000), ELOSSP(1000)
COMMON /FAMIL/ HUSB(1000), WIFE(1000), NCHILD(1000)
COMMON /AGES/ IHUSB(1000), IWIFE(1000), ICHILD(5000)
COMMON /ISEX/ KIDSEX(5000)
C... THIS SUBROUTINE CALCULATES THE AMOUNT OF ENERGY THE FAMILY
C... REQUIRES BASED ON AGE AND SEX OF FAMILY MEMBERS.
C...
ENEEDH=0.0
ENEEDW=0.0
ENEEDC=0.0
OLD=IHUSB(NFAM)
IF (IHUSB(NFAM).GT.0.AND.IHUSB(NFAM).LT.20) ENEEDH=OLD *29681.+
> 234074.
IF (IHUSB(NFAM).GE.20.AND.IHUSB(NFAM).LT.30) ENEEDH=744530.
IF (IHUSB(NFAM).GE.30.AND.IHUSB(NFAM).LE.65) ENEEDH=OLD* (-5680.)+
> 999009.
IF (IHUSB(NFAM).GT.65) ENEEDH=575875.
OLD=IWIFE(NFAM)
IF (IWIFE(NFAM).GT.0.AND.IWIFE(NFAM).LT.20) ENEEDW=OLD *18927.+
> 292993.
IF (IWIFE(NFAM).GE.20.AND.IWIFE(NFAM).LT.30) ENEEDW=612105.
IF (IWIFE(NFAM).GE.30.AND.IWIFE(NFAM).LE.65) ENEEDW=OLD* (-4483.)+
> 787659.
IF (IWIFE(NFAM).GT.65) ENEEDW=452965.
IF (NCHILD(NFAM).EQ.0) GO TO 30
NN=IDKNT+NCHILD(NFAM)-1
DO 20 J=IDKNT, NN
  OLD=ICHILD(J)
  IF (KIDSEX(J).LT.0) GO TO 10
  IF (ICHILD(J).LT.20) ENEEDC=ENEEDC+OLD*29681.+234074.
  IF (ICHILD(J).GE.20.AND.ICHILD(J).LT.30) ENEEDC=ENEEDC+744530.
  IF (ICHILD(J).GE.30.AND.ICHILD(J).LE.65) ENEEDC=ENEEDC+OLD *(-
> 5680.)+999009.
  IF (ICHILD(J).GT.65) ENEEDC=ENEEDC+575875.
  GO TC 20
10 IF (ICHILD(J).LT.20) ENEEDC=ENEEDC+OLD*18927.+292992.
  IF (ICHILD(J).GE.20.AND.ICHILD(J).LT.30) ENEEDC=ENEEDC+612105.
  IF (ICHILD(J).GE.30.AND.ICHILD(J).LE.65) ENEEDC=ENEEDC+OLD *(-
> 4483.)+787659.
  IF (ICHILD(J).GT.65) ENEEDC=ENEEDC+452965.
20 CONTINUE
30 CONTINUE
ELOSS(NFAM)=ENEEDH+ENEEDW+ENEEDC
RETURN
END

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APPENDIX (Continued)

	SUBROUTINE MIGRAT(NFAM, IDKNT)	MIGR 0
	COMMON /ENNET/ ENET(1000)	MIGR 5
	COMMON /FAMIL/ HUSB(1000), WIFE(1000), NCHILD(1000)	MIGR 10
	COMMON /IAGES/ IHUSB(1000), IWIFE(1000), ICHILD(5000)	MIGR 15
	COMMON /ISEX/ KIDSEX(5000)	MIGR 20
	COMMON /STATS/ NFAMI, KIDTOT, POPTOT, FAMPOP(1000), IDCLAN(1000)	MIGR 25
	INTEGER HUSB, FAMPOP, WIFE, CHILD, ABLET, ABLE	MIGR 30
	REAL MIGPRB, MIGTOT	MIGR 35
C...		MIGR 40
C...	THIS SUBROUTINE ALLOWS FAMILY IN DEFICIT TO GAIN A SMALL	MIGR 45
C...	AMOUNT OF ENERGY BY ASSUMING THAT THE HUSBAND AND MALE	MIGR 50
C...	CHILDREN OLDER THAN 18 TEMPORARILY MIGRATE AWAY TO	MIGR 55
C...	THE LOWLANDS TO EARN MONEY.	MIGR 60
C...		MIGR 65
	MIGPRB=0.0	MIGR 70
	IF (RANDOM(25).GT.0.5) MIGPRB=1.0	MIGR 75
	ABLET=0	MIGR 80
	ABLE=0	MIGR 85
	IF (NCHILD(NFAM).EQ.0) GO TO 20	MIGR 90
	NN=IDKNT+NCHILD(NFAM)-1	MIGR 95
	DO 10 J=IDKNT, NN	MIGR 100
	IF (KIDSEX(J).LT.0.AND.ICHILD(J).GT.18) ABLE=1	MIGR 105
	ABLET=ABLET+ABLE	MIGR 110
10	CONTINUE	MIGR 115
20	CONTINUE	MIGR 120
	MIGTOT=1.0	MIGR 125
	IF (HUSB(NFAM).LT.0.AND.ABLET.LT.0) MIGTOT=0.0	MIGR 130
	IF (HUSB(NFAM).GT.0.AND.WIFE(NFAM).GT.0.AND.ABLET.GT.0) MIGTOT=2.0	MIGR 135
	IF (HUSB(NFAM).LT.0.AND.WIFE(NFAM).GT.0.AND.ABLET.GT.1) MIGTOT=2.0	MIGR 140
C...		MIGR 145
C...	REDUCE ENERGY DEFICIT	MIGR 150
C...		MIGR 155
	IF (ENET(NFAM).LT.0.0) ENET(NFAM)=ENET(NFAM)+ 41500*MIGPRB*MIGTOT	MIGR 160
	RETURN	MIGR 165
	END	MIGR 170

APPENDIX (Continued)

```

SUBROUTINE HERD(NFAM, IDKNT)
COMMON /ANIMAL/ NANIML(3,3,1000), NA(1000), NS(1000), NY(1000)
COMMON /CLAN/ CLNSR(50), ICLNAN(3,3,50), NUMCLN
COMMON /ENNET/ ENET(1000)
COMMON /ENGAIN/ EGAINP(1000), EGAINA(1000), EGAINM(1000)
COMMON /ENLOSS/ ELOSS(1000), ELOSSP(1000)
COMMON /STATS/ NFAMI, KIDTOT, POPTOT, FAMPOP(1000), IDCLAN(1000)
DIMENSION X(15), CASH(1000), KK(6), LOWLIM(3,3), NOLDAN(3,3,1000)
DIMENSION Z(2)
INTEGER SPECIE, AGE, PRICE(3), CALORY(3,3)
INTEGER FAMPOP, POPTOT, TOTHRD
REAL WOCLS(3,3), WOOLGN(1000), NETCST, MRKT, MEATD, KILNUM
REAL KILSE
DATA WOCLS/0.0,10.8,21.6,0.0,0.0,0.0,0.0,54.1,108.2/
DATA KK/9,8,6,5,3,2/
DATA PRICE/400,150,300/
DATA CALORY/23138,46277,92554,4580,9160,18321,15508,31015,62030/
DATA LOWLIM/9,9,15,9,9,15,9,9,15/
DATA NCT/0/
C...
C...   THIS SUBROUTINE UPDATES HERD POPULATION AND
C...   CALCULATES ENERGY GAINED FROM HERDING ACTIVITIES.
C...
C...   ZERO STORAGE ARRAYS
C...
EGAINA(NFAM)=0.0
EGAINM(NFAM)=0.0
CASH(NFAM)=0.0
WOOLGN(NFAM)=0.0
TOTHRD=0
C...
C...   TOTAL HERD SIZE AND SAVE PRE-UPDATED HERD VALUES (NOLDAN)
C...
DO 10 SPECIE=1,3
DO 10 AGE=1,3
TOTHRD=TOTHRD+NANIML(AGE,SPECIE,NFAM)
NOLDAN(AGE,SPECIE,NFAM)=NANIML(AGE,SPECIE,NFAM)
10 CONTINUE
IF (TOTHRD.GT.1) GO TO 20
GO TO 120
20 DO 50 J=1,15
NCT = NCT + 1
IF (NCT.EQ.2) GO TO 30
CALL GGNORD(36,37,Z)
GO TO 40
30 Z(1) = Z(2)
NCT = 0
40 X(J)=Z(1)
50 CONTINUE
C...
C...   UPDATE HERD POPULATION
C...
NANIML(1,1,NFAM)=.39*NANIML(3,1,NFAM)-(.06*X(1)+.12) * (.39*
> NANIML(3,1,NFAM))
IF (NANIML(1,1,NFAM).LE.0) NANIML(1,1,NFAM)=0
NANIML(2,1,NFAM)=NOLDAN(1,1,NFAM)-(.02*X(2)+.04) *NOLDAN(1,1,NFAM)

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APPENDIX (Continued)

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      IF (NANIML(2,1,NFAM).LE.0) NANIML(2,1,NFAM)=0          HERD 280
      NANIML(3,1,NFAM)=NOLDAN(2,1,NFAM)+NOLDAN(3,1,NFAM) - (.02*X(4)+.04) HERD 285
    > *NOLDAN(3,1,NFAM)-(.02*X(3)+.04) *NOLDAN(2,1,NFAM)      HERD 290
      IF (NANIML(3,1,NFAM).LE.0) NANIML(3,1,NFAM)=0          HERD 295
      NANIML(1,2,NFAM)=.39*NANIML(3,2,NFAM)-(.06*X(6)+.12) *.39* HERD 300
    > NANIML(3,2,NFAM) )                                         HERD 305
      IF (NANIML(1,2,NFAM).LE.0) NANIML(1,2,NFAM)=0          HERD 310
      NANIML(2,2,NFAM)=NOLDAN(1,2,NFAM)-(.02*X(7)+.04) *NOLDAN(1,2,NFAM) HERD 315
      IF (NANIML(2,2,NFAM).LE.0) NANIML(2,2,NFAM)=0          HERD 320
      NANIML(3,2,NFAM)=NOLDAN(3,2,NFAM)+NOLDAN(2,2,NFAM) - (.02*X(8)+.04) HERD 325
    > *NOLDAN(3,2,NFAM)-(.02*X(9)+.04) *NOLDAN(2,2,NFAM)      HERD 330
      IF (NANIML(3,2,NFAM).LE.0) NANIML(3,2,NFAM)=0          HERD 335
      NANIML(1,3,NFAM)=.46*NANIML(3,3,NFAM)-(.06*X(11)+.12) *.46* HERD 340
    > NANIML(1,3,NFAM) )                                         HERD 345
      IF (NANIML(1,3,NFAM).LE.0) NANIML(1,3,NFAM)=0          HERD 350
      NANIML(2,3,NFAM)=NOLDAN(1,3,NFAM)-(.02*X(12)+.04) *NOLDAN(1,3, HERD 355
    > NFAM) )                                                     HERD 360
      IF (NANIML(2,3,NFAM).LE.0) NANIML(2,3,NFAM)=0          HERD 365
      NANIML(3,3,NFAM)=NOLDAN(3,3,NFAM)+NOLDAN(2,3,NFAM) - (.02*X(13)+ HERD 370
    > .04)*NOLDAN(3,3,NFAM)-(.02*X(14)+.04) *NOLDAN(2,3,NFAM) HERD 375
      IF (NANIML(3,3,NFAM).LE.0) NANIML(3,3,NFAM)=0          HERD 380
C...                                                           HERD 385
C...      CALCULATE ENRGY GAIN FROM CONSUMING DEAD ANIMALS    HERD 390
C...                                                           HERD 395
      DEDCAL=0                                                  HERD 400
      DEDCAL=DEDCAL+(NANIML(2,1,NFAM)-NOLDAN(1,1,NFAM)) *CALORY(2,1) HERD 405
      DEDCAL=DEDCAL+(NANIML(3,1,NFAM)-NOLDAN(2,1,NFAM) -NOLDAN(3,1,NFAM) HERD 410
    > ) *CALORY(3,1) )                                             HERD 415
      DEDCAL=DEDCAL+(NANIML(2,2,NFAM)-NOLDAN(1,2,NFAM)) *CALORY(2,2) HERD 420
      DEDCAL=DEDCAL+(NANIML(3,2,NFAM)-NOLDAN(3,2,NFAM)-NOLDAN(2,2,NFAM) HERD 425
    > ) *CALORY(3,2) )                                             HERD 430
      DEDCAL=DEDCAL+(NANIML(2,3,NFAM)-NOLDAN(1,3,NFAM)) *CALORY(2,3) HERD 435
      DEDCAL=DEDCAL+(NANIML(3,3,NFAM)-NOLDAN(3,3,NFAM)-NOLDAN(2,3,NFAM) HERD 440
    > ) *CALORY(3,3) )                                             HERD 445
      MEATD=.04*ELOSS(NFAM)                                     HERD 450
      DEMAND=MEATD+DEDCAL                                       HERD 455
      EGAINA(NFAM)=-DEDCAL                                       HERD 460
      IF (DEMAND.LE.0.0) GO TO 70                                HERD 465
C...                                                           HERD 470
C...      SLAUGHTER ADULT SHEEP TO FILL MEAT DEMAND           HERD 475
C...                                                           HERD 480
      NUMTHR=NANIML(3,2,NFAM)-LOWLIM(3,2)                      HERD 485
      IF (NUMTHR.LE.0) GO TO 70                                  HERD 490
      DO 60 I=1,NUMTHR                                          HERD 495
        NANIML(3,2,NFAM)=NANIML(3,2,NFAM)-1                    HERD 500
        WOOLGN(NFAM)=WOOLGN(NFAM)+WOOLS(3,2)                   HERD 505
        DEMAND=DEMAND-CALORY(3,2)                                HERD 510
        EGAINA(NFAM)=EGAINA(NFAM)+CALORY(3,2)                   HERD 515
        IF (DEMAND.LE.0.0) GO TO 70                              HERD 520
      60 CONTINUE                                              HERD 525
      70 CONTINUE                                              HERD 530
C...                                                           HERD 535
C...      CALCULATE MONETARY GAIN FROM WOOL                   HERD 540
C...                                                           HERD 545
      DO 80 SPECIE=1,3                                          HERD 550
        DO 80 AGE=1,3                                           HERD 555
          WOOLGN(NFAM)=WOOLGN(NFAM)+NANIML(AGE,SPECIE,NFAM)*WOOLS HERD 560
        > (AGE,SPECIE)                                           HERD 565

```

APPENDIX (Continued)

80	CONTINUE	HERD 570
C...		HERD 575
C...	CALCULATE ENERGY REQUIRED FROM MARKET	HERD 580
C...	(CONVERTED INTO CASH UNITS)	HERD 585
C...		HERD 590
	MRKT= -(ENET(NFAM)) -EGAINA(NFAM)	HERD 595
	NETCST= (MRKT/377.)-WOOLGN(NFAM)	HERD 600
C...		HERD 605
C...	STORE INFORMATION ON ENERGY GAINED FROM WOOL SALES	HERD 610
C...		HERD 615
	EGAINM(NFAM)=WOOLGN(NFAM)*377.	HERD 620
	IF (NETCST.LE.0.0) GO TO 110	HERD 625
C...		HERD 630
C...	SELL LIVE ADULT ALPACAS INTO MARKET	HERD 635
C...		HERD 640
	T=0	HERD 645
90	I=I+1	HERD 650
	IF (I.GT.6) GO TO 110	HERD 655
	AGE=MOD(KK(I),3)	HERD 660
	IF (AGE.EQ.0) AGE=3	HERD 665
	SPECIE= ((KK(I)-AGE)/3)+1	HERD 670
	DO 100 JJ=1,100	HERD 675
	IF (NANIML(AGE,SPECIE,NFAM).LE.9) GO TO 90	HERD 680
	CASH(NFAM)=CASH(NFAM)+PRICE(SPECIE)	HERD 685
	NANIML(AGE,SPECIE,NFAM)=NANIML(AGE,SPECIE,NFAM)-1	HERD 690
C...		HERD 695
C...	UPDATE ENERGY GAIN FROM MARKET (WOOL + ANIMAL SALES)	HERD 700
C...		HERD 705
	EGAINM(NFAM)=EGAINM(NFAM)+(PRICE(SPECIE)*377.)	HERD 710
C...		HERD 715
C...	CAN ENOUGH ENERGY NOW BE BOUGHT?	HERD 720
C...		HERD 725
	IF (CASH(NFAM).GE.NETCST) GO TO 110	HERD 730
100	CONTINUE	HERD 735
C...		HERD 740
C...	CALCULATE HOW MUCH ENERGY DEFICIT STILL REMAINS AFTER ANIMAL	HERD 745
C...	SALES (TOTAL CASH MADE IN SALES MINUS AMOUNT REQUIRED FROM	HERD 750
C...	MARKET, AND MULTIPLIED BY THE CALORIES OF ENERGY PER UNIT	HERD 755
C...	CASH).	HERD 760
C...		HERD 765
110	ENET(NFAM)=(CASH(NFAM)-NETCST)*377.	HERD 770
	IF (ENET(NFAM).LT.0) RETURN	HERD 775
C...		HERD 780
C...	PLACE EXCESS ENERGY INTO CLAN STORAGE	HERD 785
C...		HERD 790
	CLNSR(IDCLAN(NFAM))=ENET(NFAM)+CLNSR(IDCLAN(NFAM))	HERD 795
	ENET(NFAM)=0.0	HERD 800
120	CONTINUE	HERD 805
	RETURN	HERD 810
	END	HERD 815

APPENDIX (Continued)

	SUBROUTINE DIST	DIST 0
	COMMON /CLAN/ CLNSR(50),ICLNAN(3,3,50),NUMCLN	DIST 5
	COMMON /ENNET/ ENET(1000)	DIST 10
	COMMON /STATS/ NFAMI,KIDTOT,POPTOT,FAMPOP(1000),IDCLAN(1000)	DIST 15
C...		DIST 20
C...	DISTRIBUTE SURPLUS FOOD TO FAMILIES IN NEED	DIST 25
C...		DIST 30
	DO 20 NFAM=1,NFAMI	DIST 35
	IF (ENET(NFAM).GE.0.0) GO TO 20	DIST 40
	IF (CLNSR(IDCLAN(NFAM)).LE.0.0) GO TO 20	DIST 45
	IF ((CLNSR(IDCLAN(NFAM))+ENET(NFAM)).LT.0.0) GO TO 10	DIST 50
	CLNSR(IDCLAN(NFAM))=CLNSR(IDCLAN(NFAM))+ENET(NFAM)	DIST 55
	ENET(NFAM)=0.0	DIST 60
	GO TO 20	DIST 65
10	ENET(NFAM)=ENET(NFAM)+CLNSR(IDCLAN(NFAM))	DIST 70
	CLNSR(IDCLAN(NFAM))=0.0	DIST 75
20	CONTINUE	DIST 80
C...		DIST 85
C...	ZERO ALL CLAN FOOD SURPLUSES	DIST 90
C...		DIST 95
	DO 30 I=1,50	DIST 100
	CLNSR(I)=0.0	DIST 105
30	CONTINUE	DIST 110
	RETURN	DIST 115
	END	DIST 120

APPENDIX (Continued)

FUNCTION NEWNUM(POP,MOM)	NEWN 0
INTEGER*4 POP,MOM,CPRNT(20)	NEWN 5
COMMON /CPARNT/ IROW,CPRNT,KOUNT	NEWN 10
C....	NEWN 15
C.... THIS FUNCTION ASSIGNS A UNIQUE NUMBER TO EACH INDIVIDUAL	NEWN 20
C.... WHO ENTERS THE POPULATION. THE INFORMATION IS CURRENTLY	NEWN 25
C.... STORED ON A DIRECT ACCESS DEVICE. THE UPPER LIMIT	NEWN 30
C.... ON TCTAL INDIVIDUALS IS 20,000.	NEWN 35
C....	NEWN 40
C.... THIS INFORMATION IS USED IN THE PRE-MARITAL CHECK	NEWN 45
C.... FOR RELATEDNESS BETWEEN INDIVIDUALS. IT CAN ALSO BE USED	NEWN 50
C.... TO PRODUCE FAMILY ANCESTRY TREES (SEE PROGRAM TREE.F4).	NEWN 55
C....	NEWN 60
C.....	NEWN 65
C..... INITIALIZE	NEWN 70
C.....	NEWN 75
IF (POP.GE.0) GO TO 10	NEWN 80
IROW = 1	NEWN 85
KOUNT = 1	NEWN 90
NEWNUM = 0	NEWN 95
N = NEWNUM	NEWN 100
RETURN	NEWN 105
C.....	NEWN 110
C..... ASSIGN NUMBER TO NEW INDIVIDUAL	NEWN 115
C.....	NEWN 120
10 NEWNUM = N + 1	NEWN 125
N = NEWNUM	NEWN 130
IF (NEWNUM.LE.19999) GO TO 20	NEWN 135
WRITE(6,9000) NEWNUM,IROW	NEWN 140
STOP	NEWN 145
20 CONTINUE	NEWN 150
C.....	NEWN 155
C..... RECORD PARENTS	NEWN 160
C.....	NEWN 165
NPOP = MOD((2*N)-1,20)	NEWN 170
NMOM = MOD(2*N,20)	NEWN 175
IF (NMOM.LE.0) GO TO 30	NEWN 180
CPRNT(NPOP) = POP	NEWN 185
CPRNT(NMOM) = MOM	NEWN 190
RETURN	NEWN 195
C.....	NEWN 200
C..... PARENT BUFFER FULL, WRITE ONTO RANDOM ACCESS	NEWN 205
C.....	NEWN 210
30 NMOM = 20	NEWN 215
CPRNT(NPOP) = POP	NEWN 220
CPRNT(NMOM) = MOM	NEWN 225
IROW = KOUNT	NEWN 230
WRITE(8,IROW) CPRNT	NEWN 235
KOUNT = KOUNT + 1	NEWN 240
DO 40 I=1,20	NEWN 245
CPRNT(I) = 0	NEWN 250
40 CONTINUE	NEWN 255
RETURN	NEWN 260
9000 FORMAT (1X,'NEWNUM=',I10,' IROW=',I10)	NEWN 265
9001 FORMAT (20I4)	NEWN 270
END	NEWN 275

APPENDIX (Continued)

```

      FUNCTION NRELTV(M1,M2,K)
      INTEGER*4 PARENT(20),RELTV(15,2),CPRNT(20)
      COMMON /CPARNT/ IROW,CPRNT,KOUNT
      NREL 0
      NREL 5
      NREL 10
      C-----
      C----- THIS FUNCTION RETRIEVES ANCESTRY INFORMATION STORED ON DIRECT
      C----- ACCESS DEVICE.
      NREL 15
      C----- M1 AND M2 ARE THE INDIVIDUAL NUMBERS OF POTENTIAL MATES
      NREL 20
      C----- NRELTV: THE NUMBER OF ANCESTORS IN COMMON
      NREL 25
      C----- K: DEPTH OF SEARCH FOR ANCESTORS
      NREL 30
      C-----      1 PARENTS
      NREL 35
      C-----      2 GRANDPARENTS
      NREL 40
      C-----      3 GREATGRANDPARENTS
      NREL 45
      C-----      ECT.
      NREL 50
      C-----      IF K>3 THE ARRAY RELTV MUST BE ENLARGED
      NREL 55
      C----- CPRNT: ARRAY OF INDIVIDUALS WHICH HAVE NOT BEEN WRITTEN ONTO
      NREL 60
      C----- THE OUTPUT DEVICE
      NREL 65
      C----- RELTV: ARRAY IN WHICH DIRECT ANCESTORS ARE ACCUMULATED FOR
      NREL 70
      C----- COMPARISON. INDIVIDUALS ARE IN THE ORDER OF SELF (1) ,
      NREL 75
      C----- PARENTS (2-3) ,GRANDPARENTS (4-7) , ETC.
      NREL 80
      C-----
      NREL 85
      C----- INITIALIZE
      NREL 90
      C-----
      NREL 95
      DO 10 L=1,2
      NREL 100
      DO 10 KK=1,15
      NREL 105
      RELTV(KK,L) = 0
      NREL 110
      10 CONTINUE
      NREL 115
      RELTV(1,1) = M1
      NREL 120
      RELTV(1,2) = M2
      NREL 125
      DO 80 L=1,2
      NREL 130
      IDEPTH = (2**K) - 1
      NREL 135
      DO 70 J=1,IDEPTH
      NREL 140
      IROW = (RELTV(J,L) + 9)/10
      NREL 145
      IF (IROW.GT.2000) GO TO 20
      NREL 150
      GO TO 30
      NREL 155
      20 WRITE(6,9001) J,L,RELTV(J,L),IROW
      NREL 160
      WRITE(6,9002) M1,M2
      NREL 165
      WRITE(6,9000) (RELTV(I,L),I=1,15)
      NREL 170
      30 IF (IROW.EQ.0) GO TO 70
      NREL 175
      IF (IROW.NE.KOUNT) GO TO 50
      NREL 180
      NREL 185
      NREL 190
      NREL 195
      C----- CHECK TO SEE IF INFORMATION NEEDED IS IN CPRNT ARRAY
      NREL 200
      C-----
      NREL 205
      DO 40 IR=1,20
      NREL 210
      PARENT(IR) = CPRNT(IR)
      NREL 215
      40 CONTINUE
      NREL 220
      GO TO 60
      NREL 225
      50 READ(8,IROW) PARENT
      NREL 230
      60 NMOM = 2 * MOD(RELTV(J,L),10)
      NREL 235
      IF (NMOM.EQ.0) NMOM = 20
      NREL 240
      NPOP = NMOM - 1
      NREL 245
      INSERT = 2 * J
      NREL 250
      RELTV(INSERT,L) = PARENT(NMOM)
      NREL 255
      RELTV(INSERT + 1,L) = PARENT(NPOP)
      NREL 260
      70 CONTINUE
      NREL 265
      80 CONTINUE
      NREL 270
      NRELTV = 0
      NREL 275

```

APPENDIX (Continued)

```
      NRELS = (2**(K + 1)) - 1
      DO 100 I=1,NRELS
        IF (RELTV(I,1).EQ.0.OR.RELTV(I,2).EQ.0) GO TO 100
        DO 90 J=1,NRELS
          IF (RELTV(I,1).EQ.RELTV(J,2)) NRELTV = NRELTV + 1
        90      CCNTINUE
      100      CONTINUE
      RETURN
9000  FORMAT (1X,15(I4,1X))
9001  FORMAT(' ',RELTV(' ',I2,' ',I2,') = ',I4,', IROW=',I4)
9002  FORMAT(' ',I4,2X,I4)
      END
```

NREL 280
NREL 285
NREL 290
NREL 295
NREL 300
NREL 305
NREL 310
NREL 315
NREL 320
NREL 325
NREL 330
NREL 335

APPENDIX (Continued)

FUNCTION RANDOM(NSEED)	RAND	0
COMMON/SEED/USEED(45)	RAND	5
INTEGER USEED	RAND	10
REAL*4 RNEW	RAND	15
INTEGER PLUS/Z1000000/,IBIT/Z40000000/,HEX/Z10003/	RAND	20
INTEGER OLD,NEW	RAND	25
LOGICAL*1 NORMAL/.FALSE./	RAND	30
EQUIVALENCE(NEW,RNEW)	RAND	35
CCCCCCCC	RAND	40
CCCCCCCC	RAND	45
C... THIS FUNCTION IS USED TO GENERATE UNIFORM	RAND	50
C... RANDCM NUMBERS USED IN THE STOCHIASTIC FUNCTIONS OF	RAND	55
C... THE MODEL. THIS FUNCTION IS SPECIFIC TO IBM COMPUTERS	RAND	60
C... AND SHOULD BE MODIFIED FOR OTHER SYSTEMS	RAND	65
C...	RAND	70
OLD = HEX*USEED(NSEED)	RAND	75
USEED(NSEED) = IABS(OLD)	RAND	80
NEW=OLD/256	RAND	85
IF (NEW.LE.0) NEW=NEW+PLUS	RAND	90
NEW=NEW+IBIT	RAND	95
RANDOM = RNEW+0.0	RAND	100
RETURN	RAND	105
END	RAND	110

APPENDIX (Continued)

	SUBROUTINE GGNORD(NSEED1,NSEED2,Z)	GGNO	0
	DIMENSION Z(1)	GGNO	5
	DATA PI2/0.62831853E01/	GGNO	10
C...	THIS SUBROUTINE GENERATES NORMALLY DISTRIBUTED RANDOM NUMBERS	GGNO	15
C...		GGNO	20
	K = 0	GGNO	25
	A1 = RANDOM(NSEED1)	GGNO	30
	A2 = RANDOM(NSEED2)	GGNO	35
	K = K+1	GGNO	40
	Z(K) = SQRT(-.2E01*ALOG(A1)) *SIN(PI2*A2)	GGNO	45
	K = K+1	GGNO	50
	Z(K) = SQRT(-0.2E01*ALOG(A1)) *COS(PI2*A2)	GGNO	55
	RETURN	GGNO	60
	END	GGNO	65

APPENDIX (Continued)

MUNCA INDIAN MODEL

INITIAL CONDITIONS

FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND SEXES
1	4	57	58	0/	
2	4	24	35	1/ 0	1, 1
3	7	29	23	0/	
4	8	32	29	0/	
5	6	51	55	3/ 3	7, 1 15,-1 9, 1 5,-1 19, 1 16,-1
6	3	32	34	1/ 3	12,-1 7,-1 6, 1 1,-1
7	20	31	21	0/	
8	7	50	43	1/ 3	19,-1 11,-1 6,-1 17, 1
9	1	31	34	0/	
10	18	23	34	0/ 1	3,-1
11	18	35	22	0/	
12	9	54	50	5/ 1	14, 1 11, 1 8, 1 5, 1 18,-1 20, 1
13	17	21	23	0/	
14	18	72	71	1/ 1	5,-1 15, 1
15	3	36	23	0/	
16	18	35	34	1/ 1	6,-1 6, 1
17	15	54	54	2/ 2	7,-1 8, 1 6, 1 6,-1
18	4	78	69	4/ 5	9,-1 13, 1 4,-1 5,-1 15,-1 20,-1 11, 1 18, 1 17, 1
19	2	59	46	2/ 0	18, 1 0, 1
20	17	44	62	1/ 3	1,-1 15,-1 2,-1 5, 1
21	18	20	36	0/	
22	4	51	47	1/ 3	9,-1 6,-1 9, 1 3,-1
23	2	80	73	2/ 4	2,-1 0,-1 7,-1 1, 1 20, 1 11,-1
24	16	61	63	1/ 2	7,-1 17, 1 1,-1
25	10	61	46	3/ 3	6,-1 9, 1 3,-1 20, 1 11, 1 17,-1
26	15	66	79	3/ 3	12,-1 16, 1 19,-1 9, 1 1,-1 5, 1
27	15	41	59	3/ 4	8, 1 11, 1 2,-1 15,-1 12, 1 19,-1 20,-1
28	11	27	23	0/	
29	17	71	65	2/ 3	12,-1 13, 1 0,-1 15,-1 13, 1
30	3	29	31	1/ 1	10,-1 3, 1
31	9	47	40	0/ 2	12,-1 13,-1
32	11	38	29	0/	
33	18	31	39	0/ 1	1,-1
34	12	41	42	5/ 5	18,-1 6,-1 16, 1 14,-1 12, 1 4,-1 14, 1 17, 1 14, 1 3,-1
35	5	41	41	1/ 4	14,-1 2, 1 16,-1 0,-1 8,-1
36	12	45	59	3/ 4	7,-1 1, 1 2, 1 3, 1 6,-1 4,-1 13,-1
37	12	39	25	0/	
38	2	29	27	0/	
39	4	59	48	2/ 4	3,-1 20,-1 10, 1 15, 1 18,-1 16,-1
40	2	44	63	4/ 7	16,-1 17,-1 18,-1 20,-1 3,-1 13, 1 9, 1 5, 1 10,-1 0,-1 14, 1
41	15	62	43	2/ 4	10, 1 6,-1 11,-1 7, 1 4,-1 3,-1
42	7	38	28	0/	
43	16	23	22	0/	
44	10	51	55	1/ 3	7, 1 13,-1 7,-1 20,-1
45	13	25	31	1/ 0	1, 1
46	9	30	31	3/ 0	11, 1 9, 1 10, 1
47	10	35	21	0/	
48	1	69	70	4/ 5	12,-1 7,-1 11, 1 16, 1 0,-1 8, 1 8, 1 14,-1 7,-1
49	16	48	60	0/	
50	13	42	58	3/ 3	4,-1 16, 1 19, 1 0,-1 12, 1 12,-1
51	19	43	42	4/ 2	10,-1 13, 1 9, 1 16, 1 9,-1 18, 1
52	7	31	26	0/	
53	20	69	76	4/ 3	8, 1 15, 1 4, 1 17,-1 11,-1 20,-1 6, 1
54	7	31	38	0/ 2	16,-1 1,-1
55	4	24	33	3/ 1	9, 1 8, 1 3, 1 0,-1
56	18	56	42	1/ 0	11, 1

APPENDIX (Continued)

57	10	72	78	4/ 5	16, -1 3, -1	8, 1	15, -1	18, 1	15, -1	9, -1	4, 1	7, -1
58	18	44	58	1/ 3	18, -1	16, 1	4, -1	14, -1				
59	20	62	49	3/ 0	12, 1	19, 1	1, 1					
60	20	34	39	0/ 3	13, -1	3, -1	17, -1					
61	3	38	21	0/								
62	15	41	54	2/ 1	17, -1	16, 1	11, 1					
63	17	26	33	1/ 1	6, -1	11, 1						
64	2	32	25	0/								
65	7	72	71	1/ 1	9, 1	14, -1						
66	9	59	47	0/ 2	12, -1	15, -1						
67	8	36	38	1/ 3	7, -1	18, 1	9, -1	12, -1				
68	4	67	78	7/ 1	18, -1	1, 1	2, 1	7, 1	4, 1	2, 1	14, 1	14, 1
69	15	48	47	2/ 3	15, -1	5, -1	5, 1	10, -1	10, 1			
70	7	24	36	1/ 0	11, 1							
71	14	42	63	2/ 1	5, -1	19, 1	8, 1					
72	13	41	55	0/ 2	10, -1	3, -1						
73	13	52	54	3/ 2	20, 1	0, -1	20, 1	6, -1	14, 1			
74	9	33	35	0/ 2	2, -1	1, -1						
75	4	59	44	0/ 3	0, -1	16, -1	9, -1					
76	6	62	55	1/ 3	19, -1	18, -1	8, -1	5, 1				
77	3	61	60	3/ 4	2, 1	3, -1	2, -1	5, 1	16, 1	10, -1	18, -1	
78	3	63	42	0/ 2	4, -1	5, -1						
79	13	35	32	1/ 1	4, 1	7, -1						
80	8	51	48	1/ 2	17, -1	15, 1	19, -1					
81	9	35	39	1/ 2	2, -1	7, -1	9, 1					
82	18	40	42	2/ 4	6, 1	19, -1	19, -1	9, 1	10, -1	17, -1		
83	13	28	37	0/								
84	17	26	38	2/ 0	3, 1	8, 1						
85	16	23	36	3/ 0	6, 1	15, 1	14, 1					
86	8	49	40	2/ 2	13, -1	4, 1	18, -1	6, 1				
87	10	56	53	1/ 4	15, 1	13, -1	12, -1	10, -1	6, -1			
88	11	55	43	0/ 2	9, -1	12, -1						
89	2	55	60	3/ 5	9, -1	5, 1	6, 1	13, -1	16, -1	6, -1	0, 1	9, -1
90	9	34	34	0/ 2	1, -1	11, -1						
91	19	56	53	3/ 2	10, 1	18, 1	19, 1	5, -1	15, -1			
92	8	57	45	0/ 1	13, -1							
93	15	44	57	3/ 5	4, 1	17, 1	19, -1	17, -1	6, 1	11, -1	6, -1	19, -1
94	15	42	47	1/ 6	12, -1	1, -1	18, -1	1, -1	14, 1	11, -1	12, -1	
95	9	51	42	0/ 1	9, -1							
96	11	70	67	3/ 7	8, -1	5, -1	14, -1	1, 1	12, -1	2, -1	17, -1	15, -1
97	10	28	31	0/ 2	6, -1	6, -1						
98	15	59	44	1/ 0	7, 1							
99	15	30	21	0/								
100	15	43	43	2/ 1	10, -1	1, 1	14, 1					
TOTAL FAMILIES = 100					TOTAL CHILDREN =			327 SEX RATIO (F/M) = 0.7				

FAMILY	LLANAS	SHEEP	ALPACAS
1	65	110	107
2	67	109	113
3	72	111	111
4	70	112	106
5	67	108	109
6	66	104	114
7	73	117	105
8	68	104	99
9	60	109	105
10	69	112	102
11	70	110	108
12	72	106	105
13	66	110	108
14	66	112	108
15	73	112	107
16	66	105	110
17	61	106	104
18	66	110	108
19	68	108	112

APPENDIX (Continued)

20	69	112	109
21	75	106	114
22	69	108	112
23	68	110	111
24	71	105	111
25	62	113	104
26	71	108	115
27	71	110	101
28	69	108	110
29	73	108	109
30	69	111	101
31	68	105	114
32	72	107	110
33	68	107	109
34	73	107	109
35	67	110	113
36	72	105	110
37	67	114	114
38	71	112	112
39	65	111	101
40	70	110	111
41	66	113	104
42	64	113	109
43	66	111	110
44	74	111	107
45	62	111	106
46	68	108	107
47	66	111	110
48	60	108	107
49	70	108	109
50	64	120	114
51	68	109	111
52	71	109	113
53	69	115	108
54	69	105	113
55	61	106	108
56	69	108	106
57	68	106	111
58	72	109	111
59	64	113	109
60	65	114	106
61	69	113	114
62	69	110	107
63	65	107	110
64	67	106	103
65	66	101	111
66	65	111	107
67	73	109	111
68	66	107	109
69	71	107	105
70	69	118	113
71	67	113	112
72	67	114	109
73	71	116	113
74	74	101	107
75	66	108	108
76	74	110	103
77	67	110	105
78	69	108	110
79	74	106	108
80	67	106	105
81	67	106	107
82	66	110	104
83	64	105	109
84	72	106	108
85	69	117	110

APPENDIX (Continued)

86	65	101	102
87	64	109	109
88	67	100	104
89	62	110	112
90	68	115	110
91	69	109	99
92	68	109	110
93	67	101	116
94	74	113	108
95	67	103	105
96	70	107	110
97	72	112	101
98	72	107	109
99	69	109	111
100	65	112	109

TOTAL SHEPP EQUIVALENTS = 49241

TOTAL SHEPP = 10912 TOTAL LLAMA = 6814 TOTAL ALPACA = 10843

YEAR 1

FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND SEXES
1	4	58	59	0/	
2	4	25	36	1/ 0	2, 1
3	7	30	24	0/	
4	8	33	30	0/	
5	6	52	56	3/ 3	8, 1 16,-1 9, 1 6,-1 20, 1 17,-1
6	3	33	35	1/ 3	17,-1 8,-1 7, 1 2,-1
7	20	32	22	0/	
8	7	51	44	1/ 3	20,-1 12,-1 7,-1 18, 1
9	1	32	35	0/	
10	18	24	35	0/ 1	4,-1
11	18	36	23	0/	
12	0	55	51	5/ 1	15, 1 12, 1 9, 1 6, 1 19,-1 21, 1
13	17	22	24	0/	
14	18	73	72	1/ 1	6,-1 16, 1
15	3	37	24	0/	
16	18	36	35	1/ 1	7,-1 7, 1
17	15	55	55	2/ 2	8,-1 9, 1 7, 1 7,-1
18	4	79	70	4/ 5	10,-1 14, 1 5,-1 6,-1 16,-1 21,-1 12, 1 19, 1 18, 1
19	2	60	47	2/ 0	19, 1 1, 1
20	17	45	63	1/ 3	2,-1 16,-1 3,-1 6, 1
21	18	30	37	0/	
22	4	52	48	1/ 3	10,-1 7,-1 10, 1 4,-1
23	2	81	74	2/ 4	3,-1 1,-1 8,-1 2, 1 21, 1 12,-1
24	16	62	64	1/ 2	8,-1 18, 1 2,-1
25	10	62	47	3/ 3	7,-1 10, 1 4,-1 21, 1 12, 1 18,-1
26	15	67	80	3/ 3	13,-1 17, 1 20,-1 10, 1 2,-1 6, 1
27	15	42	60	3/ 4	9, 1 12, 1 2,-1 16,-1 13, 1 20,-1 21,-1
28	11	28	24	0/	
29	17	72	66	2/ 3	13,-1 14, 1 1,-1 16,-1 14, 1
30	3	30	32	1/ 1	11,-1 4, 1
31	9	48	41	0/ 2	13,-1 14,-1
32	11	39	30	0/	
33	18	32	40	0/ 1	2,-1
34	12	42	43	5/ 5	19,-1 7,-1 17, 1 15,-1 13, 1 5,-1 15, 1 18, 1 15, 1 4,-1
35	5	42	42	1/ 4	15,-1 3, 1 17,-1 1,-1 9,-1
36	12	46	60	3/ 4	8,-1 2, 1 3, 1 4, 1 7,-1 5,-1 14,-1
37	12	40	26	0/	
38	2	30	28	0/	
39	4	60	49	2/ 4	4,-1 21,-1 11, 1 16, 1 19,-1 17,-1
40	2	45	64	4/ 7	17,-1 18,-1 19,-1 21,-1 4,-1 14, 1 10, 1 6, 1 11,-1 1,-1 15, 1
41	15	63	44	2/ 4	20, 1 7,-1 12,-1 8, 1 5,-1 4,-1
42	7	39	29	0/	
43	16	24	23	0/	
44	10	52	56	1/ 3	8, 1 14,-1 8,-1 21,-1

APPENDIX (Continued)

45	13	26	32	1/ 0	2, 1
46	9	31	32	3/ 0	12, 1 10, 1 11, 1
47	10	36	22	0/ 0	
48	1	70	71	4/ 5	13,-1 8,-1 12, 1 17, 1 1,-1 9, 1 9, 1 15,-1 8,-1
49	16	49	61	0/ 0	
50	13	43	59	3/ 3	5,-1 17, 1 20, 1 1,-1 13, 1 13,-1
51	19	44	43	4/ 2	11,-1 14, 1 10, 1 17, 1 10,-1 19, 1
52	7	32	27	0/ 0	
53	20	70	77	4/ 3	9, 1 16, 1 5, 1 19,-1 12,-1 21,-1 7, 1
54	7	32	39	0/ 2	17,-1 2,-1
55	4	25	34	3/ 1	10, 1 9, 1 4, 1 1,-1
56	18	57	43	1/ 0	12, 1
57	10	73	79	4/ 5	17, 1 4,-1 9, 1 16,-1 19, 1 16,-1 10,-1 5, 1 8,-1
58	18	45	59	1/ 3	19,-1 17, 1 5,-1 15,-1
59	20	63	50	3/ 0	13, 1 20, 1 2, 1
60	20	35	40	0/ 3	14,-1 4,-1 18,-1
61	3	39	22	0/ 0	
62	15	42	55	2/ 1	18,-1 17, 1 12, 1
63	17	27	34	1/ 1	7,-1 12, 1
64	2	33	26	0/ 0	
65	7	73	72	1/ 1	10, 1 15,-1
66	9	60	48	0/ 2	13,-1 16,-1
67	8	37	39	1/ 3	8,-1 19, 1 9,-1 13,-1
68	4	68	79	7/ 1	19,-1 2, 1 3, 1 8, 1 5, 1 3, 1 15, 1 15, 1
69	15	49	49	2/ 3	16,-1 6,-1 6, 1 11,-1 11, 1
70	7	25	37	1/ 0	12, 1
71	14	43	64	2/ 1	6,-1 20, 1 9, 1
72	13	42	56	0/ 2	11,-1 4,-1
73	13	53	55	3/ 2	21, 1 1,-1 21, 1 7,-1 15, 1
74	8	34	36	0/ 2	4,-1 2,-1
75	4	60	45	0/ 3	1,-1 17,-1 10,-1
76	6	63	56	1/ 3	20,-1 19,-1 9,-1 6, 1
77	3	62	61	3/ 4	3, 1 4,-1 3,-1 6, 1 17, 1 11,-1 19,-1
78	3	64	43	0/ 2	5,-1 6,-1
79	13	36	33	1/ 1	5, 1 8,-1
80	8	52	49	1/ 2	18,-1 16, 1 20,-1
81	9	36	40	1/ 2	3,-1 8,-1 10, 1
82	18	50	43	2/ 4	7, 1 20,-1 20,-1 10, 1 11,-1 18,-1
83	13	29	38	0/ 0	
84	17	27	39	2/ 0	4, 1 9, 1
85	16	24	37	3/ 0	7, 1 16, 1 15, 1
86	8	50	41	2/ 2	14,-1 5, 1 19,-1 7, 1
87	10	57	54	1/ 4	16, 1 14,-1 13,-1 11,-1 7,-1
88	11	56	44	0/ 2	10,-1 13,-1
89	2	56	61	3/ 5	10,-1 6, 1 7, 1 14,-1 17,-1 7,-1 1, 1 10,-1
90	9	35	35	0/ 2	2,-1 12,-1
91	19	57	54	3/ 2	11, 1 19, 1 20, 1 6,-1 16,-1
92	8	58	46	0/ 1	14,-1
93	15	45	58	3/ 5	5, 1 18, 1 20,-1 18,-1 7, 1 12,-1 7,-1 20,-1
94	15	44	48	1/ 6	13,-1 2,-1 19,-1 2,-1 15, 1 12,-1 13,-1
95	9	52	43	0/ 1	10,-1
96	11	80	68	3/ 7	9,-1 6,-1 15,-1 2, 1 13,-1 3,-1 18,-1 16,-1 17, 1 8, 1
97	10	29	32	0/ 2	7,-1 7,-1
98	15	60	45	1/ 0	8, 1
99	15	31	22	0/ 0	
100	15	44	44	2/ 1	11,-1 2, 1 15, 1

TOTAL POPULATION = 527
 TOTAL FAMILIES = 100 TOTAL CHILDREN = 327 SEX RATIO (F/M) = 0.7

FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND BLOOD TYPES
1	4	00	00		
2	4	A0	B0	1/ 0	2,AB
3	7	00	00		
4	8	00	A0		
5	6	00	B0	3/ 3	8,B0 16,00 9,00 6,00 20,00 17,00
6	3	00	00	1/ 3	13,00 8,00 7,00 2,00

[illegible]

73	13	10	00	3/ 2	21,00	1,10	21,00	7,00	15,00	
74	8	00	00	0/ 2	4,00	2,00				
75	4	00	10	0/ 3	17,00	10,00				
76	6	00	00	1/ 3	20,00	19,00	9,00	6,00		
77	3	10	00	3/ 4	3,10	4,00	3,10	6,00	17,00	11,00 19,00
78	3	00	00	0/ 2	5,00	6,00				
79	13	10	00	1/ 1	5,10	8,00				
80	8	00	00	1/ 2	18,00	16,00	20,00			
81	9	00	00	1/ 2	3,00	8,00	10,00			
82	18	00	00	2/ 4	7,00	20,00	20,00	10,00	11,00	18,00
83	13	00	00							
84	17	10	00	2/ 0	4,00	9,00				
85	16	00	00	3/ 0	7,00	16,00	15,00			
86	8	00	00	2/ 2	14,00	5,00	19,00	7,00		
87	10	00	00	1/ 4	16,00	14,00	13,00	11,00	7,00	
88	11	10	00	0/ 2	10,00	13,10				
89	2	00	00	3/ 5	10,00	6,00	7,00	14,00	17,00	7,00 1,00 10,00
90	9	00	00	0/ 2	2,00	12,00				
91	19	00	00	3/ 2	11,00	19,00	20,00	6,00	16,00	
92	8	00	00	0/ 1	14,00					
93	15	00	00	7/ 5	5,00	18,00	20,00	18,00	7,00	12,00 7,00 20,00
94	15	00	00	1/ 6	13,00	2,00	19,00	2,00	15,00	12,00 13,00
95	9	00	00	0/ 1	10,00					
96	11	00	00	3/ 7	9,00	6,00	15,00	2,00	13,00	3,00 18,00 16,00 17,00 8,00
97	10	00	00	0/ 2	7,00	7,00				
98	15	10	00	1/ 0	8,00					
99	15	00	00							
100	15	00	00	2/ 1	11,00	2,00	15,00			

BLOOD TYPE PERCENTAGES: OO = 85.01%, AO = 12.52%, BO = 2.09%, AA = 0.19%, BB = 0.0 %, AB = 0.19%

FAMILY	ENERGY		ENERGY GAINS		ENERGY	NET
	DEMAND	PLANT	ANIMAL	MARKET		
1	1192731.	317009.	487716.	3984511.	0.	
2	1664237.	217688.	605658.	4265904.	0.	
3	1440714.	363242.	568525.	4237365.	0.	
4	1464738.	325393.	672823.	4033408.	0.	
5	4574644.	436815.	679416.	4090561.	0.	
6	3198461.	339490.	567575.	4290445.	0.	
7	1429354.	418318.	383478.	4114952.	0.	
8	3625770.	213813.	703838.	3731581.	0.	
9	1489003.	225870.	632648.	3964190.	0.	
10	1743984.	251579.	592473.	3976292.	0.	
11	1406634.	284427.	676357.	4066055.	0.	
12	4825668.	427968.	799451.	3988545.	0.	
13	1356635.	407943.	447049.	4106884.	0.	
14	2144364.	350167.	796883.	3996764.	0.	
15	1400954.	316184.	716533.	4049694.	0.	
16	2292605.	344576.	704805.	4090561.	0.	
17	3040636.	302266.	336665.	3964115.	0.	
18	6319411.	712375.	877235.	4832196.	0.	
19	2296935.	330996.	768911.	4208863.	0.	
20	2937242.	253255.	491249.	4090523.	0.	
21	1450397.	354374.	809578.	4233218.	0.	
22	3083451.	377702.	650969.	4298551.	0.	
23	3693022.	451851.	416525.	4237365.	0.	
24	2691182.	304750.	748513.	4127206.	0.	
25	4517326.	289477.	775029.	3813238.	0.	
26	4192529.	564072.	627512.	4298514.	0.	
27	5160311.	433984.	481598.	4379720.	0.	
28	1356635.	389219.	720066.	4082379.	0.	
29	3774842.	379273.	580253.	4225112.	0.	
30	2326799.	368902.	570618.	3919215.	0.	
31	2427238.	353513.	694678.	4257798.	0.	
32	1430658.	376537.	623013.	4212860.	0.	
33	1756434.	381955.	606004.	4131353.	0.	

APPENDIX (Continued)

34	7252137.	568740.	843161.	6025439.	0.
35	3649841.	543619.	522264.	4184359.	0.
36	4041245.	460875.	589905.	4208788.	0.
37	1383914.	368471.	719101.	4314913.	0.
38	1440714.	405497.	636182.	4314876.	0.
39	4743897.	382232.	588939.	3853992.	0.
40	7211044.	761920.	759276.	5856391.	0.
41	4149552.	484892.	744014.	3927396.	0.
42	1399594.	373513.	787723.	4009015.	0.
43	1356639.	344144.	509079.	4147677.	0.
44	3326265.	393333.	740955.	4049694.	0.
45	1682169.	424402.	499919.	4009015.	0.
46	3148827.	411032.	698211.	3968150.	0.
47	1406634.	303600.	534467.	4196610.	0.
48	5676818.	626523.	695169.	4706956.	0.
49	1234885.	288030.	540094.	4139457.	0.
50	4619628.	600879.	544119.	4225187.	0.
51	5044586.	381857.	763301.	4061985.	0.
52	1429358.	402311.	650969.	4706694.	0.
53	4829232.	259957.	491249.	4159853.	0.
54	2375668.	157222.	490758.	4249580.	0.
55	3076571.	388659.	642300.	4045774.	0.
56	1860385.	60534.	605167.	4078309.	0.
57	5936204.	792955.	654977.	4770291.	0.
58	3622351.	310303.	734854.	4147600.	0.
59	2862571.	144149.	567084.	4188505.	0.
60	2968896.	324918.	710431.	4004906.	0.
61	1399594.	324887.	586371.	4343414.	0.
62	3264418.	96934.	809087.	4053802.	0.
63	2395494.	393320.	499918.	4159891.	0.
64	1423674.	256889.	496876.	3947754.	0.
65	2136621.	334485.	641809.	4168072.	0.
66	2365551.	234233.	647910.	4049807.	0.
67	3646470.	315450.	509079.	4302584.	0.
68	4833694.	496268.	562440.	4070127.	0.
69	3769456.	556409.	518240.	4090486.	0.
70	1956564.	400877.	437715.	4269975.	0.
71	2907803.	294694.	605658.	4163963.	0.
72	2166949.	291297.	490759.	4131353.	0.
73	4144812.	429237.	640206.	4196535.	0.
74	2131706.	416269.	731795.	4090485.	0.
75	2653065.	423938.	806044.	4000834.	0.
76	3317985.	362419.	574152.	3951787.	0.
77	4507240.	633095.	750606.	3886604.	0.
78	2024560.	416735.	768436.	4119099.	0.
79	2261136.	354694.	521773.	4119023.	0.
80	3226394.	332644.	556322.	4017120.	0.
81	2727933.	322353.	722634.	3951862.	0.
82	4641701.	581458.	550204.	3943720.	0.
83	1361135.	418516.	481598.	4180324.	0.
84	2211353.	418872.	642300.	4082304.	0.
85	3196418.	297875.	431313.	4278156.	0.
86	3353760.	281320.	695660.	3686719.	0.
87	3953479.	389354.	796884.	4009015.	0.
88	2292641.	330295.	460234.	4029336.	0.
89	4875607.	746876.	530443.	4286413.	0.
90	2281925.	364669.	654503.	4192538.	0.
91	4326312.	595346.	614327.	3788696.	0.
92	1808980.	392145.	654503.	4192538.	0.
93	5667191.	675084.	742412.	4418740.	0.
94	4913352.	364896.	672823.	4204678.	0.
95	1780801.	332657.	552788.	4017120.	0.
96	6097553.	666009.	754140.	4861827.	0.
97	2239695.	229474.	651460.	3792730.	0.
98	1715655.	354902.	580270.	4147602.	0.
99	1435034.	338549.	543628.	4184358.	0.

APPENDIX (Continued)

100	2813410.	321117.	416525.	4261870.	0.
FAMILY	LLAMAS	SHEEP	ALPACAS		
1	70	122	122		
2	74	121	129		
3	76	126	128		
4	76	125	120		
5	73	116	123		
6	72	112	132		
7	80	133	122		
8	73	112	113		
9	65	121	121		
10	73	124	120		
11	75	120	124		
12	77	115	121		
13	71	121	124		
14	71	119	120		
15	79	124	120		
16	71	118	123		
17	70	120	121		
18	72	118	113		
19	72	118	130		
20	77	124	125		
21	82	117	129		
22	74	117	130		
23	75	120	129		
24	78	117	127		
25	68	125	116		
26	79	122	130		
27	78	122	112		
28	75	118	123		
29	78	121	128		
30	75	123	118		
31	75	116	129		
32	79	115	129		
33	73	118	125		
34	79	116	106		
35	75	124	127		
36	79	118	123		
37	71	126	131		
38	76	125	131		
39	68	120	116		
40	75	119	112		
41	72	123	119		
42	69	125	121		
43	73	121	128		
44	79	122	122		
45	69	123	120		
46	75	118	120		
47	73	126	128		
48	65	118	113		
49	78	120	124		
50	72	134	128		
51	73	123	126		
52	77	119	132		
53	75	127	123		
54	76	116	131		
55	67	117	124		
56	75	117	123		
57	72	119	121		
58	78	120	126		
59	68	121	127		
60	70	124	120		
61	75	122	131		
62	74	121	124		
63	72	115	127		

APPENDIX (Continued)

64	75	116	120
65	71	112	125
66	69	121	126
67	80	118	127
68	71	116	124
69	79	117	120
70	77	130	130
71	72	126	128
72	74	129	126
73	78	132	127
74	79	112	122
75	70	116	122
76	80	124	119
77	73	119	117
78	73	116	127
79	82	118	126
80	74	119	121
81	72	115	118
82	69	125	121
83	69	119	125
84	80	116	122
85	77	127	129
86	73	113	111
87	68	122	122
88	76	110	120
89	68	122	133
90	74	126	127
91	76	119	114
92	74	120	126
93	73	113	129
94	81	123	124
95	72	114	120
96	76	117	118
97	78	122	114
98	79	117	125
99	75	121	128
100	73	122	127

TOTAL SHEEP EQUIVALENTS = 60625

TOTAL SHEEP = 12022 TOTAL LLAMA = 7416 TOTAL ALPACA = 12340

YEAR 2

ALL CROPS HAVE BEEN DESTROYED BY HAIL.

FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND SEXES
1	4	59	60	0/	
2	4	26	37	0/	
3	7	31	25	1/ 0	1, 1
4	8	34	31	0/	
5	6	53	57	2/ 3	9, 1 17,-1 10, 1 7,-1 18,-1
6	3	34	36	1/ 3	14,-1 9,-1 8, 1 3,-1
7	20	33	23	0/ 1	1,-1
8	7	52	45	1/ 2	1, 1 13,-1 8,-1
9	1	33	36	0/	
10	18	25	36	0/ 1	5,-1
11	18	37	24	0/	
12	9	56	52	4/ 1	16, 1 13, 1 10, 1 7, 1 20,-1
13	17	23	25	0/	
14	18	74	73	2/ 2	11, 1 16,-1 7,-1 17, 1
15	3	38	25	0/	
16	19	37	36	1/ 1	8,-1 8, 1
17	15	56	56	2/ 2	9,-1 10, 1 8, 1 8,-1
18	4	80	71	2/ 4	11,-1 15, 1 6,-1 7,-1 17,-1 13, 1
19	2	61	48	1/ 0	2, 1
20	17	46	64	1/ 3	3,-1 17,-1 4,-1 7, 1
21	18	31	38	0/	

APPENDIX (Continued)

22	4	53	49	1/ 3	11,-1	8,-1	11, 1	5,-1	
23	2	82	75	1/ 4	4,-1	2,-1	9,-1	3, 1	13,-1
24	16	63	65	0/ 2	9,-1	3,-1			
25	10	63	48	2/ 3	8,-1	11, 1	5,-1	13, 1	19,-1
26	15	68	67	3/ 5	14,-1	15, 1	2,-1	17,-1	15, 1 14,-1 11, 1 3,-1
27	15	43	61	3/ 3	10, 1	13, 1	4,-1	17,-1	14, 1 21,-1
28	11	29	25	0/					
29	3	31	33	1/ 1	12,-1	5, 1			
30	9	49	42	0/ 2	14,-1	15,-1			
31	11	40	31	0/					
32	18	33	41	0/ 1	3,-1				
33	12	43	44	4/ 4	20,-1	8,-1	18, 1	16,-1	14, 1 6,-1 16, 1 16, 1
34	5	43	43	1/ 4	16,-1	4, 1	18,-1	2,-1	10,-1
35	12	47	61	3/ 4	9,-1	3, 1	4, 1	5, 1	8,-1 6,-1 15,-1
36	12	41	27	0/					
37	2	31	29	0/					
38	4	61	50	2/ 3	5,-1	12, 1	17, 1	20,-1	18,-1
39	2	46	65	4/ 6	18,-1	19,-1	20,-1	5,-1	15, 1 11, 1 7, 1 12,-1 2,-1 16, 1
40	15	64	45	2/ 4	1, 1	9,-1	13,-1	9, 1	6,-1 5,-1
41	7	40	30	1/ 0	1, 1				
42	16	25	24	1/ 0	1, 1				
43	10	53	57	1/ 2	9, 1	15,-1	9,-1		
44	13	27	33	1/ 0	3, 1				
45	9	32	33	3/ 0	13, 1	11, 1	12, 1		
46	10	37	23	0/					
47	1	71	72	4/ 5	14,-1	9,-1	13, 1	18, 1	2,-1 10, 1 10, 1 16,-1 9,-1
48	16	50	62	0/					
49	13	44	60	3/ 3	6,-1	18, 1	21, 1	2,-1	14, 1 14,-1
50	19	45	44	4/ 2	12,-1	15, 1	11, 1	18, 1	11,-1 20, 1
51	7	33	28	0/					
52	20	71	78	4/ 2	10, 1	17, 1	6, 1	19,-1	13,-1 8, 1
53	7	33	0	0/ 2	18,-1	3,-1			
54	4	26	35	3/ 1	11, 1	10, 1	5, 1	2,-1	
55	18	58	44	1/ 0	13, 1				
56	10	74	0	4/ 5	18, 1	5,-1	10, 1	17,-1	20, 1 17,-1 11,-1 6, 1 9,-1
57	18	46	60	1/ 3	20,-1	18, 1	6,-1	16,-1	
58	20	64	51	3/ 0	14, 1	21, 1	3, 1		
59	20	36	0	0/ 4	1,-1	15,-1	5,-1	19,-1	
60	3	40	23	0/					
61	15	43	56	2/ 1	19,-1	18, 1	13, 1		
62	17	28	35	1/ 1	8,-1	13, 1			
63	2	34	27	0/ 1	1,-1				
64	9	61	49	0/ 2	14,-1	17,-1			
65	8	38	40	1/ 3	9,-1	20, 1	10,-1	14,-1	
66	4	69	69	10/ 8	10,-1	7,-1	16,-1	3, 1	14,-1 4,-1 19,-1 17,-1 18, 1 9, 1 20,-1 3, 1 4, 1 9, 1
67	15	50	49	1/ 3	17,-1	7,-1	12,-1	12, 1	
68	7	26	38	1/ 0	13, 1				
69	14	44	65	2/ 1	7,-1	21, 1	10, 1		
70	13	43	57	0/ 2	12,-1	5,-1			
71	13	54	56	3/ 1	22, 1	22, 1	8,-1	16, 1	
72	8	35	37	0/ 2	5,-1	3,-1			
73	4	61	46	0/ 3	2,-1	18,-1	11,-1		
74	6	64	57	1/ 2	20,-1	10,-1	7, 1		
75	3	63	62	3/ 4	4, 1	5,-1	4,-1	7, 1	18, 1 12,-1 20,-1
76	3	65	44	0/ 2	6,-1	7,-1			
77	13	37	34	1/ 1	6, 1	9,-1			
78	8	53	50	2/ 1	1, 1	19,-1	17, 1		
79	9	37	41	2/ 2	1, 1	4,-1	9,-1	11, 1	
80	18	51	44	2/ 3	8, 1	21,-1	11, 1	12,-1	19,-1
81	13	30	39	0/					
82	17	28	40	2/ 1	1,-1	5, 1	10, 1		
83	16	25	38	3/ 0	8, 1	17, 1	16, 1		
84	8	51	42	2/ 2	15,-1	6, 1	20,-1	8, 1	
85	10	58	55	1/ 4	17, 1	15,-1	14,-1	12,-1	8,-1
86	11	57	45	0/ 2	11,-1	14,-1			

APPENDIX (Continued)

87	2	57	62	3/ 5	11,-1	7, 1	8, 1	15,-1	18,-1	8,-1	2, 1	11,-1
88	9	36	36	0/ 3	1,-1	3,-1	13,-1					
89	19	58	55	3/ 2	12, 1	20, 1	21, 1	7,-1	17,-1			
90	8	59	47	0/ 1	15,-1							
91	15	46	59	3/ 4	6, 1	19, 1	19,-1	8, 1	13,-1	8,-1	21,-1	
92	15	45	49	1/ 6	14,-1	3,-1	20,-1	3,-1	16, 1	13,-1	14,-1	
93	9	53	44	0/ 1	11,-1							
94	10	30	33	0/ 2	8,-1	8,-1						
95	15	61	46	1/ 0	9, 1							
96	15	32	23	0/								
97	15	45	45	2/ 1	12,-1	3, 1	16, 1					
98	6	21	21	0/								
99	4	22	19	0/								
100	15	21	22	0/								
101	15	22	20	0/								
102	4	22	19	0/								
103	2	22	20	0/								
104	2	22	22	0/								
105	20	22	21	0/								
106	6	21	19	0/								
107	8	21	22	0/								
108	18	21	19	0/								
109	15	21	18	0/								

TOTAL POPULATION = 525

TOTAL FAMILIES = 109 TOTAL CHILDREN = 310 SEX RATIO (F/M) = 0.7

FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND BLOOD TYPES
1	4	00	00		
2	4	A0	B0		
3	7	00	00	1/ 0	1,00
4	8	00	A0		
5	6	00	B0	2/ 3	9,B0 17,00 10,00 7,00 18,00
6	3	00	00	1/ 3	14,00 9,00 8,00 3,00
7	20	A0	00	0/ 1	1,00
8	7	00	A0	1/ 2	1,A0 13,00 8,A0
9	1	00	00		
10	18	00	B0	0/ 1	5,B0
11	18	00	B0		
12	9	00	B0	4/ 1	16,00 13,B0 10,B0 7,00 20,B0
13	17	00	00		
14	18	00	A0	2/ 2	11,A0 16,00 7,00 17,00
15	3	00	00		
16	18	00	00	1/ 1	8,00 8,00
17	15	00	00	2/ 2	9,00 10,00 8,00 8,00
18	4	00	00	2/ 4	11,00 15,00 6,00 7,00 17,00 13,00
19	2	00	00	1/ 0	2,00
20	17	00	00	1/ 3	3,00 17,00 4,00 7,00
21	18	00	00		
22	4	A0	A0	1/ 3	11,A0 8,00 11,A0 5,00
23	2	00	00	1/ 4	4,00 2,00 9,00 3,00 13,00
24	16	00	00	0/ 2	9,00 3,00
25	10	00	00	2/ 3	8,00 11,00 5,00 13,00 19,00
26	15	00	A0	3/ 5	14,A0 15,A0 2,00 17,A0 15,A0 14,00 11,00 3,00
27	15	A0	00	3/ 3	10,A0 13,00 4,A0 17,A0 14,00 21,A0
28	11	A0	00		
29	3	00	00	1/ 1	12,00 5,00
30	9	00	00	0/ 2	14,00 15,00
31	11	00	00		
32	18	00	00	0/ 1	3,00
33	12	00	00	4/ 4	20,00 8,00 18,00 16,00 14,00 6,00 16,00 16,00
34	5	00	00	1/ 4	16,00 4,00 18,00 2,00 10,00
35	12	00	00	3/ 4	9,00 3,00 4,00 5,00 8,00 6,00 15,00
36	12	00	00		
37	2	00	00		
38	4	A0	00	2/ 3	5,00 12,A0 17,A0 20,A0 18,00
39	2	00	00	4/ 6	18,00 19,00 20,00 5,00 15,00 11,00 7,00 12,00 2,00 16,00

[illegible]

APPENDIX (Continued)

105	20	00	00
106	6	00	00
107	8	00	00
108	18	00	00
109	15	00	00

BLOOD TYPE PERCENTAGES: OO = 85.14%, AO = 12.57%, BO = 2.10%, AA = 0.19%, BB = 0.0 %, AB = 0.0 %

FAMILY	ENERGY DEMAND	PLANT	ENERGY GAINS ANIMAL	MARKET	ENERGY NET
1	1182568.	0.	259357.	1074411.	0.
2	1366318.	0.	277678.	1272299.	0.
3	1698789.	0.	259357.	1522740.	0.
4	1454575.	0.	259357.	1421855.	0.
5	3936094.	0.	370232.	3631640.	0.
6	3274760.	0.	432262.	2912249.	0.
7	1735593.	0.	305634.	1530883.	0.
8	2536779.	0.	432262.	2209747.	0.
9	1437840.	0.	259357.	1421855.	0.
10	1758428.	0.	277678.	1535219.	0.
11	1400954.	0.	228342.	1329150.	0.
12	4149199.	0.	432262.	3779749.	0.
13	1356635.	0.	228342.	1316936.	0.
14	3349361.	0.	351911.	3066140.	0.
15	1395274.	0.	321387.	1267963.	0.
16	2331050.	0.	370232.	2104790.	0.
17	3127689.	0.	320896.	2916886.	0.
18	4276031.	0.	277678.	4295462.	0.
19	1518440.	0.	432262.	1304947.	0.
20	3013541.	0.	259357.	2904633.	0.
21	1440234.	0.	250197.	1308755.	0.
22	3159750.	0.	351911.	2896490.	0.
23	3053881.	0.	432262.	2666219.	0.
24	1950541.	0.	413941.	1724699.	0.
25	3878776.	0.	277678.	3639783.	0.
26	5359293.	0.	351911.	5102241.	0.
27	4664940.	0.	247154.	4549635.	0.
28	1356635.	0.	259357.	1308755.	0.
29	2365244.	0.	339708.	2185242.	0.
30	2454929.	0.	259357.	2339133.	0.
31	1420495.	0.	432262.	1272299.	0.
32	1765198.	0.	259357.	1704605.	0.
33	6239947.	0.	432262.	5148273.	-504314.
34	3745067.	0.	432262.	3437824.	0.
35	4195833.	0.	367664.	3966604.	0.
36	1378234.	0.	339708.	1280442.	0.
37	1435034.	0.	259357.	1308755.	0.
38	4178345.	0.	259357.	2770911.	-390554.
39	6761635.	0.	450583.	6365379.	0.
40	3764003.	0.	277678.	3790593.	0.
41	1688733.	0.	351911.	1426190.	0.
42	1620390.	0.	277678.	1534955.	0.
43	2771532.	0.	259357.	2628255.	0.
44	1707367.	0.	413941.	1385399.	0.
45	3227707.	0.	213080.	3255620.	0.
46	1400954.	0.	370232.	1313090.	0.
47	5890177.	0.	259357.	2849441.	-2742695.
48	1224722.	0.	259357.	1321233.	0.
49	4725608.	0.	321387.	2625163.	-1471382.
50	5107837.	0.	259357.	5053533.	0.
51	1423674.	0.	308693.	1300838.	0.
52	4373705.	0.	259357.	2616040.	-1188561.
53	1795020.	0.	351911.	1652390.	0.
54	3180058.	0.	432262.	2855699.	0.
55	1879903.	0.	321387.	1732842.	0.
56	5613434.	0.	321387.	5393889.	0.

APPENDIX (Continued)

57	3639223.	0.	268518.	3413583.	0.
58	2911770.	0.	413941.	2553119.	0.
59	2723577.	0.	259357.	2565333.	0.
60	1383914.	0.	277678.	1321233.	0.
61	3332244.	0.	259357.	2779055.	0.
62	2439619.	0.	277187.	2279077.	0.
63	1729913.	0.	351911.	1539290.	0.
64	2393242.	0.	259357.	2326655.	0.
65	3639605.	0.	432262.	3510133.	0.
66	10291206.	0.	412992.	8390322.	-1525923.
67	3433595.	0.	351911.	3179240.	0.
68	1981762.	0.	351911.	1765490.	0.
69	2946248.	0.	295999.	2828253.	0.
70	2194640.	0.	413941.	1901964.	0.
71	3871338.	0.	413941.	3534299.	0.
72	2159397.	0.	432262.	1837799.	0.
73	2699683.	0.	321387.	2448162.	0.
74	2703825.	0.	413941.	2290199.	0.
75	4602401.	0.	370232.	4234840.	0.
76	2052251.	0.	259357.	1886733.	0.
77	2299581.	0.	413941.	2063999.	0.
78	2916489.	0.	413941.	2629499.	0.
79	3049060.	0.	277678.	2904633.	0.
80	4116649.	0.	432262.	3635484.	0.
81	1441431.	0.	277678.	1357953.	0.
82	2578151.	0.	413941.	2290199.	0.
83	3280978.	0.	259357.	2779055.	0.
84	3381386.	0.	277678.	3130833.	0.
85	4048705.	0.	450583.	3761139.	0.
86	2320332.	0.	321387.	2072142.	0.
87	5049122.	0.	494292.	4714118.	0.
88	2621535.	0.	370232.	2330990.	0.
89	4330201.	0.	259357.	4299533.	0.
90	1817744.	0.	321387.	1619742.	0.
91	5190747.	0.	586846.	4641470.	0.
92	4987005.	0.	432262.	4572104.	0.
93	1789565.	0.	370232.	1462910.	0.
94	2357145.	0.	259357.	2226033.	0.
95	1735173.	0.	259357.	1724699.	0.
96	1429354.	0.	320896.	1333486.	0.
97	2881536.	0.	351911.	2670290.	0.
98	1356635.	0.	413941.	1366172.	0.
99	1397136.	0.	413941.	1272299.	0.
100	1356635.	0.	339708.	1565981.	0.
101	1356635.	0.	351911.	1313090.	0.
102	1397136.	0.	321387.	1290442.	0.
103	1356635.	0.	277678.	1643493.	0.
104	1356635.	0.	450583.	1488546.	0.
105	1356635.	0.	259357.	1357953.	0.
106	1397136.	0.	351911.	1761796.	0.
107	1356635.	0.	413941.	1476256.	0.
108	1397136.	0.	293431.	1284514.	0.
109	1378209.	0.	321387.	1484399.	0.
FAMILY	LLAMAS	SHEEP	ALPACAS		
1	21	23	22		
2	34	33	36		
3	21	23	18		
4	23	23	19		
5	35	21	23		
6	35	31	23		
7	23	23	17		
8	33	36	29		
9	23	23	19		
10	34	35	35		
11	23	23	21		

APPENDIX (Continued)

12	33	22	23
13	21	23	20
14	35	32	23
15	23	23	19
16	35	35	30
17	35	35	24
18	31	22	23
19	32	36	37
20	35	36	23
21	23	24	20
22	35	36	23
23	33	36	25
24	34	36	32
25	35	21	23
26	42	37	27
27	29	22	23
28	22	23	20
29	35	34	28
30	36	36	28
31	35	35	36
32	23	20	18
33	20	22	23
34	41	47	35
35	42	48	29
36	36	34	37
37	22	23	20
38	15	17	18
39	46	44	29
40	34	22	23
41	35	36	36
42	23	22	17
43	18	17	18
44	35	35	35
45	34	25	23
46	35	35	37
47	14	17	18
48	36	35	37
49	17	17	18
50	27	21	22
51	36	35	37
52	16	17	18
53	35	36	34
54	34	33	23
55	36	35	32
56	19	21	22
57	35	26	23
58	33	37	27
59	35	36	26
60	36	35	37
61	17	17	18
62	35	35	31
63	35	36	35
64	20	17	18
65	41	47	33
66	22	24	28
67	35	31	23
68	35	36	33
69	35	36	25
70	33	34	29
71	35	22	23
72	35	35	31
73	35	37	27
74	34	35	27
75	30	22	23
76	35	36	32
77	35	35	29

APPENDIX (Continued)

78	35	36	24
79	36	35	23
80	39	50	32
81	35	36	38
82	34	36	27
83	16	17	18
84	35	31	22
85	45	59	50
86	35	36	29
87	49	71	59
88	34	35	27
89	32	21	23
90	35	36	33
91	45	58	42
92	22	21	22
93	34	36	37
94	35	35	29
95	34	34	32
96	35	36	38
97	35	35	24
98	28	40	40
99	34	35	36
100	35	45	46
101	35	36	37
102	35	36	36
103	35	44	49
104	27	42	45
105	36	37	39
106	33	53	53
107	35	45	43
108	36	35	36
109	36	42	43

TOTAL SHEEP EQUIVALENTS = 19423

TOTAL SHEEP = 3525 TOTAL LLAMA = 3464 TOTAL ALPACA = 3138

YEAR 3

FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND SEXES
1	4	60	61	0/	
2	4	27	38	0/ 1	1,-1
3	7	32	26	1/ 1	1,-1 2, 1
4	8	35	32	0/	
5	6	54	58	2/ 3	10, 1 18,-1 11, 1 8,-1 19,-1
6	3	35	37	1/ 3	15,-1 10,-1 9, 1 4,-1
7	20	34	24	0/	
8	7	53	46	0/ 3	1,-1 14,-1 9,-1
9	1	34	37	0/	
10	18	26	37	0/ 1	6,-1
11	18	38	25	0/	
12	9	57	53	4/ 0	17, 1 14, 1 11, 1 8, 1
13	17	24	26	0/	
14	18	75	74	1/ 2	12, 1 17,-1 8,-1
15	3	39	26	0/	
16	18	38	37	1/ 1	9,-1 9, 1
17	15	57	57	2/ 2	10,-1 11, 1 9, 1 9,-1
18	4	62	72	3/ 6	6,-1 13, 1 19,-1 12,-1 16, 1 7,-1 8,-1 18,-1 14, 1
19	2	62	49	1/ 0	3, 1
20	17	47	65	1/ 3	4,-1 18,-1 5,-1 8, 1
21	18	32	39	0/ 1	1,-1
22	4	54	50	1/ 3	12,-1 9,-1 12, 1 6,-1
23	2	83	76	1/ 4	5,-1 3,-1 10,-1 4, 1 14,-1
24	16	64	66	0/ 2	10,-1 4,-1
25	10	64	49	2/ 3	9,-1 12, 1 6,-1 14, 1 20,-1
26	17	75	68	5/10	6,-1 11, 1 18,-1 18,-1 12,-1 7, 1 10,-1 15,-1 16, 1 3,-1 18,-1 16, 1 15,-1 12, 1
4,-1					

APPENDIX (Continued)

27	15	44	62	3/ 2	11, 1 14, 1 5,-1 18,-1 15, 1
28	11	30	26	0/	
29	3	32	34	1/ 1	13,-1 6, 1
30	9	50	43	0/ 2	15,-1 16,-1
31	11	41	32	0/	
32	18	34	42	0/ 1	4,-1
33	9	44	45	4/ 4	1, 1 12,-1 9,-1 17,-1 15, 1 7,-1 17, 1 17, 1
34	5	44	44	1/ 4	17,-1 5, 1 19,-1 3,-1 11,-1
35	12	48	62	3/ 4	10,-1 4, 1 5, 1 6, 1 9,-1 7,-1 16,-1
36	12	42	28	0/	
37	2	32	30	1/ 0	1, 1
38	2	47	66	4/ 5	19,-1 20,-1 6,-1 16, 1 12, 1 8, 1 13,-1 3,-1 17, 1
39	15	65	46	2/ 4	2, 1 9,-1 14,-1 10, 1 7,-1 6,-1
40	7	41	31	0/	
41	16	26	25	1/ 0	2, 1
42	10	54	58	1/ 2	10, 1 16,-1 10,-1
43	13	28	34	2/ 0	1, 1 4, 1
44	9	33	34	3/ 1	1,-1 14, 1 12, 1 13, 1
45	10	38	24	0/	
46	1	17	0	3/ 4	15,-1 10,-1 14, 1 3,-1 11, 1 11, 1 10,-1
47	16	51	63	0/	
48	13	45	61	1/ 3	7,-1 3,-1 15, 1 15,-1
49	19	46	45	2/ 2	13,-1 16, 1 12, 1 12,-1
50	7	34	29	0/	
51	20	20	0	2/ 1	7, 1 14,-1 9, 1
52	7	34	0	0/ 2	19,-1 4,-1
53	4	27	36	3/ 2	1,-1 12, 1 11, 1 6, 1 3,-1
54	18	59	45	1/ 0	14, 1
55	18	47	61	0/ 2	7,-1 17,-1
56	20	65	52	2/ 0	15, 1 4, 1
57	20	37	0	0/ 4	2,-1 16,-1 6,-1 20,-1
58	3	41	24	0/	
59	15	44	57	2/ 1	20,-1 19, 1 14, 1
60	17	29	36	1/ 2	1,-1 9,-1 14, 1
61	2	35	28	0/ 1	2,-1
62	9	62	50	1/ 2	1, 1 15,-1 18,-1
63	8	39	41	2/ 3	1, 1 10,-1 21, 1 11,-1 15,-1
64	4	70	70	9/ 7	11,-1 8,-1 17,-1 4, 1 15,-1 5,-1 20,-1 18,-1 19, 1 10, 1 4, 1 10, 1 7, 1 5, 1
65	15	51	50	2/ 3	1, 1 18,-1 8,-1 13,-1 13, 1
66	7	27	39	2/ 0	1, 1 14, 1
67	14	45	66	2/ 1	8,-1 22, 1 11, 1
68	13	44	58	0/ 2	13,-1 6,-1
69	13	55	57	3/ 1	23, 1 23, 1 9,-1 17, 1
70	8	36	38	0/ 2	6,-1 4,-1
71	4	62	47	0/ 3	3,-1 19,-1 12,-1
72	6	65	58	1/ 1	11,-1 8, 1
73	3	64	63	3/ 3	5, 1 6,-1 5,-1 8, 1 19, 1 13,-1
74	3	66	45	0/ 2	7,-1 8,-1
75	13	38	35	1/ 1	7, 1 10,-1
76	8	54	51	2/ 1	2, 1 20,-1 18, 1
77	9	38	42	2/ 2	2, 1 5,-1 10,-1 12, 1
78	18	52	45	2/ 2	9, 1 12, 1 13,-1 20,-1
79	13	31	40	0/	
80	17	29	41	2/ 1	2,-1 6, 1 11, 1
81	16	26	39	3/ 0	9, 1 18, 1 17, 1
82	8	52	43	2/ 2	1,-1 16,-1 7, 1 9, 1
83	10	59	56	1/ 4	18, 1 16,-1 15,-1 13,-1 9,-1
84	11	58	46	0/ 2	12,-1 15,-1
85	2	58	63	3/ 5	12,-1 8, 1 9, 1 16,-1 19,-1 9,-1 3, 1 12,-1
86	9	37	37	0/ 3	2,-1 4,-1 14,-1
87	19	59	56	3/ 2	13, 1 21, 1 22, 1 8,-1 18,-1
88	8	60	48	0/ 1	16,-1
89	15	47	60	3/ 3	7, 1 20, 1 20,-1 9, 1 14,-1 9,-1
90	15	46	50	1/ 5	15,-1 4,-1 4,-1 17, 1 14,-1 15,-1
91	10	31	34	0/ 2	9,-1 9,-1

APPENDIX (Continued)

92	15	62	47	1/ 0	10, 1
93	15	33	24	0/ 1	1,-1
94	15	46	46	2/ 1	13,-1 4, 1 17, 1
95	6	22	22	0/	
96	4	23	20	0/	
97	15	22	23	0/	
98	15	23	21	0/	
99	4	23	20	0/	
100	2	23	21	0/ 1	1,-1
101	2	23	23	1/ 0	1, 1
102	20	23	22	0/	
103	6	22	20	0/	
104	8	22	23	0/	
105	18	22	20	0/	
106	15	22	19	0/ 1	1,-1
107	9	21	19	0/	
108	4	21	18	0/	
109	10	22	21	0/	
110	12	21	18	0/	
111	10	21	19	0/	
112	18	21	19	0/	
113	12	21	19	0/	
114	6	21	22	0/	
115	3	21	18	0/	
116	18	22	19	0/	
117	8	21	21	0/	
118	15	22	19	0/	
119	20	21	22	0/	

TOTAL POPULATION = 530
TOTAL FAMILIES = 119 TOTAL CHILDREN = 296 SEX RATIO (F/M) = 0.7

FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND BLOOD TYPES
1	4	00	00		
2	4	A0	B0	0/ 1	1,A0
3	7	00	00	1/ 1	1,00 2,00
4	8	00	A0		
5	6	00	B0	2/ 3	10,B0 18,00 11,00 8,00 19,00
6	3	00	00	1/ 3	15,00 10,00 9,00 4,00
7	20	A0	00		
8	7	00	A0	0/ 3	1,A0 14,00 9,A0
9	1	00	00		
10	18	00	B0	0/ 1	6,B0
11	18	00	B0		
12	9	00	B0	4/ 0	17,00 14,B0 11,B0 8,00
13	17	00	00		
14	18	00	A0	1/ 2	12,A0 17,00 8,00
15	3	00	00		
16	18	00	00	1/ 1	9,00 9,00
17	15	00	00	2/ 2	10,00 11,00 9,00 9,00
18	4	A0	00	3/ 6	6,00 13,A0 19,00 12,00 16,00 7,00 8,00 18,00 14,00
19	2	00	00	1/ 0	3,00
20	17	00	00	1/ 3	4,00 18,00 5,00 9,00
21	18	00	00	0/ 1	1,00
22	4	A0	A0	1/ 3	12,AA 9,00 12,A0 6,00
23	2	00	00	1/ 4	5,00 3,00 10,00 4,00 14,00
24	16	00	00	0/ 2	10,00 4,00
25	10	00	00	2/ 3	9,00 12,00 6,00 14,00 20,00
26	17	00	A0	5/10	6,00 11,00 18,00 18,00 12,00 7,00 10,00 15,A0 16,A0 3,00 18,A0 16,A0 15,00 12,00
27	15	A0	00	3/ 2	11,A0 14,00 5,A0 18,A0 15,00
28	11	A0	00		
29	3	00	00	1/ 1	13,00 6,00
30	9	00	00	0/ 2	15,00 16,00
31	11	00	00		
32	18	00	00	0/ 1	4,00
33	9	00	00	4/ 4	1,00 12,00 9,00 17,00 15,00 7,00 17,00 17,00

APPENDIX (Continued)

[illegible]

APPENDIX (Continued)

99	4	00	00		
100	2	00	00	0/ 1	1.00
101	2	00	00	1/ 0	1.00
102	20	00	00		
103	6	00	00		
104	8	00	00		
105	18	00	00		
106	15	00	00	0/ 1	1.00
107	9	00	00		
108	4	00	00		
109	10	00	00		
110	12	00	00		
111	10	00	00		
112	18	00	00		
113	12	00	00		
114	6	00	00		
115	3	00	00		
116	18	00	00		
117	8	00	00		
118	15	00	00		
119	20	00	00		

BLOOD TYPE PERCENTAGES: OO = 85.09%, AO = 12.64%, BO = 2.09%, AA = 0.19%, BB = 0.0 %, AB = 0.0 %

FAMILY	ENERGY DEMAND	PLANT	ANIMAL	MARKET	ENERGY NET
1	1172405.	398190.	370232.	754414.	0.
2	1673754.	384065.	259357.	1280216.	0.
3	2034709.	331289.	259357.	1586302.	0.
4	1444412.	382699.	250197.	972396.	0.
5	4042074.	570004.	351911.	3242086.	0.
6	3351059.	442886.	259357.	2910929.	0.
7	1417994.	347811.	321387.	1032452.	0.
8	2612634.	249471.	339708.	2325750.	0.
9	1427677.	420143.	259357.	972396.	0.
10	1772872.	281965.	339708.	1291601.	0.
11	1395274.	289024.	259357.	1110000.	0.
12	3645655.	334310.	351911.	3232887.	0.
13	1356635.	481327.	351911.	782953.	0.
14	2678245.	458680.	259357.	2116628.	0.
15	1389594.	304388.	351911.	964253.	0.
16	2369495.	353979.	370232.	1849976.	0.
17	3214742.	364940.	432262.	2638886.	0.
18	6161161.	824805.	413941.	5168179.	0.
19	1537958.	292072.	277678.	1251941.	0.
20	3089840.	382574.	370232.	2473308.	0.
21	1741990.	352240.	351911.	1230716.	0.
22	3236049.	371737.	259357.	2816679.	0.
23	3159270.	625117.	259357.	2490197.	0.
24	1939416.	276175.	339708.	1547396.	0.
25	3925329.	657565.	444465.	2936414.	0.
26	9221665.	951279.	462786.	8024406.	0.
27	4169569.	758700.	259357.	3363329.	0.
28	1440714.	477388.	259357.	838938.	0.
29	2403689.	315463.	370232.	1885565.	0.
30	2482620.	451144.	462786.	1768393.	0.
31	7410332.	100687.	321387.	1130396.	0.
32	1773962.	447351.	259357.	1263288.	0.
33	5779042.	420340.	339708.	5397620.	0.
34	3840293.	569913.	357538.	2962729.	0.
35	4350421.	640493.	432262.	3400087.	0.
36	1372554.	357296.	259357.	965384.	0.
37	1734173.	385895.	351911.	1170094.	0.
38	6254483.	673997.	462786.	5330930.	0.
39	3888910.	749938.	259357.	3095358.	0.
40	1414815.	359724.	277678.	1439498.	0.

APPENDIX (Continued)

41	1650071.	240178.	277678.	1299443.	0.
42	2828904.	425744.	259357.	2146222.	0.
43	1996320.	407461.	323955.	1435427.	0.
44	3618506.	379735.	259357.	3174829.	0.
45	1395274.	410016.	339708.	1398707.	0.
46	4400583.	706217.	259357.	1161461.	-2427702.
47	1214559.	277412.	432262.	1390564.	0.
48	3289045.	352699.	259357.	2413817.	0.
49	3682028.	434114.	351911.	2282207.	-762543.
50	1417994.	475870.	339708.	1398707.	0.
51	2245544.	438021.	259357.	1361610.	-108276.
52	1827194.	425491.	321387.	1357915.	0.
53	3595464.	557962.	432262.	2895623.	0.
54	1899421.	436610.	351911.	1366059.	0.
55	2286477.	505800.	351911.	1555162.	0.
56	2216439.	235136.	277678.	1802398.	0.
57	2734178.	346279.	413941.	2102490.	0.
58	1379234.	104797.	494292.	1349772.	0.
59	3340943.	287065.	259357.	1987279.	0.
60	2795663.	485313.	259357.	2246052.	0.
61	1743160.	241703.	370232.	1390564.	0.
62	2684688.	482757.	259357.	2162509.	0.
63	3949978.	704927.	277678.	3176978.	0.
64	9665494.	920946.	450583.	8462856.	0.
65	3773649.	621006.	351911.	2997036.	0.
66	2270715.	361209.	432262.	1656424.	0.
67	2945877.	150711.	351911.	2494269.	0.
68	2222331.	422511.	277678.	1707244.	0.
69	3909783.	359759.	259357.	3551829.	0.
70	2187088.	377746.	432262.	1510676.	0.
71	2746301.	477461.	432262.	1913010.	0.
72	2130165.	239563.	277678.	1887487.	0.
73	4125457.	575670.	351911.	3431114.	0.
74	2031688.	434727.	432262.	1321196.	0.
75	2338026.	449349.	228342.	1950823.	0.
76	2925188.	477637.	277678.	2178871.	0.
77	3136113.	246337.	339708.	2670931.	0.
78	3532170.	373672.	370232.	2915189.	0.
79	1431268.	377155.	413941.	1423212.	0.
80	2651957.	409094.	259357.	2070973.	0.
81	3365538.	386272.	259357.	1983208.	-74650.
82	3149326.	166869.	370232.	2715756.	0.
83	4143931.	610516.	432262.	3318692.	0.
84	2348023.	281324.	431771.	1825509.	0.
85	5222637.	700325.	530934.	4157441.	0.
86	2668153.	490029.	385985.	1933406.	0.
87	4387573.	664614.	351911.	3519257.	0.
88	1826508.	416515.	370232.	1353844.	0.
89	4571712.	498317.	444465.	3682158.	0.
90	4489053.	636165.	259357.	2529368.	-452877.
91	2384836.	466298.	432262.	1659365.	0.
92	1754691.	486586.	432262.	1321196.	0.
93	1735593.	411224.	277678.	1300875.	0.
94	2949662.	452537.	277678.	2425466.	0.
95	1356635.	355001.	330548.	1280555.	0.
96	1356635.	505800.	213080.	852284.	0.
97	1356635.	256095.	413941.	1382459.	0.
98	1356635.	373175.	259357.	944988.	0.
99	1356635.	343342.	259357.	1013225.	0.
100	1668554.	471486.	259357.	1187549.	0.
101	1620390.	418843.	259357.	1111169.	0.
102	1356635.	419447.	259357.	840069.	0.
103	1356635.	496085.	259357.	856431.	0.
104	1356635.	474237.	213080.	860465.	0.
105	1356635.	155950.	259357.	1167116.	0.
106	1709055.	411629.	259357.	1276144.	0.

APPENDIX (Continued)

107	1397136.	465136.	259357.	869437.	0.
108	1378209.	278297.	413941.	1260084.	0.
109	1356635.	440459.	172905.	252816.	0.
110	1378209.	199304.	259357.	1131489.	0.
111	1397136.	389115.	172905.	24430.	-796571.
112	1397136.	467900.	321387.	1084704.	0.
113	1397136.	289020.	213080.	97869.	-829848.
114	1356635.	484031.	259357.	1035845.	0.
115	1378209.	480653.	172905.	301751.	0.
116	1397136.	421669.	213080.	954338.	0.
117	1356635.	386624.	370232.	1109209.	0.
118	1397136.	10471.	413941.	1247869.	0.
119	1356635.	324147.	370232.	937938.	0.

FAMILY	LLAMAS	SHEEP	ALPACAS
1	20	21	21
2	21	19	19
3	23	18	15
4	24	25	17
5	32	15	17
6	40	18	17
7	25	25	15
8	37	41	22
9	25	24	17
10	32	32	32
11	22	22	18
12	23	15	17
13	21	25	21
14	35	19	16
15	23	25	18
16	40	39	30
17	38	24	17
18	40	21	24
19	31	32	35
20	40	28	17
21	21	22	16
22	40	24	17
23	38	34	18
24	38	38	34
25	33	15	17
26	58	27	24
27	18	15	17
28	20	24	19
29	39	39	26
30	40	40	26
31	22	22	19
32	25	21	15
33	44	24	27
34	47	52	28
35	49	35	21
36	21	21	23
37	20	26	16
38	38	23	21
39	32	16	17
40	38	37	40
41	26	21	14
42	14	14	15
43	37	36	40
44	34	16	17
45	37	37	39
46	14	14	16
47	37	35	39
48	13	15	17
49	17	14	16
50	38	35	39
51	13	14	15

APPENDIX (Continued)

52	37	39	38
53	37	20	17
54	40	38	38
55	27	15	15
56	32	34	14
57	39	41	19
58	37	36	38
59	14	14	15
60	19	15	15
61	36	38	39
62	16	14	15
63	36	22	19
64	33	26	30
65	37	19	18
66	38	37	34
67	39	33	18
68	35	35	26
69	31	16	17
70	39	39	33
71	40	42	22
72	33	33	17
73	21	15	17
74	39	40	37
75	39	41	28
76	40	36	18
77	41	21	17
78	37	34	19
79	35	37	41
80	38	41	22
81	13	14	15
82	30	18	16
83	49	67	45
84	38	42	29
85	56	79	49
86	40	39	23
87	27	15	17
88	38	39	38
89	43	55	25
90	16	16	18
91	41	39	28
92	39	37	36
93	31	31	37
94	40	34	17
95	26	37	39
96	22	20	24
97	31	39	41
98	22	22	22
99	21	22	19
100	18	22	22
101	17	24	24
102	21	22	24
103	17	25	25
104	19	22	25
105	21	22	20
106	20	23	19
107	12	12	13
108	31	32	36
109	7	7	7
110	22	22	23
111	4	3	0
112	28	27	30
113	2	2	2
114	23	27	31
115	9	8	8
116	19	14	9
117	27	29	31

APPENDIX (Continued)

118 29 33 36
 119 23 24 27
 TOTAL SHEEP EQUIVALENTS = 18696
 TOTAL SHEEP = 3230 TOTAL LLAMA = 3530 TOTAL ALPACA = 2763

YEAR 4					
FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND SEXES
1	4	61	62	0/	
2	4	28	39	0/	
3	7	33	0	1/ 1	1,-1 3, 1
4	8	36	33	0/	
5	6	55	59	2/ 3	11, 1 19,-1 12, 1 9,-1 20,-1
6	3	36	18	1/ 3	16,-1 11,-1 10, 1 5,-1
7	20	35	25	0/	
8	7	54	47	0/ 2	15,-1 10,-1
9	1	35	38	0/	
10	18	27	38	0/ 1	7,-1
11	18	39	26	0/	
12	9	58	54	3/ 0	15, 1 12, 1 9, 1
13	17	25	27	0/	
14	17	76	69	6/11	7,-1 12, 1 19,-1 19,-1 13,-1 8, 1 11,-1 16,-1 17, 1 4,-1 19,-1 17, 1 16,-1 13, 1
15	3	40	27	0/	
16	18	39	38	1/ 1	10,-1 10, 1
17	15	58	58	2/ 2	11,-1 12, 1 10, 1 10,-1
18	4	63	73	3/ 6	7,-1 14, 1 20,-1 13,-1 17, 1 8,-1 9,-1 19,-1 15, 1
19	2	63	50	1/ 0	4, 1
20	17	48	66	1/ 3	5,-1 19,-1 6,-1 9, 1
21	19	33	40	0/ 1	2,-1
22	4	55	51	1/ 3	13,-1 10,-1 13, 1 7,-1
23	2	84	0	1/ 4	6,-1 4,-1 11,-1 5, 1 15,-1
24	16	65	67	0/ 2	11,-1 5,-1
25	10	65	50	2/ 2	10,-1 13, 1 7,-1 15, 1
26	15	45	63	3/ 2	12, 1 15, 1 6,-1 19,-1 16, 1
27	11	31	27	0/	
28	3	33	35	1/ 1	14,-1 7, 1
29	9	51	44	0/ 2	16,-1 17,-1
30	11	42	33	0/	
31	18	35	43	0/ 2	1,-1 5,-1
32	9	45	46	2/ 4	2, 1 13,-1 10,-1 18,-1 16, 1 8,-1
33	5	45	45	1/ 4	18,-1 6, 1 20,-1 4,-1 12,-1
34	12	49	63	3/ 4	11,-1 5, 1 6, 1 7, 1 10,-1 8,-1 17,-1
35	12	43	29	0/	
36	2	33	31	1/ 0	2, 1
37	2	48	67	3/ 4	20,-1 7,-1 17, 1 13, 1 9, 1 14,-1 4,-1
38	15	66	47	2/ 4	3, 1 10,-1 15,-1 11, 1 8,-1 7,-1
39	7	42	32	0/ 1	1,-1
40	16	27	26	1/ 0	3, 1
41	10	55	59	1/ 2	11, 1 17,-1 11,-1
42	13	29	35	2/ 0	2, 1 5, 1
43	9	34	35	3/ 1	2,-1 15, 1 13, 1 14, 1
44	10	39	25	0/	
45	1	18	18	3/ 3	16,-1 11,-1 15, 1 4,-1 12, 1 12, 1
46	16	52	64	0/	
47	13	46	62	1/ 3	8,-1 4,-1 16, 1 16,-1
48	19	47	46	2/ 2	14,-1 17, 1 13, 1 13,-1
49	7	35	30	0/	
50	20	21	18	2/ 1	8, 1 15,-1 10, 1
51	7	35	0	0/ 2	20,-1 5,-1
52	4	28	0	3/ 1	13, 1 12, 1 7, 1 4,-1
53	18	60	46	1/ 0	15, 1
54	18	48	62	0/ 2	8,-1 18,-1
55	20	66	53	2/ 0	16, 1 5, 1
56	20	38	0	0/ 3	3,-1 17,-1 7,-1

APPENDIX (Continued)

57	3	42	25	0/	
58	15	45	58	1/ 0	15, 1
59	17	30	37	1/ 2	2, -1 10, -1 15, 1
60	2	36	29	0/ 1	3, -1
61	9	63	51	1/ 2	2, 1 16, -1 19, -1
62	8	40	42	0/ 3	11, -1 12, -1 16, -1
63	4	71	71	7/ 6	12, -1 9, -1 18, -1
64	15	52	51	2/ 3	2, 1 19, -1 9, -1 14, -1 14, 1
65	7	28	40	2/ 1	1, -1 2, 1 15, 1
66	14	46	67	2/ 1	9, -1 23, 1 12, 1
67	13	45	59	0/ 2	14, -1 7, -1
68	13	56	58	2/ 1	24, 1 10, -1 18, 1
69	8	37	39	0/ 2	7, -1 5, -1
70	4	63	48	0/ 3	4, -1 20, -1 13, -1
71	6	66	59	1/ 1	12, -1 9, 1
72	3	65	64	3/ 3	6, 1 7, -1 6, -1 9, 1 20, 1 14, -1
73	3	67	46	0/ 2	8, -1 9, -1
74	13	39	36	2/ 1	1, 1 8, 1 11, -1
75	8	55	52	2/ 0	3, 1 19, 1
76	9	39	43	2/ 2	3, 1 6, -1 11, -1 13, 1
77	18	53	46	2/ 1	10, 1 13, 1 14, -1
78	13	32	41	0/	
79	17	30	42	2/ 1	3, -1 7, 1 12, 1
80	16	27	40	3/ 0	10, 1 19, 1 18, 1
81	8	53	44	2/ 2	2, -1 17, -1 8, 1 10, 1
82	10	60	57	1/ 4	19, 1 17, -1 16, -1 14, -1 10, -1
83	11	59	47	0/ 2	13, -1 16, -1
84	2	59	64	3/ 5	13, -1 9, 1 10, 1 17, -1 20, -1 10, -1 4, 1 13, -1
85	9	38	38	0/ 3	3, -1 5, -1 15, -1
86	19	60	57	3/ 2	14, 1 22, 1 23, 1 9, -1 19, -1
87	8	61	49	0/ 1	17, -1
88	15	48	61	3/ 2	8, 1 21, 1 10, 1 15, -1 10, -1
89	15	47	51	1/ 5	16, -1 5, -1 5, -1 18, 1 15, -1 16, -1
90	10	32	35	0/ 2	10, -1 10, -1
91	15	63	48	1/ 1	1, -1 11, 1
92	15	34	25	0/ 1	2, -1
93	15	47	47	1/ 1	14, -1 5, 1
94	6	23	23	0/	
95	4	24	21	0/	
96	15	23	24	0/	
97	15	24	22	3/	
98	4	24	21	3/	
99	2	24	22	2/ 1	2, -1
100	2	24	24	1/ 0	2, 1
101	20	24	23	0/	
102	6	23	21	1/ 0	1, 1
103	8	23	24	0/	
104	18	23	21	0/	
105	15	23	20	0/ 1	2, -1
106	9	22	20	0/	
107	4	22	19	0/	
108	10	23	22	0/	
109	12	22	19	0/	
110	10	22	20	0/	
111	18	22	20	0/	
112	12	22	20	2/	
113	6	22	23	0/ 1	1, -1
114	3	22	19	0/	
115	18	23	20	0/	
116	8	22	22	0/	
117	15	23	20	0/	
118	20	22	23	0/ 1	1, -1
119	2	21	18	0/	
120	2	21	18	0/	
121	20	21	20	0/	
122	12	21	18	0/	

APPENDIX (Continued)

123	11	21	20	0/
124	8	21	22	0/
125	18	21	24	0/
126	15	21	18	0/

TOTAL POPULATION = 527
TOTAL FAMILIES = 126 TOTAL CHILDREN = 280 SEX RATIO (F/M) = 0.7

FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND BLOOD TYPES															
1	4	00	00																	
2	4	AO	BO																	
3	7	00		1/ 1	1,00	3,00														
4	8	00	AO																	
5	6	00	BO	2/ 3	11,BO	19,00	12,00	9,00	20,00											
6	3	00	00	1/ 3	16,00	11,00	10,00	5,00												
7	20	AO	00																	
8	7	00	AO	0/ 2	15,00	10,AO														
9	1	00	00																	
10	18	00	BO	0/ 1	7,BO															
11	18	00	BO																	
12	9	00	BO	3/ 0	15,BO	12,BO	9,00													
13	17	00	00																	
14	17	00	AO	6/11	7,00	12,00	19,00	19,00	13,00	8,00	11,00	16,AO	17,AO	4,00	19,AO	17,AO	16,00	13,00		
13,AO	18,00	9,00																		
15	3	00	00																	
16	18	00	00	1/ 1	10,00	10,00														
17	15	00	00	2/ 2	11,00	12,00	10,00	10,00												
18	4	AO	00	3/ 6	7,00	14,AO	20,00	13,00	17,00	8,00	9,00	19,00	15,00							
19	2	00	00	1/ 0	4,00															
20	17	00	00	1/ 3	5,00	19,00	6,00	9,00												
21	18	00	00	0/ 1	2,00															
22	4	AO	AO	1/ 3	13,AA	10,00	13,AO	7,00												
23	2	00		1/ 4	6,00	4,00	11,00	5,00	15,00											
24	16	00	00	0/ 2	11,00	5,00														
25	10	00	00	2/ 2	10,00	13,00	7,00	15,00												
26	15	AO	00	3/ 2	12,AO	15,00	6,AO	19,AO	16,00											
27	11	AO	00																	
28	3	00	00	1/ 1	14,00	7,00														
29	9	00	00	0/ 2	16,00	17,00														
30	11	00	00																	
31	18	00	00	0/ 2	1,00	5,00														
32	9	00	00	2/ 4	2,00	13,00	10,00	13,00	16,00	8,00										
33	5	00	00	1/ 4																

APPENDIX (Continued)

[illegible]

APPENDIX (Continued)

124 8 00 00
 125 18 00 00
 126 15 00 00

BLOOD TYPE PERCENTAGES: OO = 85.58%, AO = 12.14%, BO = 2.09%, AA = 0.19%, BB = 0.0 %, AB = 0.0 %

FAMILY	ENERGY		ENERGY GAINS		MARKET	ENERGY NET
	DEMAND	PLANT	ANIMAL			
1	1162242.	486790.	277678.	799277.	0.	0.
2	1157352.	505800.	339708.	852246.	0.	0.
3	1446605.	163685.	351911.	1035996.	0.	0.
4	1434249.	392396.	259357.	1020237.	0.	0.
5	4089627.	477556.	351911.	3459502.	0.	0.
6	3427358.	393200.	351911.	2917376.	0.	0.
7	1412314.	291156.	277678.	1039502.	0.	0.
8	2329406.	404232.	259357.	1770203.	0.	0.
9	1417514.	171224.	259357.	1133337.	0.	0.
10	1787316.	406542.	413941.	1145891.	0.	0.
11	1389594.	337433.	241026.	1032490.	0.	0.
12	2985884.	473400.	259357.	2093179.	-54506.	0.
13	1356635.	285695.	259357.	960219.	0.	0.
14	1088953.	662066.	586846.	9777833.	0.	0.
15	1383914.	262846.	259357.	1089039.	0.	0.
16	2407940.	440008.	351911.	1897817.	0.	0.
17	3301795.	391794.	444465.	2580640.	0.	0.
18	6298559.	989964.	401738.	4972214.	0.	0.
19	1557476.	380144.	370232.	1219330.	0.	0.
20	3127323.	172432.	370232.	2766576.	0.	0.
21	1750754.	454424.	351911.	1040105.	0.	0.
22	3312348.	263814.	351911.	2996848.	0.	0.
23	2811694.	528684.	370232.	2096157.	0.	0.
24	1971590.	323393.	277678.	1450620.	0.	0.
25	3400277.	480534.	259357.	2935246.	0.	0.
26	4286303.	668948.	259357.	1759534.	-349083.	0.
27	1435034.	268638.	277678.	996901.	0.	0.
28	2442134.	328181.	259357.	2036591.	0.	0.
29	2510311.	441949.	370232.	1824378.	0.	0.
30	1400169.	231601.	259357.	1101819.	0.	0.
31	2094645.	432829.	351911.	1512297.	0.	0.
32	4426647.	728501.	370232.	3509002.	0.	0.
33	3876092.	758700.	351911.	2782636.	0.	0.
34	4505009.	500914.	342751.	3803891.	0.	0.
35	1366874.	424984.	277678.	921614.	0.	0.
36	1753691.	357822.	321387.	1282063.	0.	0.
37	5003371.	615988.	351911.	4150468.	0.	0.
38	3965563.	573572.	259357.	3377467.	0.	0.
39	1716571.	497212.	432262.	1382420.	0.	0.
40	1679752.	393997.	228342.	1240216.	0.	0.
41	2886276.	416722.	339708.	2347578.	0.	0.
42	2051199.	360643.	259357.	1589318.	0.	0.
43	3716313.	490047.	351911.	3023388.	0.	0.
44	1389594.	321413.	370232.	1419140.	0.	0.
45	4727505.	680555.	259357.	1490054.	-2401734.	0.
46	1204396.	289799.	475971.	1341629.	0.	0.
47	3365344.	331602.	259357.	2999864.	0.	0.
48	3769081.	358583.	259357.	1545021.	-1698452.	0.
49	1453378.	430008.	247154.	1406850.	0.	0.
50	2957512.	459101.	259357.	1008550.	-1112044.	0.
51	1799941.	379713.	339708.	1345701.	0.	0.
52	2765244.	446684.	351911.	2195496.	0.	0.
53	1918939.	118691.	277678.	1620835.	0.	0.
54	2314168.	458664.	259357.	1770090.	0.	0.
55	2217384.	318524.	259357.	1776762.	0.	0.
56	2173174.	487987.	370232.	1412430.	0.	0.
57	1372554.	312109.	370232.	1423212.	0.	0.
58	1950343.	453607.	259357.	1414956.	0.	0.

APPENDIX (Continued)

59	2942794.	439232.	197327.	2425014.	0.
60	1756407.	253815.	339708.	1386492.	0.
61	2742060.	211948.	259357.	1330508.	-934808.
62	2988311.	410841.	351911.	2477756.	0.
63	7839054.	768177.	321387.	4243323.	-1510689.
64	3879629.	567566.	259357.	3132907.	0.
65	2637513.	505800.	358029.	1954933.	0.
66	2988805.	308646.	259357.	2583693.	0.
67	2250022.	308863.	351911.	1682739.	0.
68	3203698.	399522.	213080.	2828781.	0.
69	2214779.	316016.	450583.	1708337.	0.
70	2733492.	398804.	370232.	1952105.	0.
71	2120356.	394666.	277678.	1574464.	0.
72	4178454.	374361.	259357.	2122283.	-560333.
73	2065059.	371881.	370232.	1450657.	0.
74	2640226.	309873.	351911.	2103621.	0.
75	2362282.	505800.	277678.	1711466.	0.
76	3223166.	352762.	351911.	2741091.	0.
77	2988191.	433475.	351911.	2444128.	0.
78	1421105.	420452.	351911.	1431393.	0.
79	2809842.	405277.	259357.	2282056.	0.
80	3450098.	355091.	277678.	2363318.	0.
81	3236379.	505800.	259357.	2604089.	0.
82	4239157.	531240.	462786.	3406193.	0.
83	2375714.	440809.	370232.	1639007.	0.
84	5336725.	921141.	339708.	4145114.	0.
85	2714771.	305395.	370232.	2206844.	0.
86	4444945.	384744.	259357.	2823729.	-1080007.
87	1835272.	388116.	354970.	1362025.	0.
88	4046660.	750571.	259357.	3138147.	0.
89	4603206.	410685.	259357.	1906960.	-2293843.
90	2412527.	381606.	277678.	1948845.	0.
91	2086128.	294227.	277678.	1608583.	0.
92	1749840.	505800.	351911.	1235654.	0.
93	2249456.	433856.	462786.	1433315.	0.
94	1356635.	435825.	413941.	1435540.	0.
95	1356635.	500837.	259357.	795206.	0.
96	1356635.	465555.	321387.	907458.	0.
97	1356635.	376315.	259357.	875658.	0.
98	1356635.	246239.	277678.	952038.	0.
99	1687481.	357033.	259357.	1259858.	0.
100	1650071.	494044.	277678.	1042933.	0.
101	1356635.	409526.	277678.	958334.	0.
102	1620390.	499032.	321387.	932911.	0.
103	1356635.	466869.	321387.	791134.	0.
104	1356635.	439053.	259357.	859334.	0.
105	1687481.	374150.	277678.	1230716.	0.
106	1356635.	425769.	259357.	464879.	-298964.
107	1397136.	372309.	259357.	924630.	0.
108	1356635.	403133.	259357.	733679.	0.
109	1397136.	328250.	259357.	943895.	0.
110	1356635.	461228.	166312.	57002.	0.
111	1356635.	324437.	277678.	1021406.	0.
112	1356635.	311286.	172905.	48935.	-792688.
113	1668554.	329227.	259357.	1316973.	0.
114	1397136.	497990.	339708.	909512.	0.
115	1356635.	417312.	259357.	833207.	0.
116	1356635.	319030.	246663.	1074449.	0.
117	1356635.	470095.	259357.	844178.	0.
118	1669554.	469452.	259357.	1037730.	0.
119	1378209.	29218.	259357.	1249792.	0.
120	1378209.	335922.	237503.	923574.	0.
121	1356635.	492431.	259357.	760824.	0.
122	1378209.	241306.	259357.	362938.	-653151.
123	1356635.	228557.	172905.	40716.	-882703.
124	1356635.	478524.	259357.	909399.	0.

APPENDIX (Continued)

125	1356635.	184522.	351911.	1045873.	0.
126	1378209.	457513.	321387.	1158181.	0.
FAMILY	LLAMAS	SHEEP	ALPACAS		
1	21	22	23		
2	26	25	24		
3	25	17	14		
4	25	27	15		
5	21	13	14		
6	35	16	14		
7	27	17	15		
8	44	47	18		
9	25	23	15		
10	32	32	34		
11	24	24	16		
12	16	13	14		
13	20	25	19		
14	62	29	28		
15	23	24	16		
16	40	40	28		
17	38	20	15		
18	45	27	28		
19	29	31	37		
20	40	20	14		
21	23	21	15		
22	37	20	14		
23	44	25	15		
24	40	40	37		
25	21	14	14		
26	15	13	14		
27	23	26	20		
28	20	18	16		
29	42	43	25		
30	25	25	19		
31	24	16	14		
32	37	17	18		
33	53	57	20		
34	49	24	15		
35	24	24	27		
36	22	19	15		
37	22	18	14		
38	23	14	14		
39	37	35	41		
40	27	17	15		
41	14	17	17		
42	38	37	43		
43	28	14	14		
44	36	37	43		
45	14	13	15		
46	37	37	40		
47	13	18	20		
48	15	13	15		
49	41	34	41		
50	13	14	14		
51	38	39	39		
52	37	17	14		
53	39	36	39		
54	26	14	14		
55	37	31	15		
56	37	30	15		
57	38	36	42		
58	11	24	27		
59	19	20	15		
60	36	38	41		
61	14	13	15		
62	27	18	15		

APPENDIX (Continued)

63	21	21	21
64	33	16	15
65	39	36	31
66	43	21	15
67	40	41	25
68	20	13	14
69	41	39	31
70	44	44	18
71	38	29	15
72	18	16	16
73	37	39	39
74	40	43	24
75	39	21	15
76	40	18	14
77	32	20	15
78	35	37	44
79	18	17	14
80	14	16	18
81	26	16	15
82	52	72	37
83	39	43	29
84	46	42	23
85	44	37	19
86	20	13	14
87	38	39	41
88	37	26	18
89	15	13	15
90	43	40	25
91	41	38	37
92	29	30	38
93	43	33	16
94	29	42	45
95	20	19	23
96	19	24	24
97	21	22	21
98	22	24	19
99	18	24	20
100	19	26	27
101	24	24	28
102	17	24	24
103	19	23	24
104	23	24	21
105	21	23	16
106	13	13	14
107	18	20	22
108	13	9	7
109	21	20	19
110	10	1	0
111	20	19	21
112	1	1	1
113	18	24	22
114	13	21	30
115	21	25	14
116	19	20	24
117	18	21	24
118	20	21	23
119	25	26	27
120	14	14	1
121	15	14	12
122	9	7	10
123	7	4	0
124	23	23	26
125	22	23	22
126	26	30	34

TOTAL SHEEP EQUIVALENTS = 17963
 TOTAL SHEEP = 3112 TOTAL LLAMA = 3497 TOTAL ALPACA = 2692

APPENDIX (Continued)

YEAR 5
ALL CROPS HAVE BEEN DESTROYED BY HAIL.

FAMILY	CLAN	HUSBAND	WIFE	CHILDREN	CHILD AGES AND SEXES
1	4	62	63	0/	
2	4	29	40	0/	
3	7	34	0	1/ 1	2,-1 4, 1
4	8	37	34	0/	
5	6	56	60	2/ 2	12, 1 20,-1 13, 1 10,-1
6	3	37	39	1/ 3	17,-1 12,-1 11, 1 6,-1
7	20	36	26	0/	
8	1	36	39	0/	
9	18	28	39	0/ 2	1,-1 8,-1
10	18	40	27	0/	
11	9	59	55	3/ 0	16, 1 13, 1 10, 1
12	17	26	28	0/	
13	17	77	70	4/11	8,-1 13, 1 20,-1 20,-1 14,-1 9, 1 12,-1 17,-1 5,-1 20,-1 17,-1 14, 1 14, 1 19,-1
10,-1					
14	3	41	28	0/	
15	18	40	39	1/ 1	11,-1 11, 1
16	15	59	59	2/ 2	12,-1 13, 1 11, 1 11,-1
17	4	64	0	2/ 5	8,-1 15, 1 14,-1 9,-1 10,-1 20,-1 16, 1
18	2	64	51	1/ 0	5, 1
19	17	49	67	1/ 3	6,-1 20,-1 7,-1 10, 1
20	18	34	41	0/ 1	3,-1
21	4	56	52	1/ 3	14,-1 11,-1 14, 1 8,-1
22	7	55	48	1/ 6	16,-1 11,-1 7,-1 5,-1 12,-1 6, 1 16,-1
23	16	66	68	0/ 2	12,-1 6,-1
24	10	66	51	2/ 2	11,-1 14, 1 8,-1 16, 1
25	15	46	64	3/ 2	13, 1 16, 1 7,-1 20,-1 17, 1
26	11	32	28	0/	
27	3	34	36	1/ 1	15,-1 8, 1
28	9	52	45	0/ 2	17,-1 19,-1
29	11	43	34	0/	
30	18	36	44	0/ 2	2,-1 6,-1
31	9	46	47	2/ 4	3, 1 14,-1 11,-1 19,-1 17, 1 9,-1
32	5	46	0	1/ 3	19,-1 7, 1 5,-1 13,-1
33	12	50	64	3/ 3	12,-1 6, 1 7, 1 8, 1 11,-1 9,-1
34	12	44	30	0/	
35	2	34	32	1/ 1	1,-1 3, 1
36	2	49	68	2/ 3	8,-1 14, 1 10, 1 15,-1 5,-1
37	15	67	48	2/ 4	4, 1 11,-1 16,-1 12, 1 9,-1 8,-1
38	7	43	33	0/ 2	1,-1 2,-1
39	16	28	27	1/ 0	4, 1
40	10	56	60	1/ 2	12, 1 18,-1 12,-1
41	12	30	36	3/ 0	1, 1 3, 1 6, 1
42	9	35	36	3/ 1	3,-1 16, 1 14, 1 15, 1
43	10	40	26	1/ 0	1, 1
44	1	19	19	3/ 3	17,-1 12,-1 16, 1 5,-1 13, 1 13, 1
45	16	53	65	0/	
46	13	47	63	1/ 3	9,-1 5,-1 17, 1 17,-1
47	19	48	47	1/ 2	15,-1 14, 1 14,-1
48	7	36	31	0/	
49	20	22	19	2/ 1	9, 1 16,-1 11, 1
50	7	36	0	0/ 1	6,-1
51	4	29	19	3/ 2	1,-1 14, 1 13, 1 8, 1 5,-1
52	18	61	47	1/ 0	16, 1
53	18	49	63	0/ 2	9,-1 19,-1
54	20	67	54	2/ 0	17, 1 6, 1
55	20	39	0	0/ 3	4,-1 18,-1 8,-1
56	3	43	0	0/	
57	15	46	59	1/ 0	16, 1
58	17	31	38	1/ 2	3,-1 11,-1 16, 1
59	2	37	30	0/ 2	1,-1 4,-1

APPENDIX (Continued)

60	9	64	52	1/ 2	3, 1 17,-1 20,-1
61	8	41	43	0/ 3	12,-1 13,-1 17,-1
62	4	20	0	6/ 5	13,-1 10,-1 19,-1 6, 1 17,-1 7,-1 12, 1 6, 1 12, 1 9, 1 7, 1
63	15	53	52	2/ 3	3, 1 20,-1 10,-1 15,-1 15, 1
64	7	29	41	2/ 0	3, 1 16, 1
65	14	47	68	2/ 1	10,-1 24, 1 13, 1
66	13	46	60	0/ 2	15,-1 8,-1
67	13	57	59	1/ 1	25, 1 11,-1
68	8	38	40	0/ 2	8,-1 6,-1
69	4	64	0	0/ 2	5,-1 14,-1
70	3	66	65	3/ 3	7, 1 8,-1 7,-1 10, 1 21, 1 15,-1
71	3	68	47	0/ 2	9,-1 10,-1
72	13	40	37	2/ 1	2, 1 9, 1 12,-1
73	8	56	53	2/ 0	4, 1 20, 1
74	9	40	44	2/ 2	4, 1 7,-1 12,-1 14, 1
75	18	54	47	2/ 1	11, 1 14, 1 15,-1
76	13	33	0	0/	
77	17	31	43	2/ 2	1,-1 4,-1 8, 1 13, 1
78	16	28	41	3/ 0	11, 1 20, 1 19, 1
79	8	54	45	2/ 2	3,-1 18,-1 9, 1 11, 1
80	10	61	58	1/ 4	20, 1 18,-1 17,-1 15,-1 11,-1
81	11	60	48	0/ 2	14,-1 17,-1
82	2	60	65	3/ 4	14,-1 10, 1 11, 1 18,-1 11,-1 5, 1 14,-1
83	9	39	39	0/ 3	4,-1 6,-1 16,-1
84	19	61	58	3/ 2	15, 1 23, 1 24, 1 10,-1 20,-1
85	8	62	50	0/ 1	18,-1
86	15	49	62	3/ 2	9, 1 22, 1 11, 1 16,-1 11,-1
87	16	48	0	1/ 3	6,-1 6,-1 19, 1 16,-1
88	10	33	36	0/ 2	11,-1 11,-1
89	15	64	49	1/ 0	12, 1
90	15	35	26	0/ 2	1,-1 3,-1
91	15	48	48	1/ 1	15,-1 6, 1
92	6	24	24	0/	
93	4	25	22	0/	
94	15	24	25	0/	
95	15	25	23	0/	
96	4	25	22	0/	
97	2	25	23	0/ 1	3,-1
98	2	25	25	1/ 0	3, 1
99	20	25	24	0/	
100	6	24	22	1/ 1	1,-1 2, 1
101	8	24	25	0/ 1	1,-1
102	18	24	22	0/	
103	15	24	21	0/ 1	3,-1
104	9	23	21	0/	
105	4	23	20	0/ 1	1,-1
106	10	24	23	0/	
107	12	23	20	0/	
108	10	23	21	0/	
109	18	23	21	0/ 1	1,-1
110	12	23	21	0/	
111	6	23	24	0/ 1	2,-1
112	20	18	20	0/	
113	18	24	21	0/	
114	8	23	23	0/	
115	15	24	21	0/	
116	20	23	24	0/ 1	2,-1
117	2	22	19	0/	
118	2	22	19	0/	
119	20	22	21	0/	
120	12	22	19	0/	
121	6	67	60	1/ 1	13,-1 10, 1
122	8	22	23	0/ 1	1,-1
123	18	22	25	0/	
124	17	21	18	0/	
125	17	21	18	0/	

126	5	21	18	0/
127	2	21	18	0/
128	7	21	18	0/
129	4	21	19	0/
130	2	21	19	0/

[illegible]

[illegible]

APPENDIX (Continued)

123	18	00	00
124	17	00	AO
125	17	00	AO
126	5	00	00
127	2	00	00
128	7	AO	00
129	4	00	00
130	2	00	00

BLOOD TYPE PERCENTAGES: DO = 85.50%, AO = 12.21%, BO = 2.10%, AA = 0.19%, BB = 2.0 %, AB = 0.0 %

FAMILY	ENERGY DEMAND	PLANT	ENERGY GAINS		ENERGY NET
			ANIMAL	MARKET	
1	1152079.	0.	259357.	1138577.	0.
2	1352869.	0.	259357.	1219029.	0.
3	1489533.	0.	259357.	1505662.	0.
4	1424086.	0.	166803.	1315616.	0.
5	3504148.	0.	339708.	3104858.	0.
6	3503657.	0.	351911.	3291360.	0.
7	1406634.	0.	259357.	1456275.	0.
8	1407351.	0.	259357.	1442514.	0.
9	2113679.	0.	321387.	1857101.	0.
10	1383914.	0.	259357.	1286663.	0.
11	3064764.	0.	259357.	1402816.	-1275991.
12	1356635.	0.	259357.	1206248.	0.
13	9559991.	0.	388553.	8461953.	-507411.
14	1378234.	0.	277678.	1226041.	0.
15	2446385.	0.	277678.	2208541.	0.
16	3388448.	0.	351911.	3224518.	0.
17	4583828.	0.	351911.	4359816.	0.
18	1576994.	0.	321387.	1336502.	0.
19	3148678.	0.	259357.	3081823.	0.
20	1759518.	0.	259357.	1655632.	0.
21	3388647.	0.	351911.	3256601.	0.
22	4697205.	0.	629573.	4139760.	0.
23	1955510.	0.	370232.	1757309.	0.
24	3439076.	0.	339708.	3210343.	0.
25	4343610.	0.	259357.	3625533.	0.
26	1429354.	0.	259357.	1234787.	0.
27	2480579.	0.	228342.	1810429.	-292240.
28	2538002.	0.	351911.	2421395.	0.
29	1390006.	0.	228342.	1287228.	0.
30	2122336.	0.	259357.	2040097.	0.
31	4551554.	0.	351911.	4401512.	0.
32	2758845.	0.	370232.	2611704.	0.
33	4025919.	0.	351911.	3918839.	0.
34	1402258.	0.	321387.	1231281.	0.
35	2085128.	0.	259357.	1997345.	0.
36	3763078.	0.	259357.	1677348.	-1697030.
37	4096150.	0.	259357.	1824604.	-2073494.
38	2037254.	0.	277678.	1959080.	0.
39	1709433.	0.	259357.	1555275.	0.
40	2943648.	0.	259357.	2254874.	-398605.
41	2453912.	0.	339708.	2194516.	0.
42	3814120.	0.	259357.	2366127.	-1333107.
43	1647669.	0.	259357.	1546679.	0.
44	4921937.	0.	259357.	879126.	-3761355.
45	1194233.	0.	413941.	1005082.	0.
46	3441643.	0.	166803.	1735632.	-1219958.
47	3087802.	0.	250197.	668685.	-2268822.
48	1443215.	0.	259357.	1276144.	0.
49	3054728.	0.	259357.	2162170.	-201625.
50	1201083.	0.	277678.	1101028.	0.
51	3837739.	0.	432262.	3470133.	0.
52	1938457.	0.	259357.	1813331.	0.
53	2341859.	0.	259357.	2150633.	0.

APPENDIX (Continued)

54	2272263.	0.	370232.	1948335.	0.
55	2224275.	0.	444465.	1996742.	0.
56	754769.	0.	259357.	823745.	0.
57	1969861.	0.	259357.	1851032.	0.
58	3000166.	0.	277678.	1956591.	-961809.
59	2122637.	0.	277678.	1946864.	0.
60	2740005.	0.	259357.	879126.	-1644595.
61	3034929.	0.	259357.	2695596.	0.
62	6406528.	0.	259357.	5408743.	-337753.
63	3926182.	0.	351911.	3114019.	-513449.
64	2380473.	0.	259357.	2310519.	0.
65	3031733.	0.	351911.	2897923.	0.
66	2277713.	0.	370232.	1989390.	0.
67	2444130.	0.	277678.	2209904.	0.
68	2242470.	0.	462786.	1926394.	0.
69	1581086.	0.	370232.	1278368.	0.
70	4236180.	0.	259357.	1998647.	-2197997.
71	2098430.	0.	401738.	1845942.	0.
72	2708352.	0.	277678.	2635342.	0.
73	2329317.	0.	351911.	2115422.	0.
74	3310219.	0.	259357.	3228552.	0.
75	3056317.	0.	351911.	2812419.	0.
76	811569.	0.	21387.	811530.	0.
77	3189887.	0.	259357.	1241309.	-1992281.
78	3451494.	0.	339708.	2834285.	-109663.
79	3323432.	0.	351911.	2275006.	-646812.
80	4251219.	0.	487225.	3895993.	0.
81	2403405.	0.	277678.	2188183.	0.
82	4879208.	0.	370232.	4666995.	0.
83	2761389.	0.	388553.	2425240.	0.
84	4442890.	0.	351911.	1343703.	-2717248.
85	1844036.	0.	339708.	1578988.	0.
86	4133713.	0.	277678.	3945003.	0.
87	2933314.	0.	259357.	1191960.	-1630457.
88	2440218.	0.	351911.	2175327.	0.
89	1793727.	0.	277678.	1701287.	0.
90	2074006.	0.	321387.	1825622.	0.
91	2287901.	0.	351911.	2332368.	0.
92	1356635.	0.	259357.	1216126.	0.
93	1356635.	0.	351911.	1078521.	0.
94	1356635.	0.	259357.	1276182.	0.
95	1356635.	0.	213080.	1243496.	0.
96	1356635.	0.	259357.	1222535.	0.
97	1706408.	0.	277678.	1509960.	0.
98	1679752.	0.	321387.	1455634.	0.
99	1356635.	0.	259357.	1304721.	0.
100	1961990.	0.	321387.	1716895.	0.
101	1668554.	0.	259357.	1498273.	0.
102	1356635.	0.	259357.	1332129.	0.
103	1706408.	0.	259357.	1632598.	0.
104	1356635.	0.	259357.	643237.	-549955.
105	1668554.	0.	259357.	1486058.	0.
106	1356635.	0.	259357.	428008.	-707086.
107	1356635.	0.	259357.	1202705.	0.
108	1356635.	0.	157152.	888363.	-414983.
109	1668554.	0.	259357.	1514031.	0.
110	1356635.	0.	259357.	236530.	-689672.
111	1687481.	0.	259357.	1514597.	0.
112	1390437.	0.	259357.	1221366.	0.
113	1356635.	0.	259357.	1381365.	0.
114	1356635.	0.	259357.	1325117.	0.
115	1356635.	0.	321387.	1255786.	0.
116	1687481.	0.	333590.	1559460.	0.
117	1397136.	0.	259357.	1210885.	0.
118	1397136.	0.	228342.	85504.	-1145653.
119	1356635.	0.	241036.	668119.	-547385.

APPENDIX (Continued)

120	1397136.	0.	259357.	358866.	-927376.
121	2164481.	0.	333590.	1873388.	0.
122	1668554.	0.	259357.	1490129.	0.
123	1356635.	0.	321387.	1093148.	0.
124	1378209.	0.	172905.	57078.	-1244140.
125	1378209.	0.	141890.	24430.	-1272107.
126	1378209.	0.	259357.	1216578.	0.
127	1378209.	0.	259357.	1232375.	0.
128	1378209.	0.	370232.	1105137.	0.
129	1397136.	0.	259357.	1220047.	0.
130	1397136.	0.	182065.	57078.	-1200540.

FAMILY	LLAMAS	SHEEP	ALPACAS
1	21	21	20
2	22	20	18
3	24	15	15
4	27	19	15
5	20	18	23
6	27	16	15
7	25	16	14
8	25	18	16
9	33	33	29
10	25	19	16
11	13	16	15
12	21	24	17
13	30	21	21
14	24	19	16
15	41	40	23
16	28	16	15
17	29	20	19
18	30	32	36
19	33	15	14
20	26	17	19
21	27	15	15
22	97	67	22
23	38	37	33
24	22	23	24
25	12	20	21
26	22	24	16
27	17	15	17
28	41	35	21
29	25	20	16
30	18	14	14
31	25	12	13
32	43	26	16
33	41	16	14
34	21	19	19
35	19	16	14
36	16	13	14
37	17	13	14
38	33	29	31
39	30	18	18
40	14	21	20
41	37	36	34
42	20	13	14
43	19	19	18
44	14	14	15
45	21	22	21
46	14	17	18
47	13	13	15
48	22	18	20
49	13	16	19
50	30	29	31
51	36	24	23
52	34	31	31
53	20	18	14

APPENDIX (Continued)

54	40	22	15
55	38	20	14
56	21	21	24
57	11	27	24
58	15	13	15
59	31	32	31
60	14	13	15
61	20	14	14
62	15	18	19
63	23	12	15
64	42	37	27
65	39	17	15
66	42	43	21
67	17	28	29
68	39	38	29
69	37	28	14
70	15	12	19
71	36	36	32
72	44	32	19
73	38	17	14
74	32	14	14
75	24	17	14
76	20	21	24
77	16	16	14
78	14	19	23
79	19	16	15
80	57	63	24
81	39	41	24
82	38	24	17
83	48	25	16
84	16	13	14
85	32	33	33
86	29	19	14
87	14	14	16
88	43	40	20
89	39	35	36
90	30	31	33
91	48	22	15
92	17	24	23
93	20	20	24
94	18	24	20
95	24	24	19
96	23	22	17
97	20	23	17
98	21	29	27
99	20	20	22
100	19	27	27
101	20	25	18
102	22	24	16
103	22	18	15
104	13	13	14
105	19	21	19
106	15	13	6
107	24	23	17
108	19	0	0
109	21	16	18
110	5	6	7
111	20	27	19
112	11	22	31
113	21	19	16
114	20	21	22
115	19	22	21
116	21	24	20
117	20	22	18
118	15	15	0
119	15	15	13

APPENDIX (Continued)

120	9	6	11
121	51	23	14
122	19	20	19
123	21	21	18
124	3	1	1
125	4	0	0
126	13	14	3
127	23	23	23
128	28	28	32
129	30	27	21
130	3	1	1

TOTAL SHEEP EQUIVALENTS = 16275
TOTAL SHEEP = 2803 TOTAL LLAMA = 3258 TOTAL ALPACA = 2412

1

2

3

4

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