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A BEEF PRODUCTION MODEL FOR THE SAVANNAS OF COLOMBIA
MODEL DESCRIPTION AND USER NOTES

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Summary

A fully interactive beef production model is described. The beef component is based on the Kahn model built at Reading University, which itself originally shared a limited number of features with the Texas A and M model of the late 1970s. Herds of up to 30 animals may be handled for up to 20 years of simulated time. The model is flexible, and the structure allows mob grazing, rotational grazing, and grazing among multiple forage species. Animals may be bought, sold, culled or weaned as required. Cash flows are produced, along with net present values and internal rates of return, and for any particular run, economic re-analysis may be carried out to investigate changes in economic parameters. Provision also exists to investigate dual-purpose beef-milk systems. The major relationships within the model are documented, its use illustrated, and output files are described.

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1 INTRODUCTION

These notes describe a beef production simulation model for the extensive ranching systems found in the Eastern Savanna plains of Colombia. Changes and modifications are outlined up to version 4.2, completed on 20 December, 1986. The core of the system (called RUSMOB) is a model built and described by Kahn and others (Kahn and Spedding, 1983, 1984; Kahn and Lehrer, 1984) which was taken as a starting point and modified somewhat, leading to its validation for conditions in the Llanos.

The first section describes the basic relationships used in the beef production model (with their sources), and how some of these have changed since earlier versions of the model. The growth of forage and the animal-plant interface is described in the second section; currently this is the most dynamic area of the system, so work in progress is briefly outlined. The third section examines the structure of the whole computer-based system, incorporating a small number of economic routines to calculate cash flows, net present values and internal rates of return; the interactive interface allows the user to run the model as a management game, essentially. The fourth section is concerned to demonstrate the use of the model, by listing internal assumptions and explaining output from the model. These notes conclude with an indication of areas where development can be expected to continue over the next few months. Appendices contain variable name lists, the interactive panels, a subroutine list and subroutine call list, and sample input and output files. A complete listing of RUSMOB is not given here, since it comprises some 7500 lines of FORTRAN code (or 120 pages), split in two approximately equal parts between the simulation model and the interactive system.

Throughout these notes, names in capital letters follow the following convention: RUSMOB refers to the entire computer-based system; FORTRAN names for subroutines are referred to as "subroutine NAME"; any other FORTRAN name in capital letters may be taken as referring to a variable, a short description of which can be found in Appendix B.2. If the variable is an array, it will usually be referred to as NAME(i), where i may be the letter itself to denote generality, or a number, to denote a particular

position in the array, or a range, such as 1-4, denoting the first four positions in the array

2 THE BEEF MODEL

2.1 Structure and Major Relationships

The model used is an adaptation of one built by Kahn (1982) which shared a limited number of features with the TAMU model of Sanders (1977). The major variables which have to be input to the model, and which between them, it is hoped, are capable of describing the whole variety of production systems of interest, are as follows

- feed quality and quantity, in terms of crude protein percentage, digestibility and availability,
- the average adult weight of the cows, if all the cows are of one breed, then one value suffices. If not, then individual values have to be input. This variable enables the model to distinguish between breeds and sexes for the calculation of growth rates and intake capacity, for example
- the maximum potential peak milk yield per cow, again a breed-dependent characteristic
- a multiplication factor for standard activity energy expenditure; different environments can thus be accounted for (sparse pasture, difficult terrain, heat stress etc)

The dynamics of the system are represented by a flow of energy. Animal performance is treated on an individual basis, i.e. each animal's growth, milk production etc are calculated at each integration time step (henceforth dt), which itself is variable between 1 and 30 days. The model is deterministic, with the following stochastic discrete events: calf death, adult death, cow abortion, oestrus in non-cycling cows, oestrus in cycling cows, conception following oestrus, calf sex at birth, and long-term sterility following dystocia or delayed reconception following the same. It may be noted that real-system levels of variability can be introduced by what amounts to internalising previously extrinsic (driving) variables, for instance pasture production, which is dependent, *inter alia*, on weather

A diagram illustrating herd dynamics and the fate of individual members is given in Figure 1. Calves, following weaning, enter a followers herd for as long a time as is required; ultimately, they die, are sold, or the heaviest are used to replace natural losses in the breeding herd. Breeders and followers can be bought, also. The beef component is organised into a three-tier hierarchical structure. The effect of this is to divide the program into two major loops. These can be seen in Figure 2, an event-sequencing diagram, showing the calculations performed for each animal in the herd at each dt . This diagram shows the logical flow of the program, and not the structure of the model as written in code. The structure of early versions of the model (V3.0) is shown in Figure 3. Subsequent paragraphs describe the quantification of the model in terms of energy requirements and dry matter intake, lactation, weight change, normative weight, and reproduction. What follows is a resumé of Kahn (1982), Kahn and Spedding (1983, 1984), and Kahn and Lehrer (1984). As regards the sources of these equations, ARC (1980) is responsible for much of the energetics relationships, Conrad (1966) for voluntary intake, Sanders (1977) for lactation, Brody (1945) for normative weight, and Kahn and Sanders for reproduction. The death routines have been changed completely to account for local death rates, and other significant modifications are noted below.

DRY MATTER INTAKE

Dry matter intake is calculated as the minimum of two functions, the physical limit,

$$I = \text{VICOE}F * \text{WM} / (1 - \text{DIG}),$$

where WM = normative weight, DIG = DM digestibility, and VICOE, faecal dry matter output per kilogram of liveweight, = 0.0094, varying with stage of lactation to a maximum of 0.0116 in the fifth month, and the physiological limit,

$$I = \text{DDM} / \text{DIG},$$

where DDM = MENEED / (18.5 * 0.82), MENEED is the ME requirement of the animal, 18.5 ME is the gross energy content per kg DM of feed, and 0.82 is the ratio of ME to digestible energy. The requirement of the animal can be partitioned,

$$\text{MENEED} = (\text{MAINT} + \text{AC} + \text{PREG} + \text{LACT}),$$

FIGURE 1 RUSMOB HERD DYNAMICS

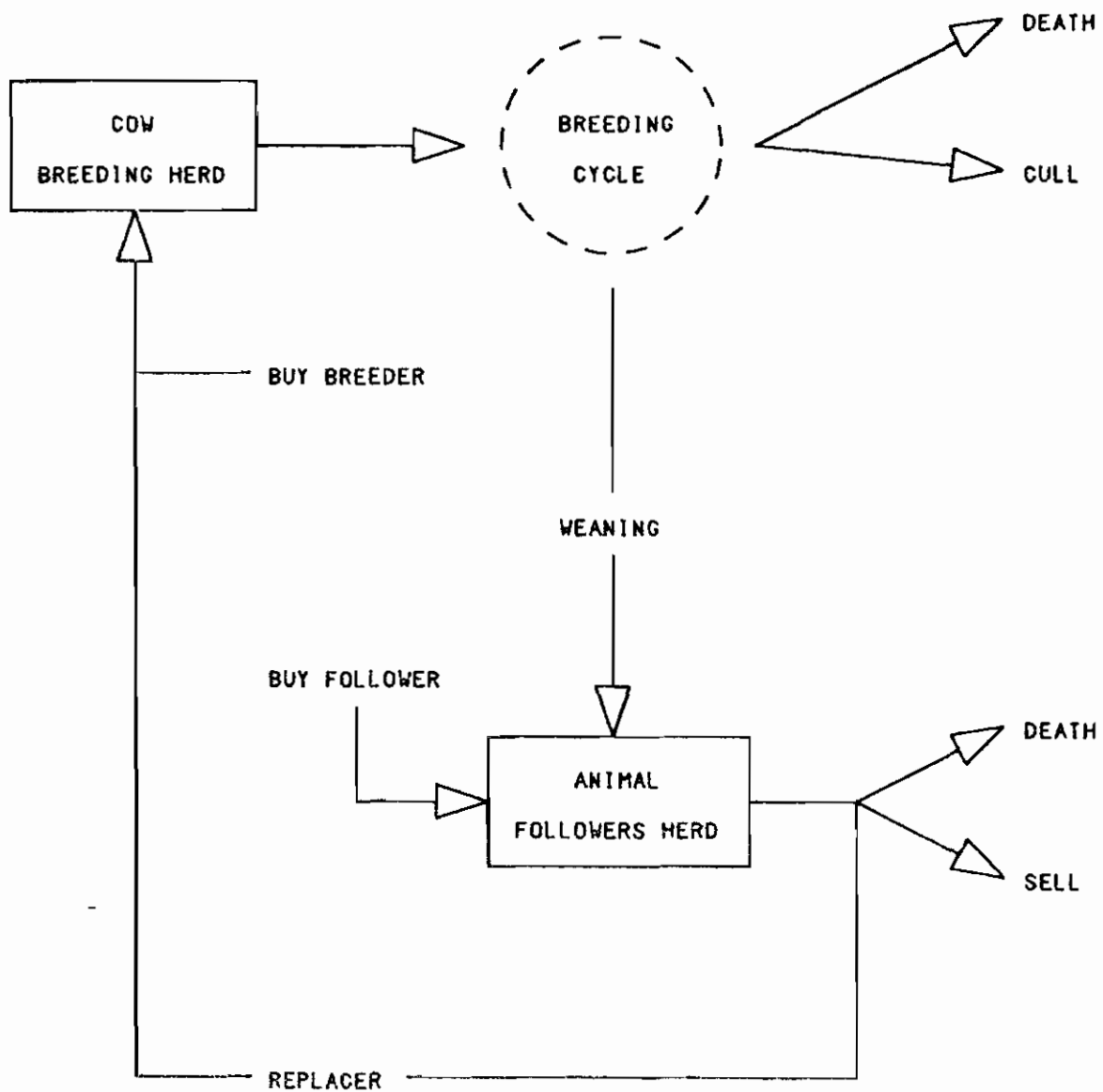


FIGURE 2 GENERAL EVENT SEQUENCE, BEEF MODEL

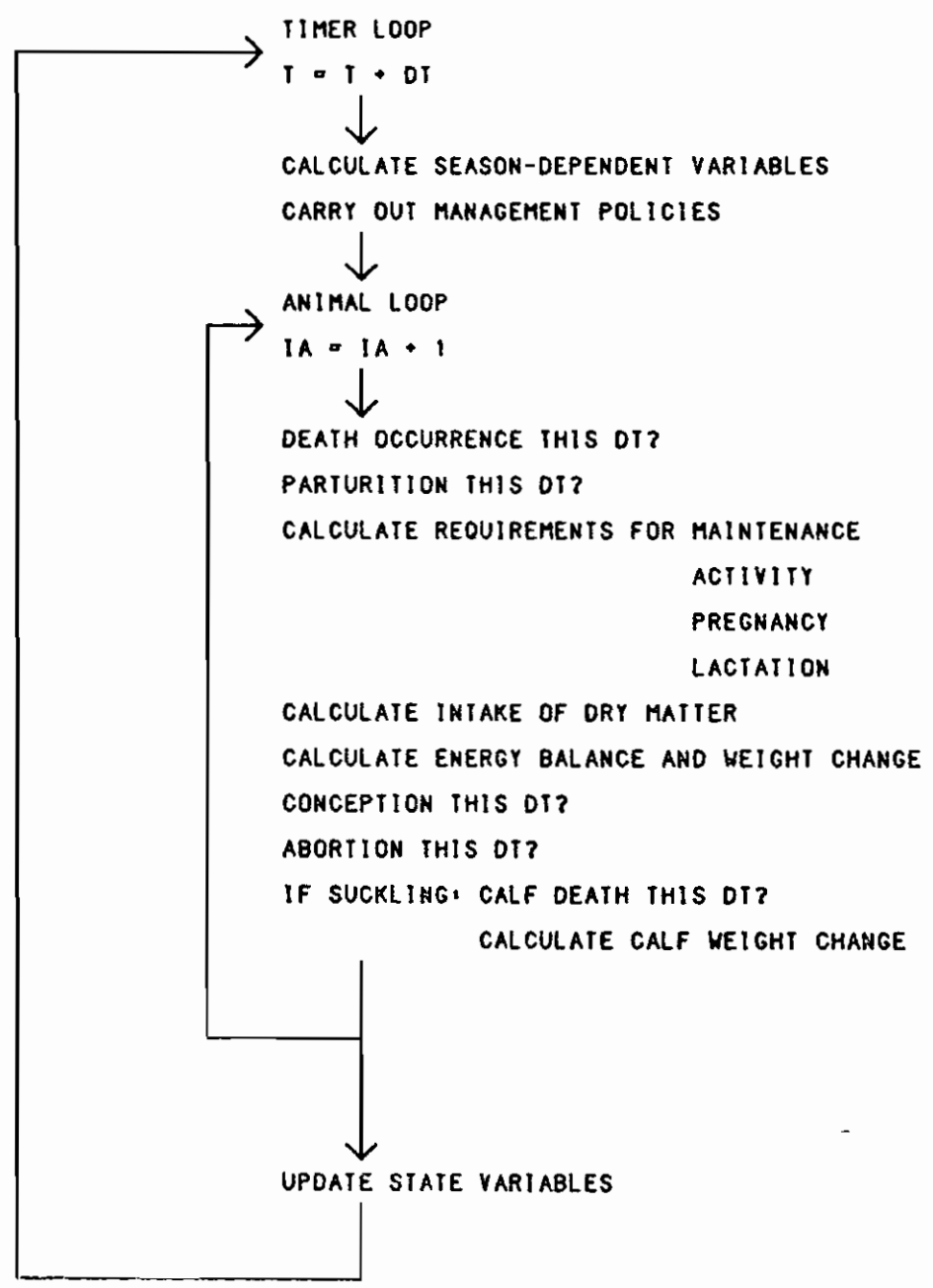
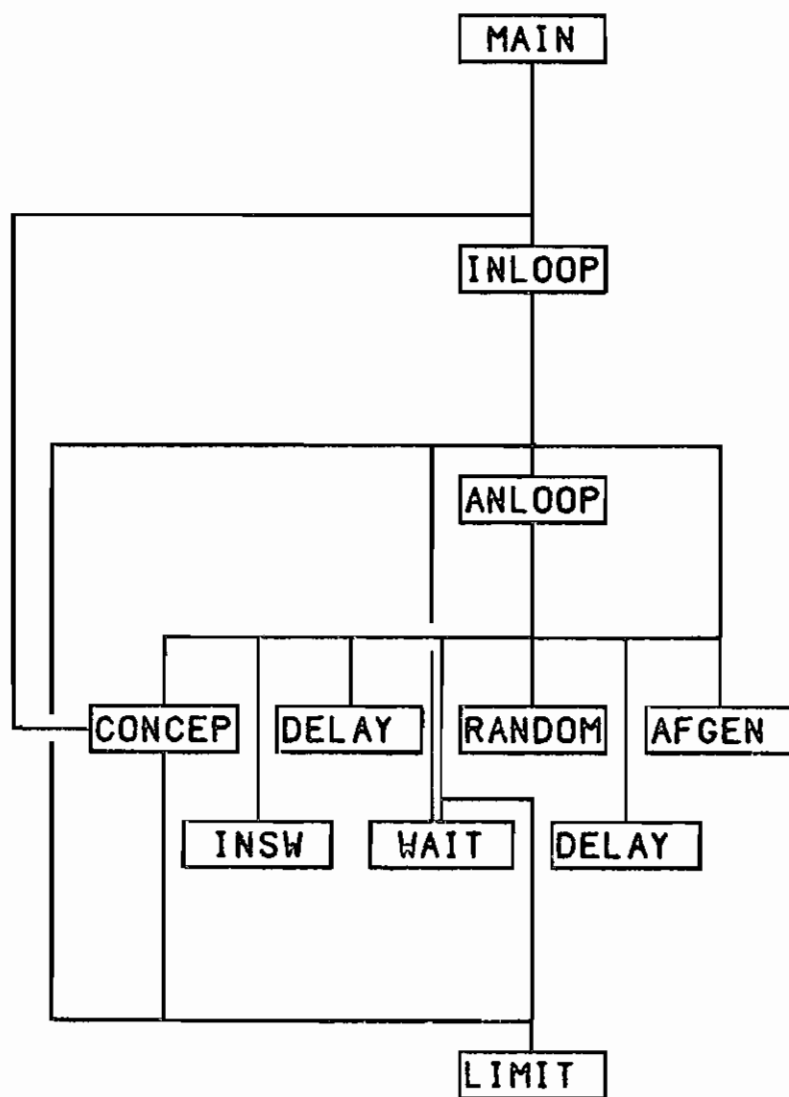


FIGURE 3 RUSMOB V3.0 PROGRAM STRUCTURE



where MAINT = the maintenance requirement, AC = the activity requirement (about 25% of MAINT in grazing animals), PREG = the requirement for pregnancy and LACT = that for lactation. In turn, these are calculated as follows:

$$\begin{aligned} \text{MAINT} &= \text{FM} / \text{KM}, \\ &= \text{COF} * ((\text{W}/108)**0.67) / (\text{DIG} * 0.81 * 0.35 + 0.503) \end{aligned}$$

where FM = fasting metabolism, KM = utilisation efficiency, DIG = digestibility, and COF = 0.53 for cows, heifers and stags, and 0.67 for bulls. In calves, FM = FMC * W ** 0.73, where FMC is a coefficient which varies with age

$$\text{AC} = 0.012 * \text{W} * \text{F},$$

where F = a factor varying from 1.0 for lush grazing conditions to 2.0 for more sparse and rigorous conditions

$$\text{PREG} = (10 * (a - b * \exp(-ct)) * 0.0201 * \exp(-ct)) / 0.133,$$

where a = 151.665, b = 151.64, c = 5.76E-5, t = number of days pregnant, and 0.133 = the efficiency of utilisation of metabolisable energy for pregnancy

$$\text{LACT} = \text{PPM} / \text{KL},$$

where PPM = energy content of milk yield and KL, the conversion efficiency, = 0.35 * ME/GE + 0.42, GE being the gross energy content of the feed

LACTATION

Lactation potential is given by a two-phase function,

$$\text{PM} = \begin{cases} \text{PROP} * \text{PMA} + (1 - \text{PROP}) * \text{PHA} / \text{ND} * (\text{LTIME} + \text{DELTA} * 0.5) & \text{pre-peak} \\ \text{PMA} * \exp(\text{LTIME} - \text{ND} + \text{DELTA} * 0.5 * \text{PHEXP}) & \text{post-peak,} \end{cases}$$

where PMA = maximum potential daily yield, PROP = the proportion yielded at day 0, ND = number of days to peak yield, LTIME = number of days lactating, and PHEXP = the rate of decline post-peak. The daily amount so calculated is reduced by two factors:

- age,

$$\text{CFA} = 1.0 + 0.01 * (\text{AGE} - 7) - 0.01 * (\text{AGE} - 7)**2, \quad 0 \leq \text{CFA} \leq 1,$$

- previous under-nutrition,

$$\text{LDEP} = \text{LTIME} / 240, \quad 0 \leq \text{LDEP} \leq 1,$$

whereby the present milk potential is reduced even if present feeding levels are more than sufficient to meet undampened lactation potential after a period of undernutrition. In this way a reduction in milk

potential releases energy for weight gain, the only method in the model as yet of taking explicit account of compensatory gain

Tissue is mobilizable to help meet lactation potential, the amount being given by

$$MCONV = MFAC * MFAC * LFAC,$$

where $MFAC = WMAX - 8 * \exp(-3 * W / WM)$, $MFAC = WMAX - 3 * \exp(-2 * WM / WMA)$, $LFAC = (270 - LTIME) / 270$ if $LTIME \leq 270$ or 0 if $LTIME > 270$, WM is normative weight, $WMA =$ mature normative weight, and $WMAX =$ maximum amount of tissue mobilizable per day, here 1.4 kg per cow

WEIGHT CHANGE

Weight gain or loss occurs when the the energy balance has been calculated, i.e. the surplus or deficit of energy in minus energy out for production. The following equations are used

- the efficiency of ME utilisation for tissue anabolism,

$$KF = 0.78 * ME / GE + 0.006,$$

is adjusted depending on feed levels by the factor

$$C = KM / (KM - KF) / (L - 1) * (1 - (KF / KM) ** (L - 1)),$$

where $L = MER / MAINT$, and $MER =$ the total ME intake by the animal.

- the energy value of gain is

$$EVG = 5.12 + (26.0 - 5.12) / WMA * W ;$$

Kahn (1982) has a very long discussion of the derivation of this key variable

NORMATIVE WEIGHT

Normative weight is calculated as follows:

$$WM = BW + (0.33 * WMA - BW) / 180 * t,$$

a linear section from birth with birthweight BW to 6 months, and an exponential saturation curve above 6 months of age,

$$WM = WMA * (1 - 0.67 * \exp(-k * (t - 180) / 30)),$$

where $t =$ age in days and $k =$ growth rate coefficient, 0.065 to give 98% of WMA @ 5 years, or 0.053 to give 98% of WMA @ 6 years. Calf birth weight is calculated as $BW = WMA / 15$, males are assumed to weigh 10% more than females at birth. Female mature weight is multiplied by 1.15 to give steer mature weight. Birth weight is reduced by a factor $(W / WM) ** 0.5$ if the dam is underweight.

REPRODUCTION

The derivation of the reproduction formulae is based on little evidence, as the different effects are essentially impossible to separate and quantify. Basically we have

$$\begin{aligned}
 \text{PEST} &= \text{PESTCO} * \text{CFT} * \text{CFM} * \text{CFW} * \text{CFDW} * \text{CFAGE}, \\
 \text{CCYC} &= \text{CFW} ** 0.1 * \text{CFDW} ** 0.1, \\
 \text{PCON} &= 0.75 * \text{CFT} ** 0.5 * \text{CFW} ** 0.2 * \text{CFDW} ** 0.2 * \text{CFAGE} ** 0.5 \\
 &\quad * \text{SEASON},
 \end{aligned}$$

where PEST = the probability of oestrus given that the cow was not in oestrus the previous cycle, CCYC = the probability that an animal in heat last month comes back into heat, and PCON = the probability of conception following oestrus. The factors in the equations are listed below:

- $\text{CFT} = 1 - 1/\exp(9 \text{ E-}7 * (\text{APTIME} - \text{APDEL T}) ** 3.9)$, $0.001 \leq \text{CFT} \leq 1$,
 a correction factor for time since calving, where APTIME = no of days post-partum, APDEL T = 10, a suckling factor,

$$\text{CFM} = \begin{cases} (\text{WM}/(0.6 * \text{WMA}) - 0.67)/0.33, & \text{WM} < 0.6 * \text{WMA}, \\ 1, & \text{WM} \geq 0.6 * \text{WMA}, \end{cases}$$

a correction factor for animal maturity;

$$\text{CFW} = \begin{cases} -0.35 + 1.5 * (\text{W}/\text{WM}), & \text{CFW} > 0, \quad \text{W}/\text{WM} < 0.9, \\ 1, & \text{W}/\text{WM} \geq 0.9, \end{cases}$$

a correction factor for condition;

$$\text{CFDW} = 1 - 0.6 * \text{WL}, \quad \text{CFDW} > 0,$$

a correction factor for weight loss, where WL = weight loss per day;

$$\text{CFDW} = \begin{cases} 1 - (\text{AGE} - 4) * 0.01, & \text{AGE} \geq 4.0, \\ 1, & \text{AGE} < 4.0, \end{cases}$$

a correction factor for age

PESTCO = $1.0 - 0.15 * (\text{DEL T}/30)$ to adjust for values of dt other than 30, where DEL T = dt, and SEASON = 1 in the breeding season and 0 out of season

One last factor affecting reproduction is that of dystocia; 36% of cows have difficult calvings, which delays oestrus by 29 days. The probability of resultant sterility is calculated as

$$\text{STER} = 1 - \text{CFA},$$

where $CFA = 1 + 0.01*(AGE-9) - 0.01*(AGE-9)**2$, $0.001 \leq CFA \leq 1$, if $AGE > 9$, otherwise $CFA = 1.0$

2.2 Development to V4.2

General changes included a modularisation of the Kahn model with the aim of improving efficiency and reducing running time, a transcribing of the original FORTRAN IV (1966) code into FORTRAN 77, and heavy revision and restructuring of input and output code.

MORTALITY

The mortality routines have been changed radically from those used in V1.0 and V2.0. The old TAMU routines were too complicated to allow of objective adjustment. Death rates have now been changed so that the probability of death is minimal except for old age, the first 30 days of life, and starvation. The preliminary validation runs have shown that simple death probabilities can accurately reflect the age structure in a herd over ten to twenty years in the savannas, whilst death is assumed to occur if the weight index falls below 0.48 (Kleiber, 1961). Calf death and abortion probability (the latter introduced because of its importance in extensive systems) are defined to be nutrition-related and parametric, since it is not reasonable to postulate causal mechanisms for such events (apart from starvation) in a model of this level of resolution. The possibility of abortion exists for the seventh to ninth month of pregnancy. The probability of calf death during the first month of life is high, but decreases thereafter.

HERD DYNAMICS

A followers herd was introduced; in V2.0, calves were either sold or entered the breeding herd immediately post-weaning. This modification means that a calf now becomes a follower for as long or as short a period as is required by the management policy being pursued. The model can now handle up to 200 breeding cows and 400 followers (see Figure 1), but note that an animal identification number (for a breeder, up to 200, and from 201 to 600 for a follower) is unique and is not re-assigned on death or removal from the herd. Array overflows occur if more than 400 followers accrue during a run, with all sorts of ensuing problems (i.e. other

variables are over-written)

PARAMETER RESETTING

In resetting parameters, it was felt that unless there were good reasons for changing anything, it was better to leave as much as possible unchanged; the paucity of data on many of the important relationships would make it extremely difficult to render these in mathematical terms with any degree of objectivity. The major reason for having to reset parameters at all is the fact that the Llanos represents a poor-quality production system, where weight indices (the ratio of current weight to potential weight) of the order of 0.5 to 0.75 are observed most of the time; the original validation runs were concerned with weight indices of 0.85 to 1.0.

The following were reset:

- RATE, the parameter which describes the first derivative of the growth curve for heifers, was reset to 0.054, the lower value quoted by Kahn, in accordance with *Bos indicus* cattle elsewhere
- the milk curve was redrawn (Figure 4), giving a plateau of 5.0 kg from day 0 to 60 of lactation, followed by a shallow exponential decline to approximately 2.8 kg at day 270. Integration of the curve gives a total lactation potential yield of some 1100 kg.
- suckling calf roughage intake on poor diets was grossly underestimated. Calf weight was therefore replaced with calf normative weight in the voluntary intake equations, thus bringing the relationship into line with that for post-weaners and adults.
- tissue mobilization for lactation; this was increased from the zero allowed at low weight indices in V2.0 in a manner shown in Figure 5. This is based on no evidence at all, but is intuitively reasonable.
- conception probabilities, two functions were redrawn and the parameter probabilities adjusted (Figure 6) in an attempt to obtain realistic conception rates (in excess of 50% where earlier version of the model would have none) and also a realistic relationship between conception and weight.

ADJUSTMENTS MADE DURING VALIDATION

Preliminary validation work, described in another document (Thornton, 1987), highlighted a number of problems, particularly with respect to

FIGURE 4 RUSMOB MILK CURVES

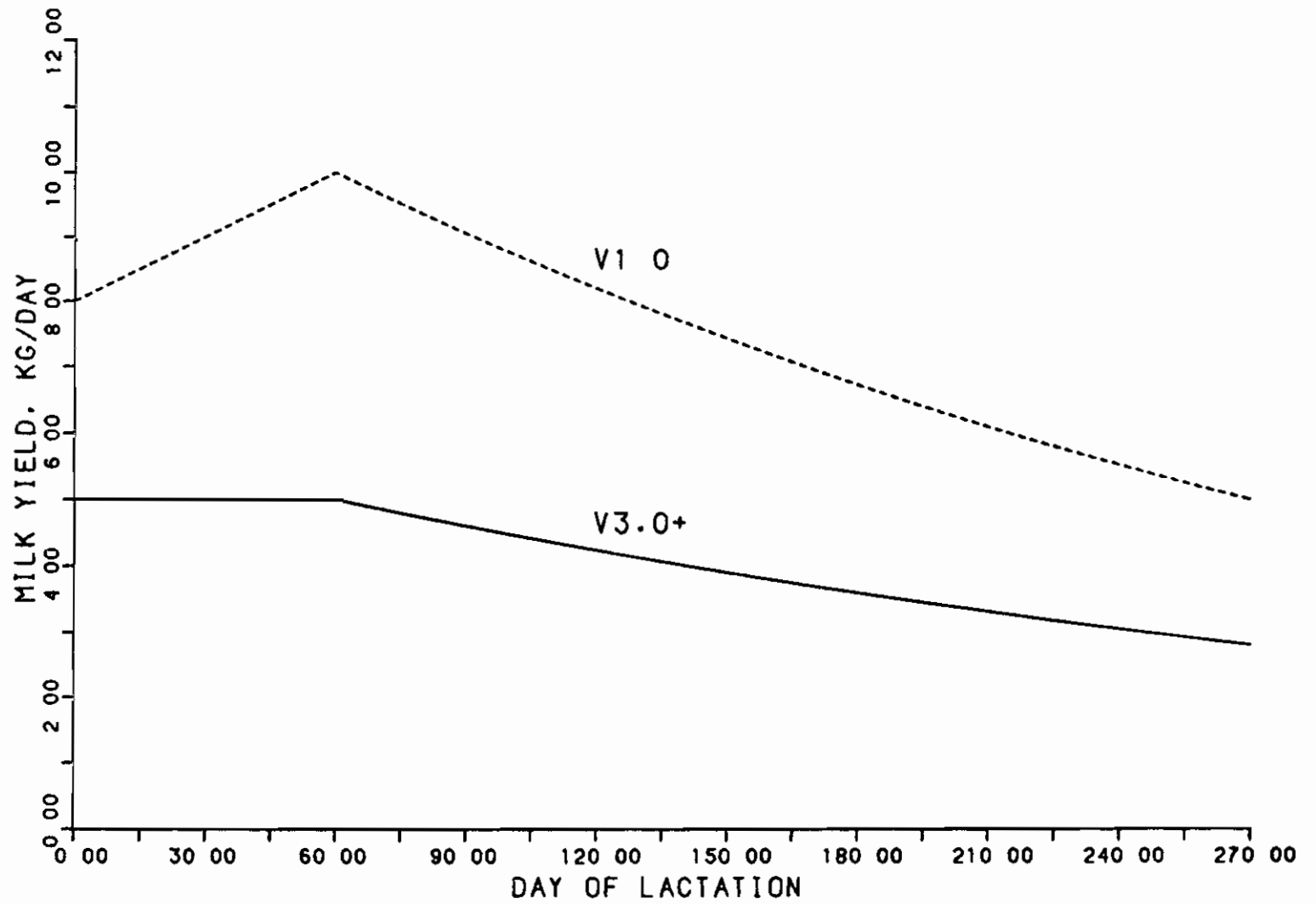


FIGURE 5 TISSUE MOBILIZATION

WFAC = MULTIPLICATIVE FACTOR TISSUE MOBILISABLE TO SUPPORT LACTATION
W/WM = WEIGHT TO NORMATIVE WEIGHT RATIO

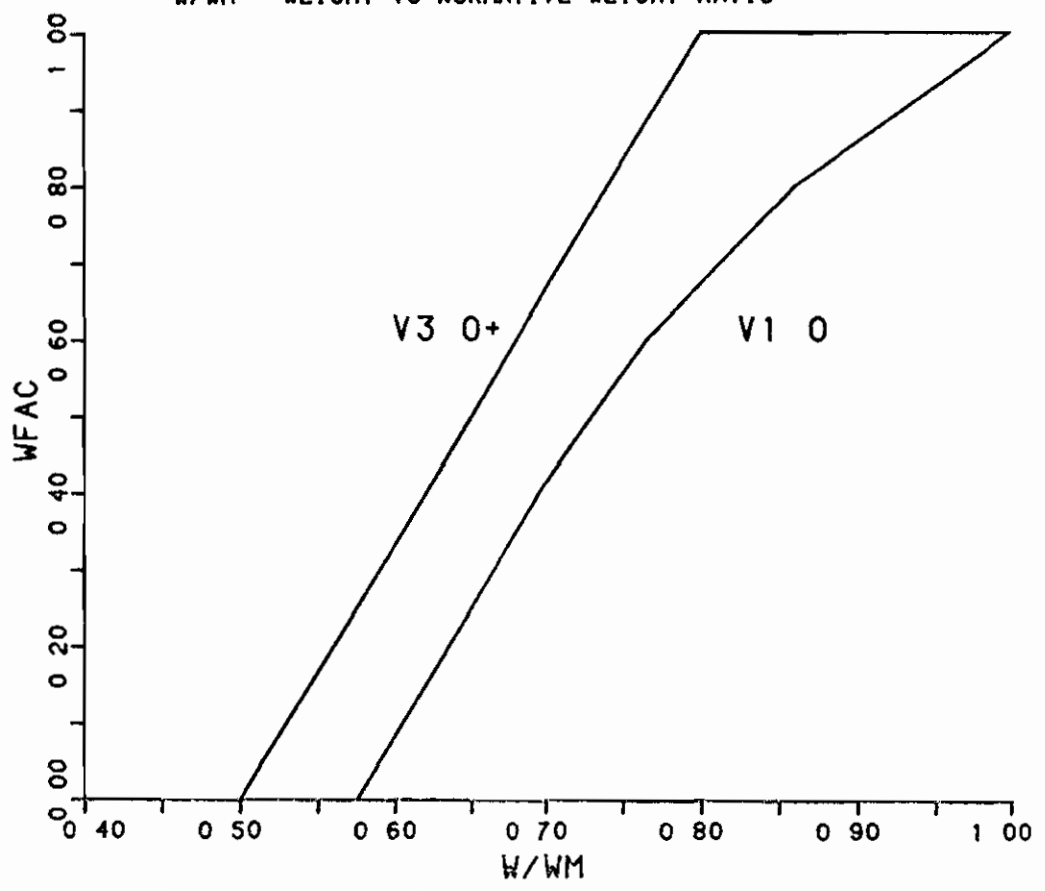
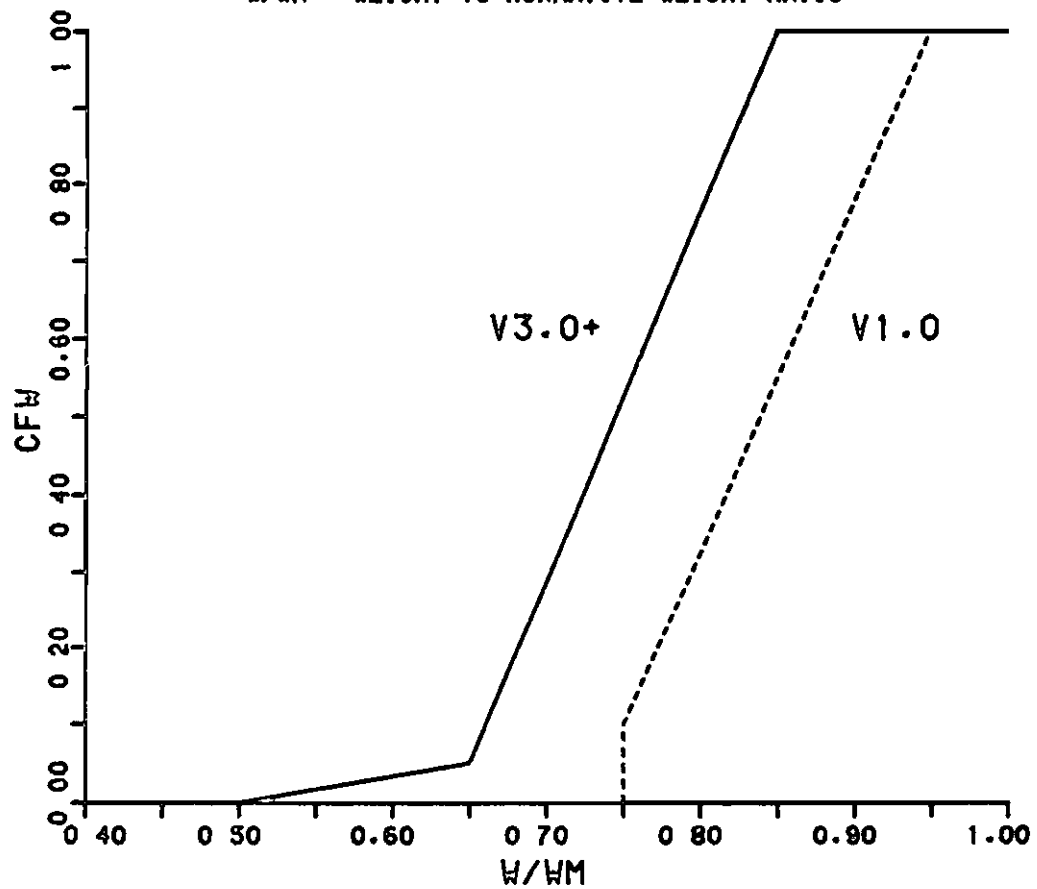


FIGURE 6 CONCEPTION CHANGES I

CFW = LIVEWEIGHT-CONCEPTION PROBABILITY
MULTIPLICATION FACTOR
W/W_N = WEIGHT TO NORMATIVE WEIGHT RATIO



conception probabilities and weaning weights. The problem for the first of these was identified to be the maturity factor. Since normative weight increases irrespective of plane of nutrition (unless death occurs), the modified factor defines maturity to have no effect on conception ability once the ratio WM/HMA has reached values in excess of 0.6. The shape was adjusted to inhibit conceptions at low liveweights and in comparatively immature animals (Figure 7).

For weaning weights, it was concluded that it is possible that plane of nutrition acts on milk production potential (and hence weaning weight) in a way not explicitly accounted for in the model, when diverse production systems are considered. In effect, this parameter may be seen as a measure of genetic potential coupled with the overall quality of the diet in the relevant production system. This poses no real problems, but remains conceptually unsatisfactory.

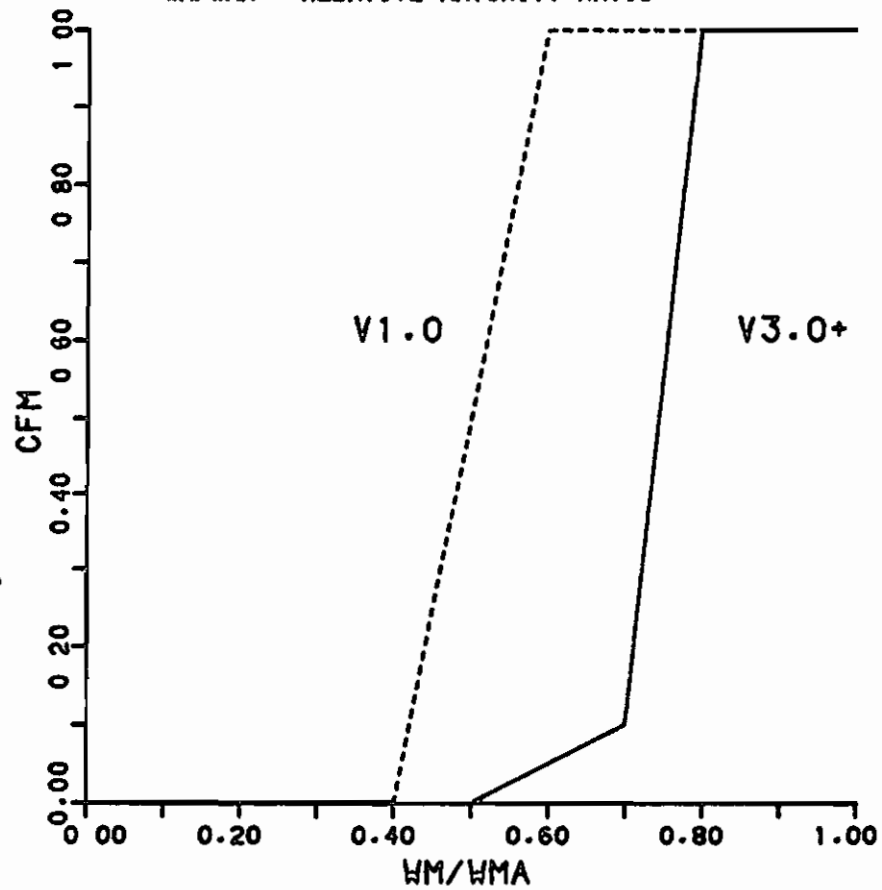
3 FORAGE ROUTINES

Historically, two aspects of forage have been of interest for beef simulation modelling - its quantity, and its quality, measured usually as dry matter digestibility and/or protein content. The interface between animal and plant has always been the hardest part of modelling animal-based production systems, and most models by-pass the problems involved due to their complexity and the lack of data which surrounds this interface. The present model goes only a small way towards tackling these problems.

Both the TAMU and Kahn's model make use of tabular forage; forage quality on any day is calculated by interpolating between two (often monthly) digestibility and crude protein values. Thus if digestibility for day 30 and for day 60 of the year are 42.0 and 44.0 percent respectively, the value used for day 45 would be 43.0. It is usually assumed that such tables do not change from one year to the next. This is, in fact, a more flexible way of deriving forage quality values than would at first appear to be the case, there is no reason why the table values should remain constant, but could easily be made to change in response to certain weather variables, for example. A more profound criticism of the approach

FIGURE 7 CONCEPTION CHANGES II

CFM = MATURITY-CONCEPTION PROBABILITY
MULTIPLICATION FACTOR
WM/WMA = RELATIVE MATURITY RATIO



is that there is no feedback between growth or accumulation of biomass on the one hand, and forage quality on the other. When animal behaviour is added to the picture, it is apparent that tabular representation can account for only a fraction of the complexity of the real system. The problem is really as follows: animal growth can be modelled with a good degree of accuracy, if it is known what sort of material is actually ingested. Plant growth can also be modelled, given sufficient information. The behaviour of the animal, and its effect on the sward, through selective grazing both within and between species, make the prediction of what the animal eats, when presented with a particular pasture, extremely hazardous indeed.

In the present case, pasture has had to be treated in many ways like an experimental variable. To date, savanna has been treated as a homogeneous resource, and data have been so few as regards its growth that there has been little alternative to the tabular approach (although the model makes provision for animals grazing different types of savanna, such as recently burnt or *bajo* savanna). The problem here is to impute "reasonable" values for digestibility, crude protein content, and growth rate over time, which may be taken as being typical.

The situation for improved pasture is rather different, especially if grass-legume mixtures are being considered. In contrast to savanna, availability of such pasture would appear to be much more critical, necessitating some sort of explicit growth model. Considerable effort is being expended on the construction of a simple two-species pasture which can be used to examine animal-pasture interactions, and as a bonus it should be able to be used in RUSMOB also. A short summary of the salient features follows:

PASMDD

At this stage PASMDD is a purely conceptual model of grazing in a two-species pasture. It was constructed (Fisher and Thornton, 1987; Thornton and Fisher, 1987) to help set up an experimental program for the Ecophysiology section in Carinagua, in an effort to understand the dynamics of grass-legume pastures both with and without grazing animals. It currently has the status of hypothesis, although it appears to react in

sensible ways to various external stimuli. The idea for a simple model came from the work of Noy-Meir (1975, 1976), who considered continuous and rotational grazing in a mono-species pasture, using just two functions - a net growth function and a consumption function.

The original PASHOD model used six basic functions, five of which are shown in Figure B. The sixth was a simple ramp function relating intake to biomass. This number is in the process of being extended, to allow multi-season simulations. Pasture growth itself uses three:

- I Leaf Area Index = $f(\text{Biomass})$
- II Senescence Rate = $f(\text{Biomass})$
- III Potential Growth Rate = $f(\text{Leaf Area Index})$

Potential growth rate may be modified to Actual growth rate by a consideration of competition, both spatial and non-spatial; the latter is accounted for by the fourth function,

- IV Actual Relative Growth Rate = $f(\text{Potential Relative Growth Rate})$

The effect of the animal is limited to a consideration of its consumption of the two species and the feedback which this has on subsequent biomass, the selection (or preference) function.

- V Proportion of legume in diet = $f(\text{Proportion of legume available})$.

(In PASHOD, the sixth function relating intake to biomass completed the original specification of the model,

- VI Intake kgDM/100kgLW = $f(\text{Biomass})$,

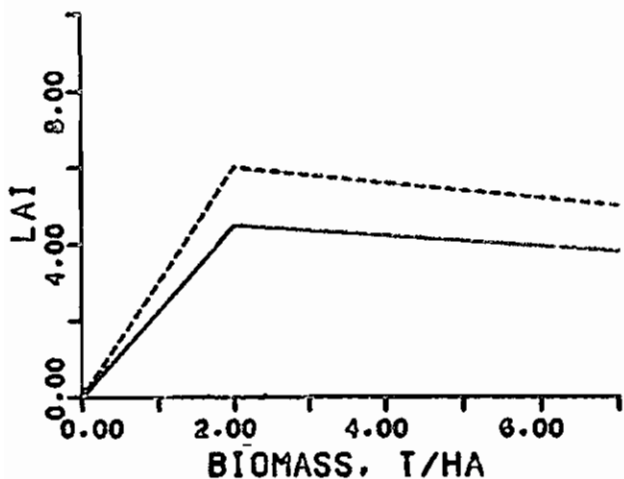
but clearly this is not needed here, since the beef model has its own intake equations to drive the forage component.) A seventh function is being evaluated, to allow forage to be grown from one season to the next, this consists of a factor which modifies actual growth rate in response to water-limiting conditions.

Simulation proceeds on a daily basis, first by calculating today's biomass on the basis of yesterday's, and then subtracting today's consumption (if any).

Two aspects in particular are important with regard to the use of this model in RUSMOB: seasonal changes in the function parameters, and herbage quality. For the first of these, it is possible that the effect of season

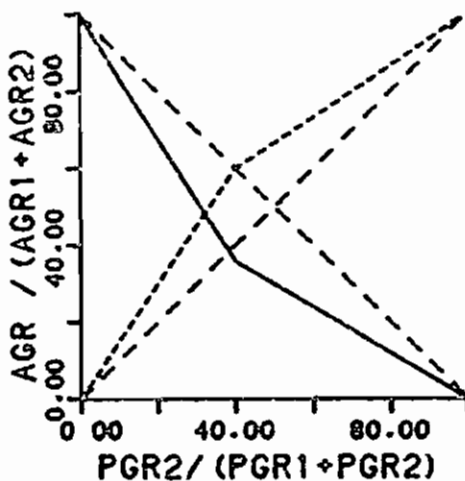
I LAI=F(V)

LEGUME GRASS



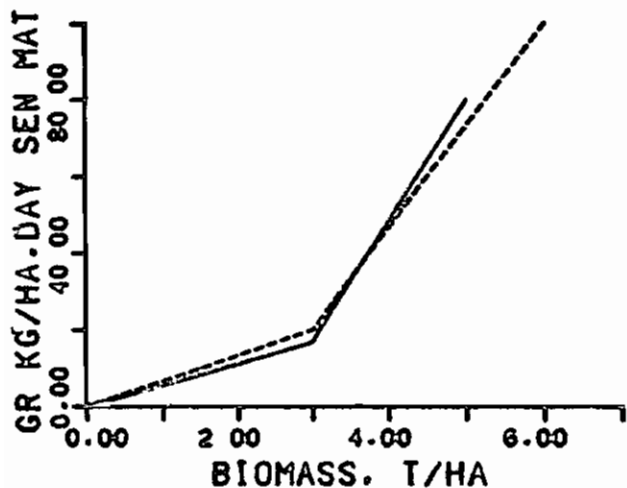
IV CON=F(P(2))%

LEGUME GRASS



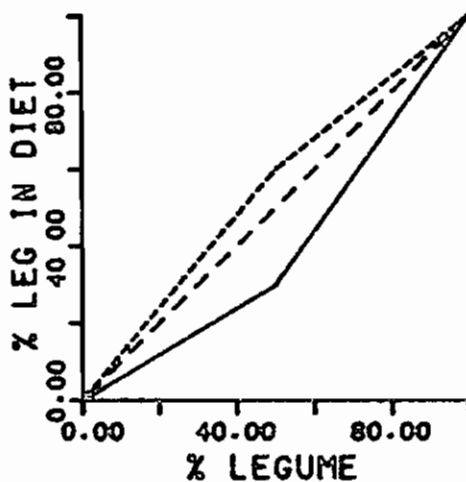
II PSM=F(V)

LEGUME GRASS



V PD=F(P(1))

TYPE I IV V



III PGR=F(LAI)

LEGUME GRASS

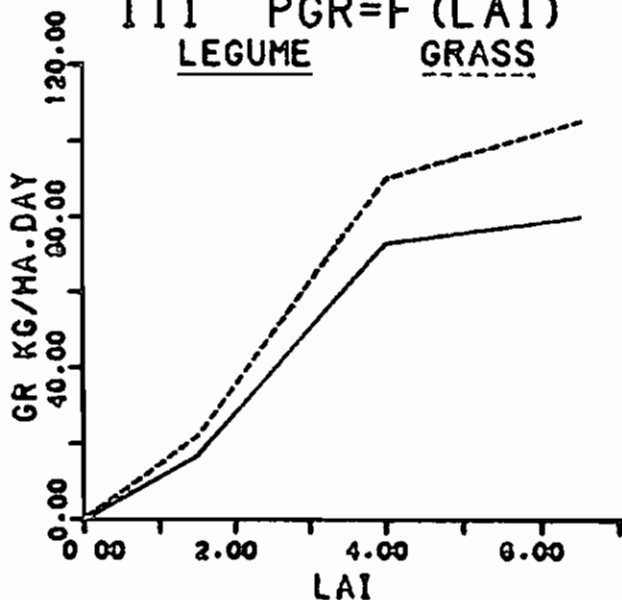


FIGURE 8
BASIC PASMODO FUNCTIONS

on such a model can be limited to changes in potential growth rates, brought about primarily because of lack of water at regular times of the year. This is currently being investigated. For the second, no satisfactory method of linking the changes in digestibility in some way to the functions considered has been found yet. A mechanism relating the proportion of new growth in the pasture to its quality proved too inflexible. Again, pending further investigation, digestibility is handled using tables over time, with the attendant disadvantages of this method. The subroutine corresponding to PASM0D within the system is called PASMIP.

A full description of this pasture model may be found elsewhere (Fisher and Thornton, 1987, Thornton and Fisher, 1987). Its incorporation into RUSMOB necessitates only slight modifications; consumption has to be calculated outside the growth routine, for example, and provision has to be made to marry up the daily time step of PASM0D with whatever time step is operating in the rest of RUSMOB. The general structure of all forage routines is outlined in section 4.2.

4 SYSTEM STRUCTURE

4.1 General

General features of the system include the following:

- simulation runs of up to 20 years can be carried out, with breeding herds of up to 30-40 animals
- the type of run is set by a mode variable; the mode of a run cannot be changed once the run has started
- a run can be carried out entirely in a batch mode, whereby decisions are made using fixed decision rules built into the model
- a run can be carried out in an interactive mode, the simulation can be halted at any time, the animals, forage or cash flows inspected, and almost any management may be imposed for as long or as short a time as required
- at the end of the run, net present values and internal rates of return are calculated, if possible, these may be incremental, compared

with a base-line cash flow Economic re-analysis is then possible, by the re-reading of the entire event file for the run This file keeps a record of every significant event (conception, death, sale, for instance) that happens to each animal Thus, the influence of a drop in price can be examined on the same biological sequence of events without having to re-run the entire simulation

- animals may be divided into mobs on the basis of age, sex, or physiological status, and then fed a whole variety of forage within mobs Provision also exists for rotational grazing of improved pasture

- available forage resources number four, three different types of savanna are allowed, as is one paddock (or multiple paddocks for rotational grazing) of improved grass-legume pasture How this is fed is entirely up to the user, within the limits of an extensive set of allowable combinations

- monthly cash flow data are output in a fashion to facilitate subsequent analysis, if, for example, they prove to be ill-conditioned (multiple roots etc)

- individual animal weights may be output to a file for subsequent input to a graphing program, for example, to obtain a visible record of weight evolution over time

- provision exists for investigating dual-purpose systems, by specifying a milk offtake rate and a milk price

The herbage routines, economic routines, input-output capabilities and the interactive system are now described in some detail

4 2 Herbage and Grazing

Control of any run is handled by a number of user-set parameters One of these is IRUM If this is set to zero, then the simulation makes use of the original forage tables as used in early versions of the model and during the preliminary validation runs In this case, there is only one type of forage (savanna), but the area (ARE) and starting biomass (BIOL) are set internally, since there is no feedback from the amount consumed to the amount of dry matter in the pasture, i e , availability is unlimited This run mode has been preserved to facilitate de-bugging after gross changes have been made to the model code (by running the model using the

same input data to see if the output data are directly comparable with those obtained before the changes were made)

If IRUM is set to 1, then the amount of forage is determined on a daily basis for up to four different resources with areas of AREA(i) ha and starting biomasses of BID(i) kg/ha. Resource numbers 1 to 3 are reserved for types of savanna with significantly different characteristics, whilst resources 4 and 5 refer to a legume and a grass respectively. If both a grass and a legume exist, then a mixture is assumed (hence there is a maximum of FOUR forage resources). The three savannas are handled in separate modules, and so can have different growth and quality characteristics. Thus, for example, if the following values are entered,

	Resource No	1	2	3	4	5
Area ha		20	0	0	2	0
Biomass kg/ha		4600	0	0	3500	0

the run starts with 20 ha of savanna with an initial biomass of 4.6 t/ha, and 2 ha of pure legume pasture with 3.5 t/ha dry matter.

New resources can be bought into the run at any stage of the simulation, simply by entering relevant non-zero areas and starting biomasses.

Two subroutines are concerned with sorting out what a particular animal has access to among different forage resources at any time, called MOBRAT and MOBGRA. First, an animal is assigned to its relevant physiological status group (Table 1). Implanted decision rules or interactive intercession then assigns a five digit code which is stored in one of the positions of each animal's array (VV(1,23), where 1 is the animal number). This code starts with a 1, the next three digits, 1 or 0, refer to the availability or otherwise, of the three types of savanna, whilst the fifth digit refers to the grass-legume improved pasture. Thus, an animal assigned a code of 11001 has access to savanna type 1 and whatever improved pasture there may be. When it is the animal's turn to eat, the code is decoded, and if the relevant digit for each resource number is not zero, then that forage resource goes to help make up the animal's diet at that time.

The mixing of the diet for any particular animal, where that animal has

TABLE 1 ANIMAL PHYSIOLOGICAL STATUS GROUPS

Group	Status	Group	Status
1	Dry empty	14	Female age < 1 yr
2	Pregnant 1-3 mos	15	1-2 yr
3	4-6 mos	16	2-3 yr
4	7-9 mos	17	3-4 yr
5	Lactating 1-3 mos	18	> 4 yr
6	4-6 mos	19	Male age < 1 yr
7	7-9 mos	20	1-2 yr
8	Pregnant 1-3, lactating 3-6 mos	21	2-3 yr
9	7-9 mos	22	3-4 yr
10	Pregnant 4-6, lactating 7-9 mos	23	> 4 yr
11	- null -		
12	Calf male < 12 mos		
13	Calf female < 12 mos		
BREEDING HERD		FOLLOWERS HERD	

Note - each animal's status (not calves) is stored in array VV(1,9)

- the number in each group in any month is stored in array NHEAD

Also NHEAD(24) = NHDSUM(m,1) = no of animals in breeding herd,

25 2 = no of calves,

26 3 = no of followers, in month m

access to more than one resource, is carried out in subroutine MIXER or subroutine CALMIX, depending on whether the animal is classified as an adult (breeder or follower) or as a calf, except for the selection of grass and legume from a mixed sward, which is carried out in subroutine PASMIP directly. In many cases it is not necessary to use this routine, since most animals will often have access to only one resource at any time (although this may change through time), and clearly such a diet would not have to be mixed. It is apparent, however, that some type of preference functions will be required when subroutine MIXER has to operate, at present, information is scanty regarding such functions, so that multiple forage resources should be used with care. The following forage code combinations present no problem, being essentially single resources

11000	savanna type 1
10100	2
10010	3
10001	improved pasture, mixed in subroutine PASMIP

The next most useful set of codes is that concerned with the grazing of small banks of improved pasture,

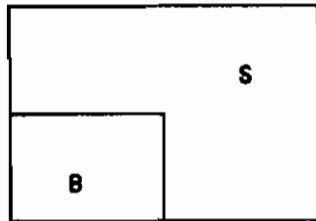
11001	} savanna + improved pasture
10101	
10011	

Many of the other possible code combinations can be seen to be unrealistic for most uses; at any one time, it is unlikely for an animal to have access to more than one type of savanna (bearing in mind that the code can be changed as often as possible). Generally speaking, then, it is reasonable to restrict the codes to those considered above.

The consideration of forage codes has a direct bearing on the types of grazing system that can be accommodated in the model. The types of system that users are likely to be interested in are illustrated in Figure 9. Obviously it is difficult to include every type, but it will be appreciated that "grazing system" really refers only to a changing of available resources through time, seen in this sense, the model is in fact capable of handling most systems. Of the systems considered in Figure 9, there is only one where explicit preference functions are required outside PASMIP (type I).

FIGURE 9 EXAMPLES OF RUSMOB GRAZING SYSTEMS

TYPE I

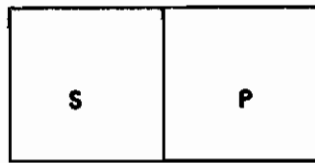


FREE ACCESS OR STRATEGIC

DIET = S (+B)

PREFERENCE FUNCTIONS NEEDED

TYPE II

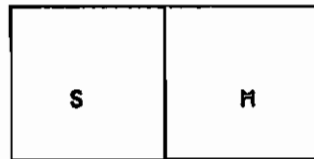


ROTATIONAL OR STRATEGIC

DIET = S OR P

NO PREFERENCE FUNCTIONS

TYPE III

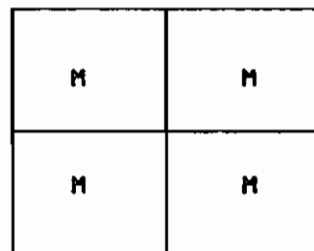


ROTATIONAL OR STRATEGIC

DIET = S OR M

NO PREFERENCE FUNCTIONS

TYPE IV



ROTATIONAL

DIET = M

NO PREFERENCE FUNCTIONS

NOTE - ASSUMED THAT ANIMAL HAS ACCESS TO ONE TYPE OF SAVANNA ONLY

- ASSUMED THAT LEGUME/GRASS PREFERENCE FUNCTIONS ARE EXTANT

- BASICALLY ANY SYSTEM CAN BE IMPOSED WITHIN THE STRUCTURE OF RUSMOB

- S = SAVANNA

B = BANK OF IMPROVED PASTURE

- M = MIXTURE OF LEGUME AND GRASS

P = PURE SWARD LEGUME OR GRASS

If it transpires that a savanna mosaic is of importance, i.e., an animal having instantaneous access to more than one type of savanna and some sort of improved pasture, then this can be handled at the cost of deriving or imputing a preference function which may or may not change over time

Imposing rotational grazing for a mob (code 10001) necessitates the input of special data; this is described in section 4.5 on the interactive system. The constituent paddocks can be of any (unequal) size, and there is a similar latitude in allowable occupation times

Suckling calves constitute a mob in their own right, and can be assigned different pasture from that consumed by their dams

All four forage subroutines (SAV1, SAV2, SAV3 and PASHIP) are built on similar lines. Each is in two main parts: the first deals with growth, the second with subtracting the amount of that resource consumed during time dt from the current biomass. The point of entry to the routine is controlled by the value of the one passed parameter in each case (1 or 2). The sequence of events for herbage is shown in Figure 10. The sequence can be illustrated by reference to one resource, e.g. savanna type 1. Assume that the beef model time (dt) step is 5 days, and that day 100 starts with there being 4230 kg of dry matter:

DAY 100	BIO(1) = 4230
	+ net growth day 101 = 4270
	+ day 102 = 4312
	+ day 103 = 4356
	+ day 104 = 4402
	+ day 105 = 4450

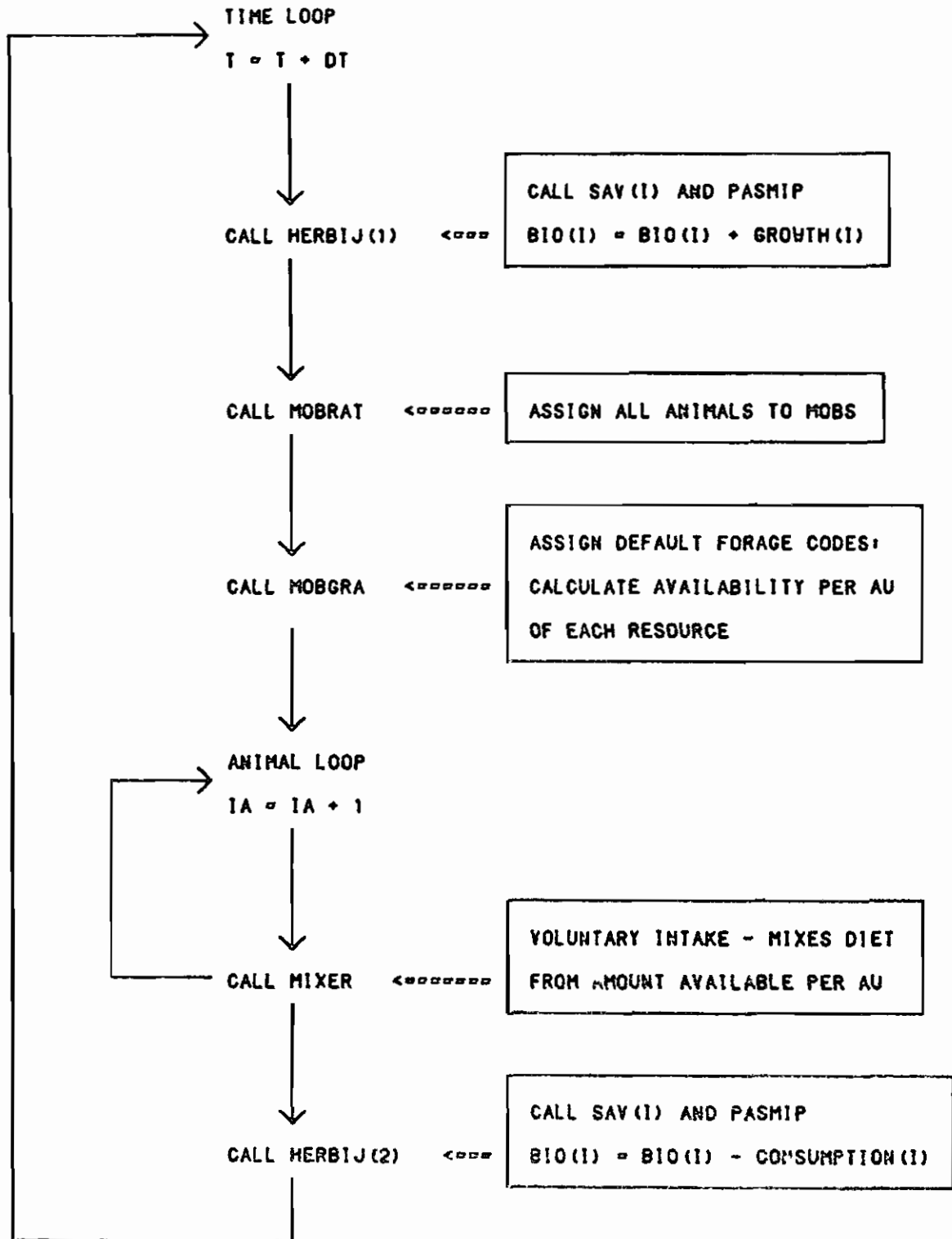
Assume 32 animal units have access to this forage,
Availability per AU per day:

$$QQ(1) = (4450 / (32 * 5)) * AREA(1) = 28 * AREA(1)$$

Consumption FSUR(1) = 5 * 32 * V I

If V I = 60 (and V I <= QQ(1), else availability is

FIGURE 10 HERBAGE EVENT SEQUENCE



limiting), $ESUM(1) = 960 \text{ kg}$

Thus, $BIO(1) = 4450 - 960 / AREA(1)$

DAY 105

$BIO(1) = 4418$

:

:

An interesting point to arise from the above example is the following what happens if $QB(1)$ is less than voluntary intake (i.e. availability is limiting)? At present, the decision rule operating in the model simply assigns whatever is available to each animal unit. Clearly, rationing rules could become very complex, and this is one area where the interactive nature of the computer system can help to overcome problems associated with animals running out of forage.

4.3 Economic Routines

The objective of these routines is the following:

- 1) to keep track of every sale or purchase, and where one occurs, to note the relevant price and store and cumulate the result until the end of the run
- 2) at the end of the biological run, to try to calculate the net present value (NPV) and internal rate of return (IRR) for the cash flow
- 3) if required, to calculate the incremental NPV and IRR of the present cash flow and a previous cash flow stored in a file
- 4) if required, to re-analyse a particular biological run using different economic parameters (i.e., go back to 1)

Subroutine PRICE is called every dt , to set the prices for the categories of animal considered. At present, these are as follows:

1=1	cows bought	\$/kg
2	cull cows sold	\$/kg
3	female calf sold	\$/kg
4	male calf sold	\$/kg
5	female rollover sold	\$/kg

6 male follower sold \$/kg

These can be changed or added to as required

Annual price data from 20 years at the Feria in Medellin were analysed to try to identify cycles and trends in the data. Monthly data from 1975 were analysed to investigate seasonal variation in price. The paucity of data would make a nonsense of spectral analysis; a case could be made for a cycle length of 4, 5 or 6 years. Thus price simulation is crude: it is assumed that a cosine wave of a certain period and amplitude is sufficient to fit the data (judged wholly subjectively). The yearly data were deflated using the Colombian Consumer Price Index, and de-trended using linear regression (a method open to debate) to produce the time series shown in Figure 11a. It should be noted that the trend line has a negative slope, in contradistinction to Juri et al (1977), although why this should be is not clear. Annual prices are currently calculated in RUSMOB using a cosine cycle of 6 years with no trend imposed. This average value is then multiplied by a monthly factor to account for seasonal variation about this mean, the monthly factors being the average of 11 years oscillations about recorded means. It is recognised that this is not an elegant method for simulating prices. There are two separate price cycles, for male and female animals. Another input required of the user, in addition to cycle lengths and amplitudes, is the point in the cycle where the user wants to begin. It is assumed as a starting point that the relative increments between the various categories are always the same (i.e. the same form of cycle applies to each price category within the sexes).

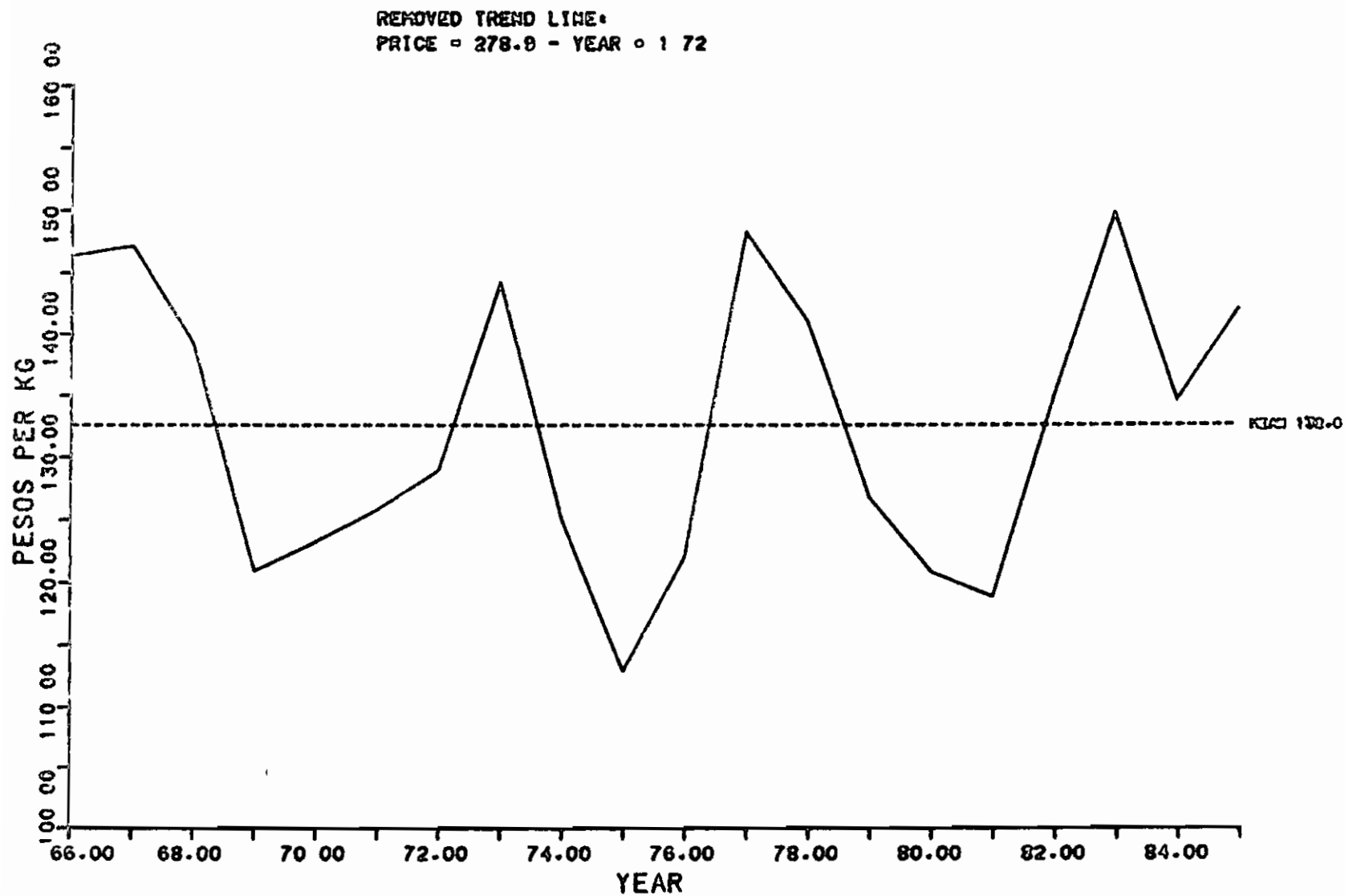
The buying price of an animal is assumed to be correlated with the female sale price. Its actual value is determined randomly, using a relation which takes account of the theoretical degree of correlation, so that at some times, the sale price is greater than the buying price, and at other times it is less. This was done to preclude the possibility of the rancher (or the user) becoming a cattle dealer. The relationship used is as follows:

$$BP = (SP - SP_0/s_1) * CORR + ((1 - CORR^2) * RNN)^{0.5} * s_2 + BP_0$$

where

- BP = buying price at time t,
 SP = selling price at time t,

FIGURE 11 STEER PRICES, MEDELLIN, 1966-1985
DETRENDED AND DEFLATED



SP_0 = mean selling price,
 s_1 = standard deviation of the selling price,
 CORR = theoretical correlation coefficient between SP and BP,
 RNN = a random normal number,
 s_2 = standard deviation of the buying price, and
 BP_0 = mean buying price

Price standard deviations were estimated from a large number of random generations. Figure 11b shows simulated prices for 24 years (four complete cycles), with a correlation coefficient of 0.70 between selling price and buying price. Random normal numbers are generated using the Marsaglia-Bray variation of the Box-Muller method (subroutine MARSAG), which returns two random normal numbers for every call (although only one is used). This subroutine in turn calls a different random uniform number generator from that used in the rest of the system, to allow separate seeding.

For lack of information, the milk price, if used, is set at a constant value (at the time of writing, C\$32 / kg), although this can be changed between economic analyses.

Whenever an animal is bought or sold, subroutine ACOUNT is called to cumulate the number of pesos paid or received for that category. At the end of each month, subroutine ECONOM is called, and the month's cash balance is calculated. At the end of the run, the NPV is calculated at 5, 10, 15, 20, 25 and 100%, and the IRR is found using a simple iterative procedure (subroutine ZIR). The month's cash flow is defined as follows:

$$BAL(1) = BEN(1) - COST(1)$$

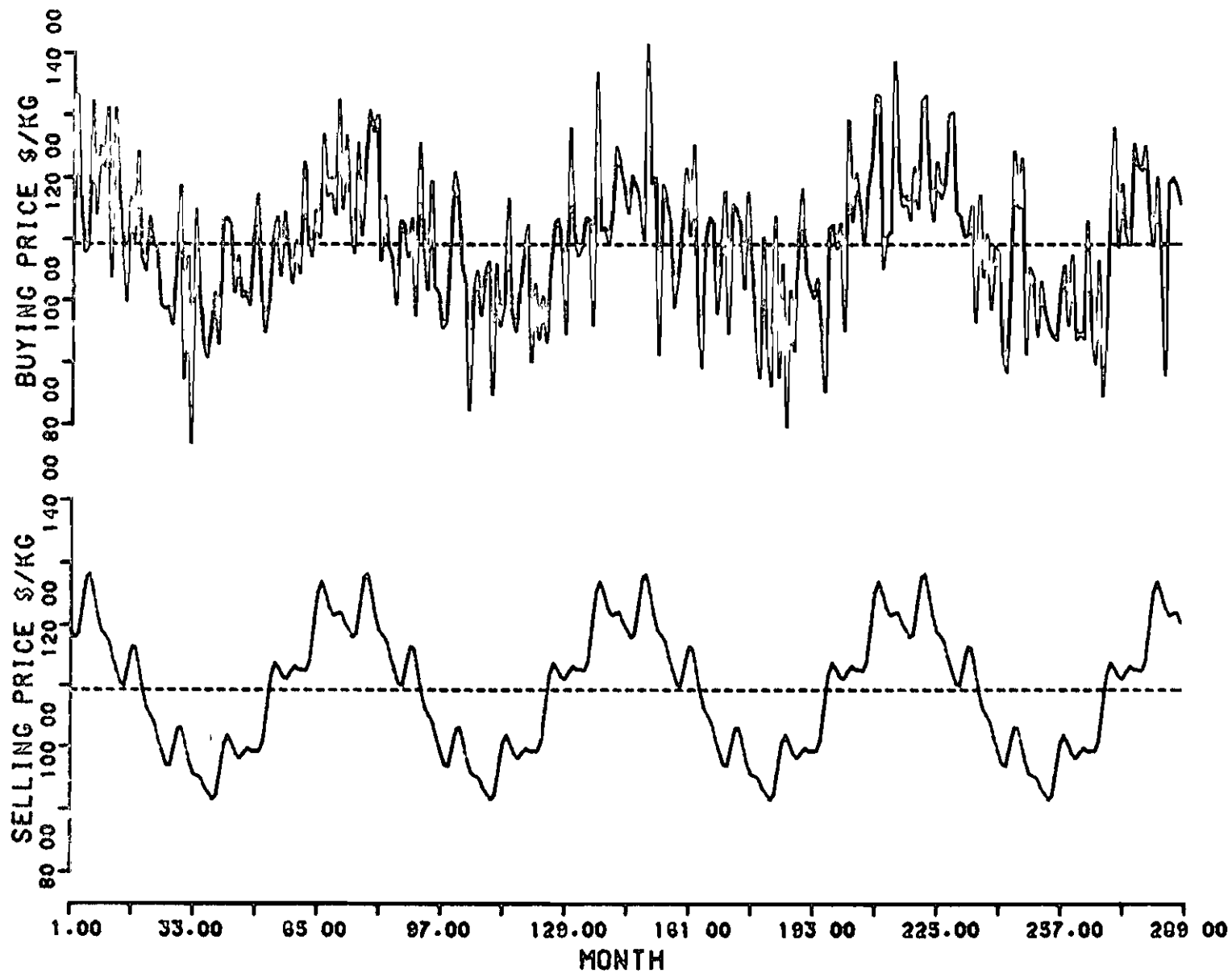
where $BEN(1) = CULL(1) + CARF(1) + CFOL(1) + CAPIT(1) + ZMILK(1)$ and
 $COST(1) = CHERD(1) + CBUY(1) + CGAST(1)$

for month 1. $CULL(1)$, $CARF(1)$ and $CFOL(1)$ contain the money received from the sale of culls, calves and followers, respectively, while $CAPIT(1)$ refers to the capitalisation of the herd at the end of the run and $ZMILK(1)$ contains the month's income from milk sales, if any. $CHERD(i)$ contains the capital costs, $CBUY(1)$ the money paid out for new cows, and $CGAST(1)$ the variable costs that month. These last costs may be calculated either per head of stock or through explicit input, i.e.

$$CGAST(1) = CVAR * nLover of animals + CGAST(1),$$

where CVAR is a fixed charge (or zero) and the $CGAST(1)$ on the right hand

FIGURE 118 CORRELATED BUYING AND SELLING PRICES, 4 CYCLES
CORRELATION COEFFICIENT (THEORETICAL) = 0.67 (0.70)



side of the equation is an input datum (again, this may be zero) Credit and borrowing are not considered in this schema. The IRR of the resultant cash flow is calculated twice, the first time on a monthly basis (being converted to a yearly basis); for the second, the flow is cumulated into years first, and then the IRR of the annual flow is calculated. All printouts from the economic analyses go to the file on logical unit 11 (see Table 2). For each twelve-month period, the average prices paid or received are calculated and printed.

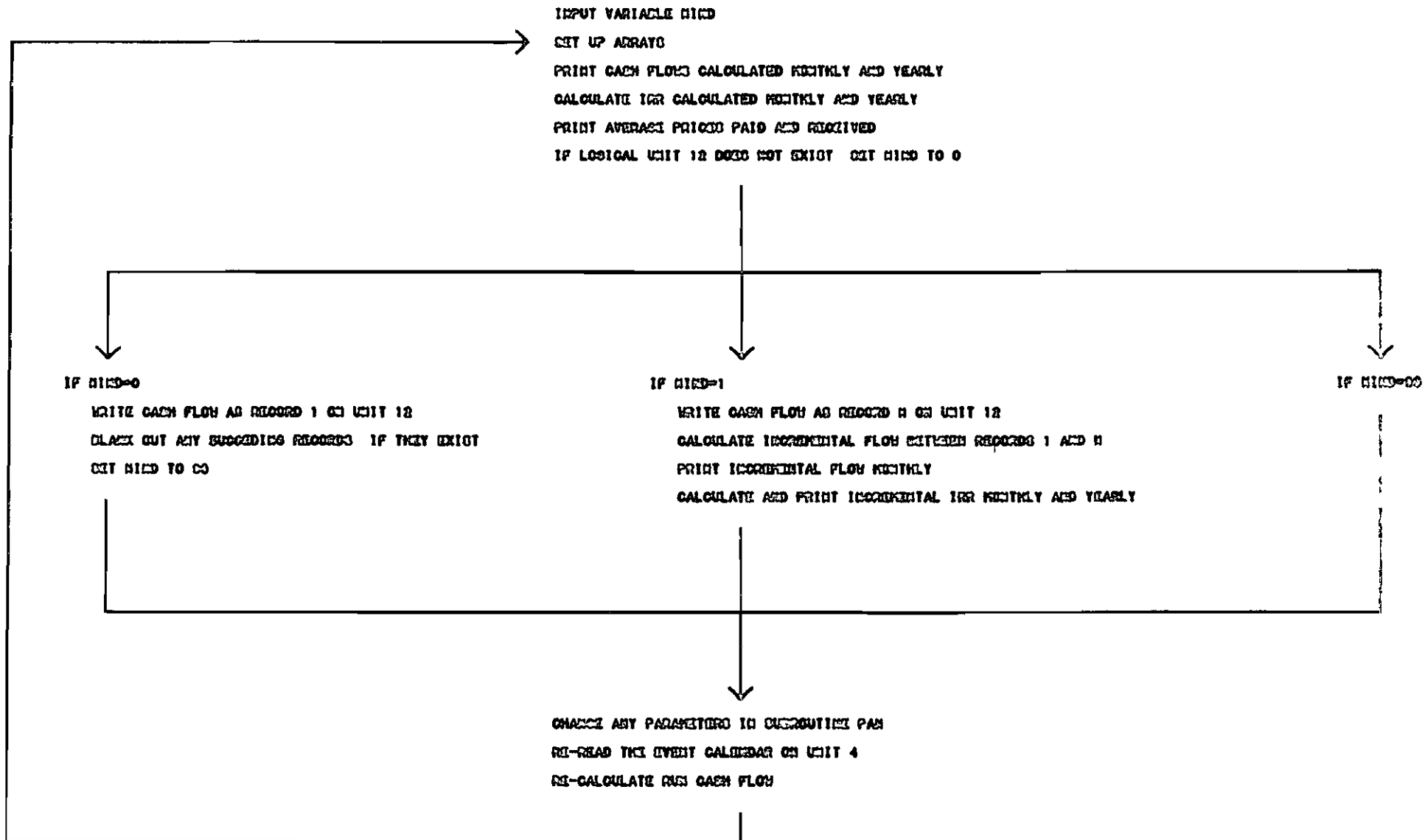
The next task is the calculation of the incremental flow and subsequent calculations. This is controlled by a variable NIND, whose operation is described in Figure 12. The possibilities are as follows:

1) the run is seen as a base-line simulation; the cash flow is written as the first record of a new file.

2) the run is subsequent to a base-line simulation, and the user wants to compare the current production system with the base-line one. In this case, all cash flows are written as records subsequent to the first (base-line) record in the file, and incremental flows are calculated for each analysis and re-analysis of the biological data.

In the sequence of tasks, the re-analysis of a run comes next. This is controlled from subroutine ANALIZ, which rewinds the file on logical unit 4 (the calendar of events), and then goes through this file recalculating the monthly cash flow, using parameters which may have been changed in PAN (either in situ or interactively). For example, the next event read from the file may be the sale of a calf; subroutine PRICE is called with the correct simulation date for this event, and the price received is cumulated in the relevant array; if the next event to occur happens in the subsequent month, then subroutine ECONOM is called to calculate the cash flow for the "present" month. Of course, if the next event does not occur until 2 months later, then subroutine ECONOM is still called for the subsequent month (all the relevant arrays for that month will then contain zero). Obvious changes that can be made to the re-analysis would include the form of the price cycle (amplitude, trend, or starting point), the relative prices pertaining to each category, or the price received per kilogram of milk. At the conclusion, the same sequence of analysis takes place as for the original run - monthly and yearly IRRs are calculated, and

FIGURE 12 RUSMOB V4.1 CASH FLOW MODULE STRUCTURE



the incremental flow is calculated. Up to six additional analyses may be stored in unit 12 by columns, if more are carried out, then the column containing the most recent analysis keeps changing.

Two points relate to all analyses:

- it may be that the cash flow is ill-conditioned and hence not amenable to the calculation of an IRR (multiple roots etc). A subsidiary program could then be used to read the cash flow(s) in unit 12 and print to a file with a format suitable for reading into Lotus 1-2-3, for instance, where the nature of the ill-conditioning could be investigated, if required.
- in accordance with usual practice, for the annual cash flows (which are cumulated from the monthly values), the capital costs and variable costs for month 1 are assigned to year 0.

4.4 Input-Output

Data may be entered in one of two ways - by file, or through use of the interactive system (see section 4.5). The major input file occupies logical unit 15 (Table 2). This is largely unchanged from early versions of the beef model, although there are some additions. Table 3 shows the contents of this file, record by record, as read by RUSMDB. (Refer to Appendix B.2 for variable name list). It should be noted that there are as yet no data checking routines in RUSMDB for this file; great care is needed, therefore, when changing this file.

A large amount of data is entered as defaults in the actual FORTRAN code of the model. Many of these can be changed with care. The major implicit assumptions are outlined in Section 5 as these relate to parameter values and decision rules currently operating in the model. A number of these can be changed using the interactive system.

Results from the run are printed to a number of files (Table 2). In normal use, units 6, 9, 10 and 11 will be of most interest, many of the other files being concerned with dc-debugging tasks.

Data input-output is controlled by a number of parameters.

TABLE 2 RUSMOB EXTERNAL FILES

Logical Name Unit	Name	Function	Program Names	
			Reads	Writes
4	AA4	biological event calendar	MAIN +ANALIZ	INLOOP +ANLOOP
5	terminal	run progress report	-	MAIN
6	OUTPUT	animal output file	-	MAIN +INLOOP +ANLOOP +MDPGRA +CONCEP
7	ANIMAL	individual animal weight	-	ANLOOP +MAIN
8	DUMF	animal debug output	-	ANLOOP
9	PASTO	pasture output	-	HERBIJ
10	PASDUMP	pasture debug output, improved pasture	-	PASMIP +ROTBRA
11	CASHFLO	economic routines output	-	ECONOM +INCREM +ANALIZ +ZIR
12(*)	INCFLO	incremental cash flows	INCREM	INCREM
13	NXDUT	interactive debug output	-	NX----
15 *	REDDAT	data input	MAIN	-

* necessary for program operation (the rest are created as required)

(*) assumed to exist if NINC=1, if not NID is set to 1

INPUT The initial herd size is specified by NA This number of animals records is read from the input file If there are more animals in the file, then these are read into an array SPARE Then, if MODE>9, that is to say, the buying of breeding cows is allowed for this run, and sufficient numbers of heifers for replacement purposes cannot be generated, animals may be bought automatically, their weights, ages etc being found in the array SPARE For interactive runs, or where default management decisions are by-passed (IDEFLA=1, see below), the buying of breeding animals operates rather differently, and in most cases the animals in SPARE(1, j) will not be used

OUTPUT JEV = 0 suppresses printing the calendar of events
 = 1 the calendar is printed to unit 6 (DEFAULT)

JHERD = 0 suppresses the print-out of yearly herd composition tables
 = 1 prints herd composition tables (DEFAULT)
 = 2 prints very large quantities of information to unit 6 for de-bugging purposes

JA = 0 unit 7 not used
 = n vital statistics of animal number "n" are written to logical unit 7 in Genstat-readable format (DEFAULT: n=1)

IPRDEL = 0 unit 8 not used (DEFAULT)
 = 1 prints 24 variables for animals 1 to 5 at each dt for debugging purposes to unit 8

Of the other files, unit 4 is designed for internal reading and writing of the event calendar, unit 12 holds monthly cash flows (whence they may be transcribed to unit 11), and unit 13 contains all responses made using the interactive system, for debugging and for storing information relating to parameter or management changes Examples of program output are discussed in Section 5 of these notes

4.5 The Interactive System

The model can be run in three modes: pure batch, semi-batch, and interactive. This is controlled by the value of MODE.

MODE = 0 or 10 results in batch mode, the model operates solely on the basis of the contents of the main data input file and the decision rules built into the model. The interactive system plays no part.

MODE = 1 or 11 results in semi-batch mode, two interactive panels are called up, allowing the user to change some important run parameters, such as run length or number of animals in the herd, and the other allows the user to carry out economic analyses interactively, where prices and costs, for example, can be changed.

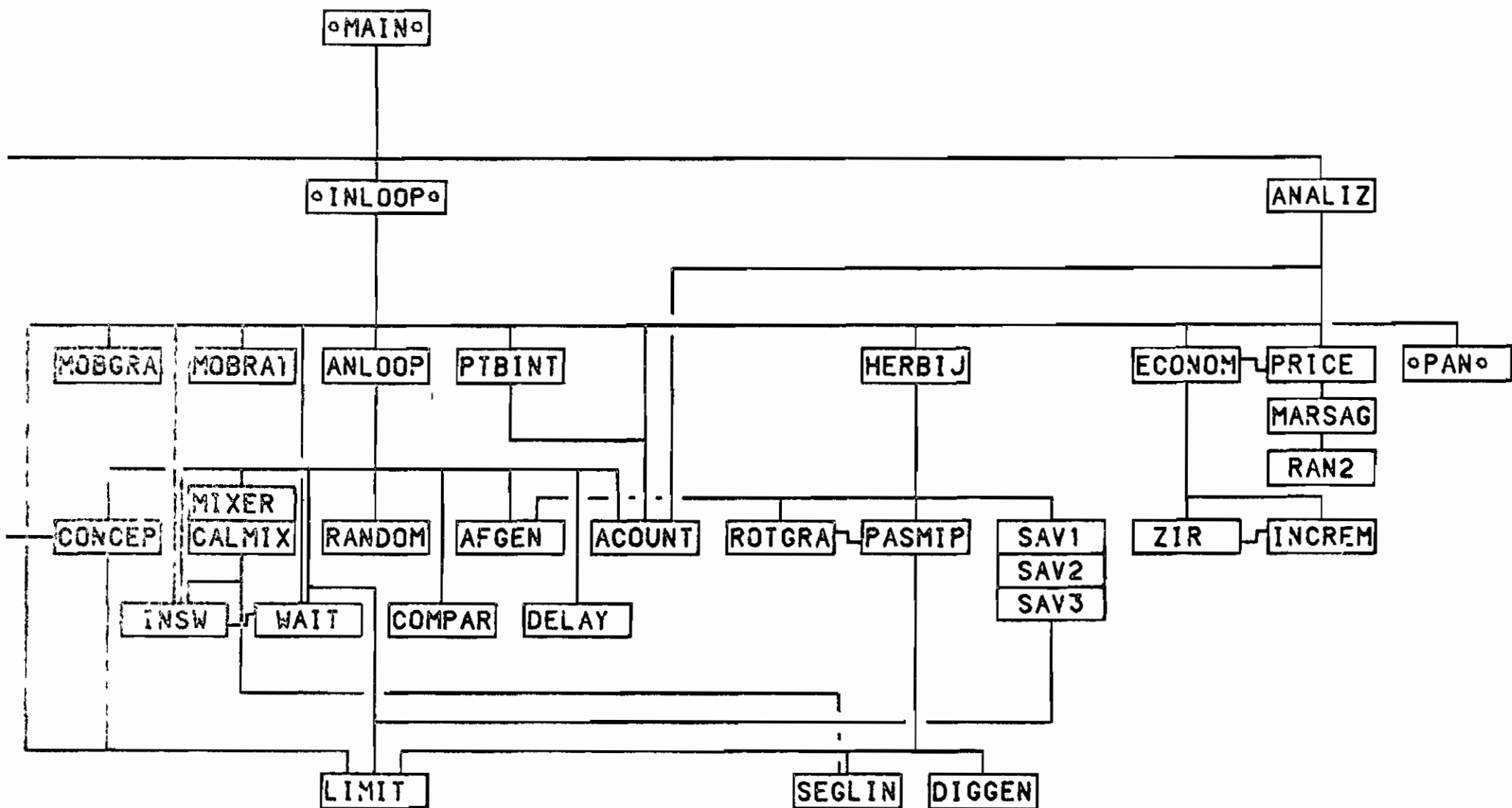
MODE = 2 or 12 results in full interactive mode. The user can set four (default) annual stop dates, and when these occur, or at any other time the user wishes, the simulation stops, and animal numbers, weights, sex and status can be displayed, pasture status can be investigated, the cash flow to date or the event calendar can be displayed, and stock can be weaned, sold, or bought as required.

As noted in Section 4.4, if MODE is greater than 9, then animals may be bought automatically if there is a shortfall of breeders. MODE options 10, 11 or 12 are unlikely to be used much, since most users will want more control over the buying of stock. One further point of relevance is that if MODE is set to 0 in the input file, the interactive system will never be called, whereas if it is set to 2, the initial panels will be called up (and the mode can be changed, if required).

The whole of RUSMOB is shown in Figures 13 and 14, with the original relative residence locations indicated in Figure 15. At a later date a module will be created, thus simplifying the use of the system for the general user. The interactive routines (those shown in Figure 14) are now described in turn.

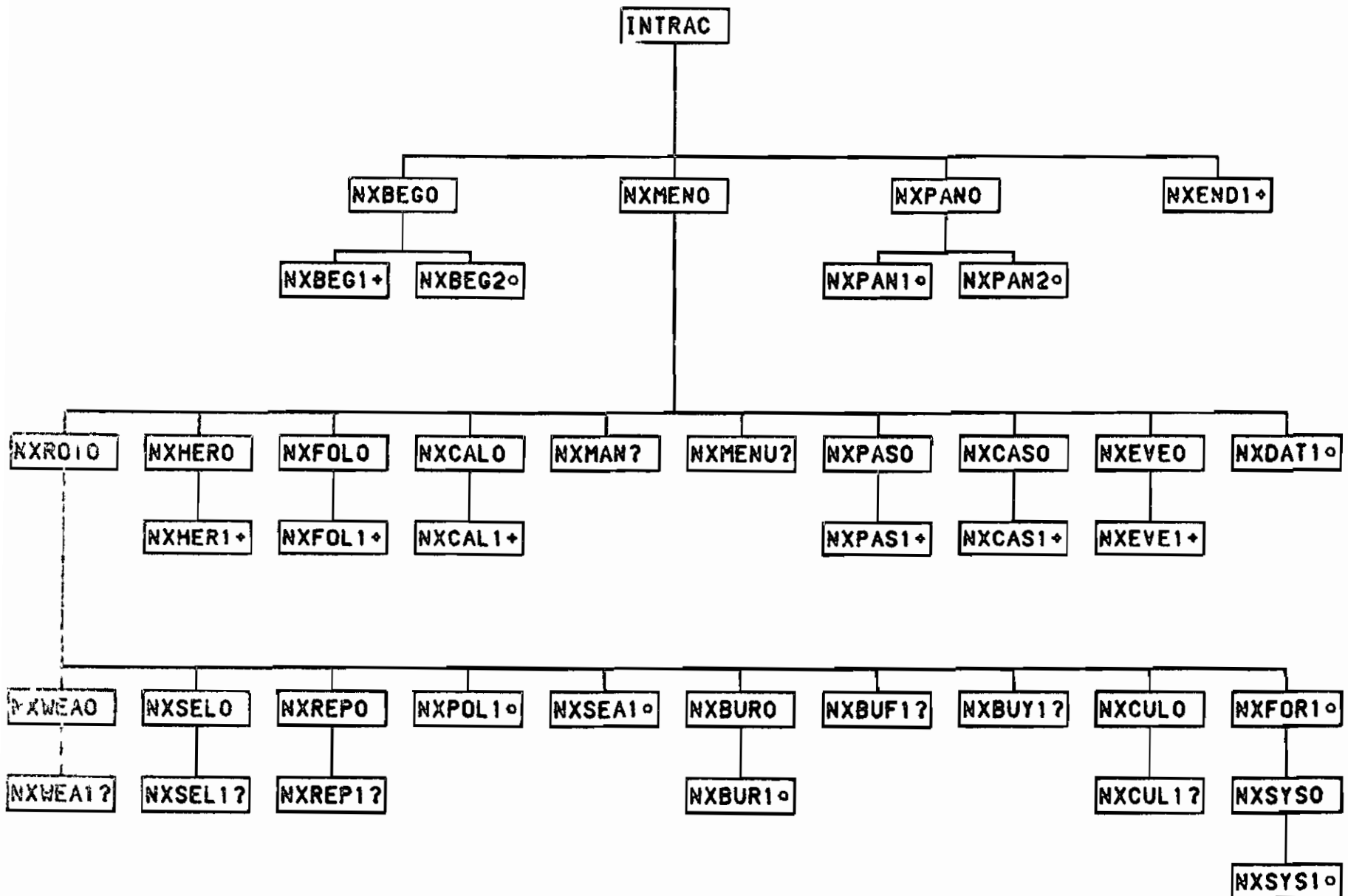
Subroutine INTRAC is the interface between the simulation model and the

FIGURE 13 RUSMOB V4.2 FORTRAN PROGRAM STRUCTURE (PART 1)



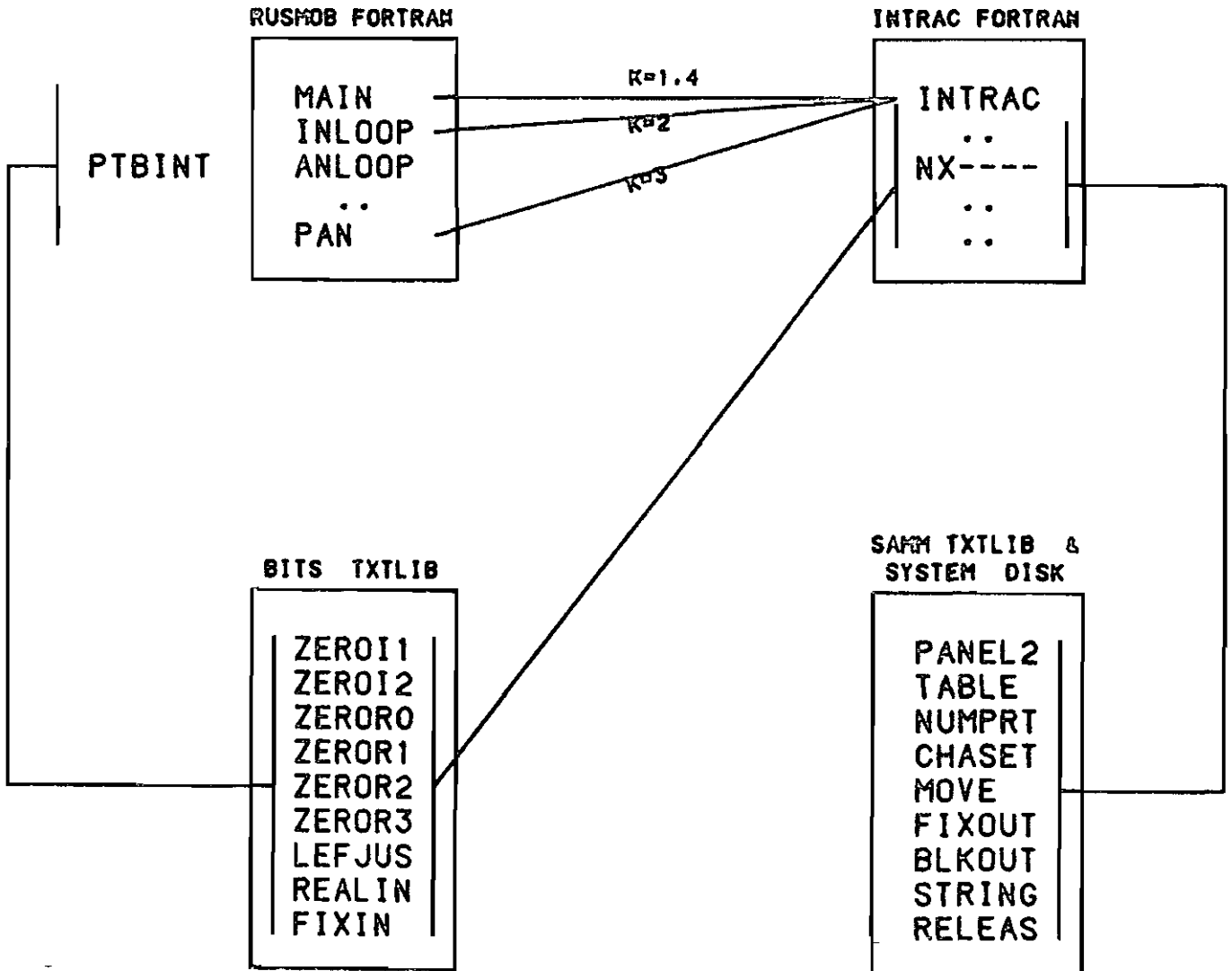
◦--◦ DENOTES CONNECTION TO THE INTERACTIVE SYSTEM

FIGURE 14 RUSMOB V4.2 FORTRAN PROGRAM STRUCTURE (PART 2)



- ◊ DATA ENTRY PANEL
- ? CHOOSE AND ENTER PANEL
- ◊ DISPLAY PANEL

FIGURE 15 RUSMOB V4.1 PHYSICAL LAYOUT OF PROGRAM



- K IS A PADDED PARAMETER TO DETERMINE THE POINT OF ENTRY TO INTRAC
- THE CLASS CODES REPRESENT DIFFERENT PHYSICAL LOCATIONS THE LINES REPRESENT COMMUNICATION PATHWAYS

interactive system, and calls up the relevant routine at the next level down in the system hierarchy, depending on the value of the passed parameter. At the start of the run, this has the value 1, in which case control passes to subroutine NXBEG0 and thence to subroutine NXBEG1, the first panel of the system, which simply spells out what the system is and the date of the last update.

Subroutine NXBEG2, the next panel called, is the major data entry panel at the start of the run, this and the previous panel are always shown unless MODE=0 from the data input file. If MODE is then set to zero, no more panels are seen. If MODE is set to 1, then no more panels are seen until the economic panels at the end of the simulation, even if simulation stop dates are entered. Data input facilities are as follows:

- a run name (up to 25 alphanumeric characters)

- a random number seed (a four-digit integer)

- the run type - if IRUM=0, original tabular forage data are used, and availability is unlimited. If IRUM=1, the areas and starting biomasses of the forage resources have to be specified. Once set, IRUM cannot be changed.

- the run mode - currently may take the values 0, 1, 2, 10, 11, or 12.

To summarise

MODE = 0	is	pure batch mode,
1		semi-batch mode;
2		interactive mode;
10		pure batch mode + automatic cow buying, if available,
11		semi-batch mode + " "
12		interactive mode + " "

The conditions under which cows are automatically bought were described above in section 3.4.

- run length - this is the simulation length in days. An upper limit of 7200 exists, and it is not recommended that values less than 720 are used (in fact, 3600 should be regarded as a working minimum, to avoid

possibilities of floating under- or over-flow pending the inclusion of data checking routines)

- the cash flow flag (NIND, see Figure 12) If NIND=0, the simulation is assumed to be the base-line run, and no subsequent re-analyses will result in any incremental NPVs or IRRs. If NIND=1, then it is assumed that the base-line cash flow already exists, and incremental analysis will take place, as long as all cash flows are of the same length

- the time step - this is variable between 1 and 30 days. Validation work showed that a good compromise between accuracy and efficiency was achieved with DELT set to 5; unless there are good reasons for changing it, it is recommended that this is left well alone

- annual stop dates; four of these may be set. They must be between 0 and 360 inclusive, and divisible by delt. If a stop is wanted at time $t=0$, set ISTOD(1) to 0 and ISTOD(2) greater than 0. Note that the manual stop date ISTOP, settable from the main menu panel, overrides these set dates in a particular way (see below)

- potential milk yield for the breed of animal in question, kg per day

- initial herd size; it is recommended that this be left at 30 individuals - the same comments as for DELT apply here

- forage areas and initial biomasses - these have to be set if IRUM=1. Note that pasture can enter and leave the production system during the run at stop dates, so choice here is not binding

It may be noted, from an inspection of the panels (see Appendix B 3) that, in general, keys PF1 or PF2 take the user on in the simulation or up and down in the hierarchy of panels, and that the run can always be abandoned using PF9. The user has to press PF9 once only to abort the run, and there is no possibility of recovering, save starting again.

If the parameter passed with subroutine INTRAC has the value 2, then control passes to the main menu (subroutine XMENU), which is the case at

all stop dates. Arrows are used to move the cursor until it occupies the line containing the option wanted, and PF1 then activates that option. In order of appearance in the menu, these options are as follows (subroutine NX---0, a panel controlling program, calls up subroutine NX---1 (and subroutine NX---2, if it exists) which is the panel calling program):

a) display the monthly cash flow (subroutines NXCAS0, NXCAS1) from the present (current date) back to the start of the run, with cumulative totals displayed at the bottom of the screen

b) display the breeding herd (subroutines NXHER0, NXHER1) - each animal's identification number, age, weight, normative weight, days pregnant, days lactating, and age at last calving

c) display the followers herd (subroutines NXFDL0, NXFDL1) - each animal's ID number, sex, weight, normative weight and age

d) display all calves (subroutines NXCAL0, NXCAL1) - the ID of the dam, the calf's sex, weight, normative weight, and age in days.

e) display the status of the pastures (subroutines NXPAS0, NXPAS1) - for each of the five types of pasture (with 4 areas), area, current biomass, ungrazeable residue, digestibility %, crude protein content %, and availability in terms of kg/AU. This panel has no meaning if IRUM=0

f) display all events from the event calendar that have occurred within the last year (subroutines NXEVE0, NXEVE1) - this shows the day, the year and the month of the occurrence, the event, and details of the animal(s) concerned. Events reported are adult death, calf death, birth, conception, abortion, weaning, replacement (i.e., a follower becomes a breeder), adult sale, calf sale, or animal buying

g) go to the management options menu (see below, subroutine NXHAN)

h) set the next halt date (subroutine NXDAT1) - a date thus set will override the annual dates set at the start of the run. Thus if ISTOD(1)=180, ISTOD(2)=360, ISTOD(3)=ISTOD(4)=0 and ISTOP is set manually

to day 270, year 2, at the second stop, the sequence and dates of run stops will be as follows:

stop number	1	ITIME	180	
	2		360	
	3		630	(360 + 270)
	4		720	(360 + ISTD(2))
	5		900	(720 + ISTD(1))
	:		:	etc
	:		:	

The user can thus impose an express run, by setting the next stop date manually to the end of the run

The Management Menu (subroutine NXMAN) - this is the second menu in the hierarchy. Again, options are selected using the cursor, but here PF2 is used to activate each option, since PF1 returns the user to the main menu. The available options here are all controlled through subroutine NXROT0:

a) buy animals for the breeding herd (subroutine NXBUY1) - there is much flexibility here, as the user enters the age of the animal in months, its weight, mature weight, and days pregnant. The herd ID number is assigned automatically on hitting the return key. A maximum of 10 animals may be bought at each stop date. Note that each animal's condition is implied by the interplay between age and weight (which between them and mature weight imply a particular normative weight).

b) cull breeders (subroutines NXCULO, NXCUL1) - the entire breeding herd is displayed, along with weights and age at last calving, and if culling of an animal is to take place, the cursor is positioned on the relevant line and the return key pressed. After this, an asterisk appears next to the animal's ID number. As many may be culled as required.

c) wean calves (subroutines NXHEA0, NXHEA1) - calf dam ID numbers, ages, sex and weights are displayed, and weaning may be done manually using the same mechanism described above for culling animals.

d) buy folio cows (subroutine NXBUF1) - this is the same as for buying breeders, except pregnant folio cows can not be bought, but sex may be

specified Again, a limit of 10 per stop date exists

e) sell followers (subroutines NXSELO, NXSEL1) - displays ID number, sex, weights and age, and the mechanism is the same as for culling animals

f) select followers as replacers (subroutines NXREPO, NXREP1) - the entire female part of the followers herd is displayed, and replacers may be picked manually using the same cursor mechanism as for culling animals Note that if an animal has already been selected to be sold, then an "S" appears by the animal ID number Similarly, if an animal has been selected as a replacer, and the follower sell panel is called, then an "R" appears by the ID number The most recent selection overrides any other. The same thing happens if a breeder is selected for culling ("C") and the calf is selected for weaning ("W") Since the most recent selection is the overriding one, weaning the calf and culling the dam would have to take place on successive stop dates (which could be as close as successive time increments)

g) pasture and mob management (subroutines NXFOR1, NXSYS0, NXSYS1) - three things can be done with this option:

- change the forage areas, and phase out or bring in different forage resources by setting the relevant biomasses and areas to zero or to values greater than zero

- change mob forage codes; for instance, the user might want to assign improved pasture to pregnant animals

- use PF4 to bring up another panel and impose rotational grazing, by entering the number of paddocks in the system, their areas and biomasses, and the number of days of occupancy Note that rotational grazing applies only to those animals with forage code 10001; for codes such as 11001, if any, such animals are restricted to savanna only Rotational grazing will then take place immediately, starting from paddock 1 Note also that if rotational grazing is concluded during a run (by selecting this menu and setting the number of paddocks to 1), then the current biomass on the paddock being grazed at the time of the stop date becomes the (one)

improved pasture resource - this may not be paddock number 1

h) burn any of the three types of savanna (if their areas are greater than zero) being utilised (subroutines NXBUR0, NXBUR1) - place the cursor on the relevant savanna number (1, 2 or 3) and press the return key. The resultant (burnt) biomass may be entered or changed by the user.

i) change the breeding season (subroutine NXSEA1) - assign 1 or 0 to each month in the panel, corresponding to whether the breeding herd has access to bulls during that month or not.

j) change policy rules in the model (subroutine NXPOL1). Possibilities here include the following:

- change the minimum age at weaning. Note that weaning is always done automatically at whatever age this is set to, i.e., as soon as a suckling calf reaches this age, it is weaned. This must be set ≥ 30 days.

- change the default animal management dates, these refer to the dates at which pregnancy tests are carried out, replacers initiated into the herd, etc., on the basis of the automatic decision rules (see Section 4). Both, one or neither may be set.

- change the maximum age of animals in the breeding herd, beyond which culling is automatic. This may be set to zero, in which case old age will ultimately be responsible for death.

- change other culling criteria - the number of permissible consecutive negative pregnancy tests (use in conjunction with the default animal management dates), or the maximum permissible number of days since the last conception.

- follower sales may be made to conform to minimum ages or weights (both sex-dependent), e.g. an individual male follower may be sold off as soon as it reaches a minimum age or a minimum weight, or, if at least one of the management dates is not set to zero, the animal will be sold off at the first opportunity (specified by that date) as long as its age or weight (or

both) exceeds these minima

- the required number of breeders can be changed, with the difference being bought or sold off automatically. The full implications of changing this from the starting value have not yet been explored, so it is strongly recommended that this is not touched

- the setting of a flag (IDEFLA) to override all default management rules, with the exception of weaning, which takes place automatically at the age specified in this panel

- the milk offtake rate (DFRAT) can be changed, and the constant price received for milk can be adjusted (PREIS)

At the conclusion of the day-to-day simulation, subroutine INTRAC is called with a value of the passed parameter of 3, which then passes control to the additional economic analysis panels (subroutines NXPANO, NXPANI and NXPAN2). One analysis is always carried out with the default settings for costs and prices. For any additional analyses, the following parameters can be changed from the first panel:

- variable costs per head (CVAR - see below); this may be set to a positive number or pesos, or to zero

- parameters for the sale and female price cycles - amplitudes and yearly trends (both percent), cycle lengths in years, starting points in the cycles (between 0 0 and the cycle length - note that cosines are used, so starting at 0 0 is equivalent to starting on the crest of the wave), and the initial prices for the animal categories (in pesos per head for cows bought and pesos per kg for cows sold)

- the milk price can be changed; it should be noted that the offtake rate obviously cannot be changed, and is a parameter embedded within each biological run

In the second panel, detailed cost schedules may be entered, F#2 may be used to switch back and forth between the two economic data panels. The

arrays CBAST (direct costs) and CHERD (capital costs), both of length $12*20+1$, are of interest here. There are default values for these, month by month, used for the first UNPROMPTED economic analysis. Generally,

$$\text{CHERD}(i) = 0,$$

$$\text{and } \text{CBAST}(i) = \text{constant}, n$$

$$\text{or } \text{CBAST}(i) = n + \text{CVAR} * \text{no. of animals}, \text{ if } \text{CVAR} > 0$$

To change these for subsequent analysis:

- capital costs, enter a quantity X for each year (1 to 20), stored as IHE(1), and then a month M, IME(1). The cost will then occur in month number M; if M=0, then each month of that year will have an associated cost of X/12

- direct costs, enter a quantity Y for each of 12 months; the values are assumed to be unchanged from year to year. These quantities then become CBAST(1), subject to the value of CVAR (as above)

All values are set to zero before the call to this panel. If all are still zero on return to the calling program, CBAST(1) and CHERD(1) are UNCHANGED. Thus if all zeros are really wanted as part of the analysis, enter 1 peso somewhere. Because of the nature of the arrays (i.e. their size), the defaults cannot easily be reflected in the contents of the panel at call time, thus, if the defaults are wanted for a subsequent analysis, enter any one of the months IME(1) as 99, this will over-ride everything without exception, and CBAST(1) and CHERD(1) will be set as per the block data segment in subroutine ECONDM, that is to say, the default values (subject, of course, to the user's value of CVAR)

Once the user has decided to end all analysis, subroutine INTRAC is called once more, passing the value 4, and subroutine NXEND1 is called, announcing that the run is finished and telling the user where to find program output

A final connecting link for the interactive system is that provided by subroutine PTBINT. This handles the actual management decisions decided upon after the interactive system has been called. It works through arrays for each of the six basic events (cull, sell, wean, buy breeder, buy follower, select breeder from followers). For all but the buying arrays,

these consist simply of flags in the relevant array positions for the animals selected for each of the events. Subroutine PTBINT then goes through each array, sorts out the pertinent counters, writes the event to the file on unit 4, and calls subroutine ACDUNT if money changes hands. It can be seen as a version of subroutine INLOOP, but for interactively-performed events. For the buying arrays, the new animals are initialised into their respective herds (breeders and followers) in the normal way of subroutine INLOOP. The whole routine can be skipped if the logical flags remain unflagged from one ITIME to the next.

5 USE OF THE SYSTEM

At present, RUSHOB is run using the command RUMTEST, which runs an executive file of the same name (listed in Appendix B 6). This section is concerned with two areas: first, the internal assumptions and data parameters set in the model are listed (Some of these can, and some cannot, be changed using either the input data file or the interactive system; where a parameter is purely internal, it is indicated as such.) To change an internal parameter, it is necessary to edit the FORTRAN source code and then recompile using the VS compiler with optimiser level 3 operating. The second area is to analyse the data output files produced from a specimen run, and to explain what is produced.

5.1 Internally-Set Parameters, Decision Rules and Default Values

The variables which can be set from the data input file are shown in Table 3, whilst those which may be changed using the interactive panels are listed in Table 4. Table 5 shows a list of parameters and their default values at the start of any run. The values in this table can be changed using the interactive system, or the defaults can be changed through editing the source code and recompilation, or through the input file. Note that only the most important input file defaults are given - the rest are either obsolete, or their value will be very much run-dependent. The digestibility and crude protein content figures pertain when IRUM is equal to 0, the source for these was Lebdoosokojo (1977). A list of the internally-set parameters is given in Table 6, the only way to change

TABLE 3 RUSMOB DATA INPUT FILE

Record	Variable(s)	FORTRAN Format
1	NSEED IRUM MODE NIND TITLE	4I5,T25,A25
2-3	ANAME	9A8
4	ACF(1-12)	12F6 0
5	SEASON(1-12)	12F6 0
6	PMA VIP WMA) MINWT PP WMR EXTRA APDELT BIOL SUPROP	12F6 0
7	FINTIM DELT CDELT JEV JHERD DATE NA IAREA IPRDEL JA PDELT ICCD	12F6 0
8	AREA(1-5) BIO(1-5)	*
9	AMP(1-2) TREND(1-2) CYCLIC(1-2) START(1-2)	*
10	PRINIT(1-6)	*
11	NWEAN MANDAT(1-2) CCUL MCUL KCUL SWTF SWTM SAGEF SAGEM IDEFLA OFRAT PREIS	*
12	NDIG NCF NDM NCFW NCF NDMLIM NLD NCD NFMC NSUP NDIGS	12I5
17-15	DIGF(1-2,1-14)	12F6 0
16-18	CPF(1-2,1-14)	12F6 0
19-20	DMF(1-2,1-14)	12F6 0
21	CFWF(1-2,1-5)	12F6 0
22	CFDWF(1-2,1-5)	12F6 0
23	DMLIML(1-2,1-6)	12F6 0
24	LDEPF(1-2,1-3)	12F6 0
25	CDF(1-2,1-6)	12F6 0
26	FDCF(1-2,1-5)	12F6 0
27-32	SUPDMF(1-2,1-28)	(12F6 0)
33-38	SUPDIG(1-2,1-28)	(12F6 0)
39-44	SUFDCF(1-2,1-28)	(12F6 0)
45-50	HSF(1-2,1-28)	(12F6 0)
51-100	VV(1,n), n=4 1 2 5 3 10 12 13 14 15 18 20	*

Note - refer to variable name list (Appendix B 2), some of the variables are obsolete,

- number of cows records read must be greater than NA+1

TABLE 4 INTERACTIVE PANELS AND DATA ENTRY

RUSMDB	Calling	User-Changeable Variables
PANEL#	Program	
00	NXEND1	
01	NYMENU	
02	N\DAT1	MYR MDA
03	NXMAN	
04	NXHER1	
05	N\FOL1	
06	NXCAL1	
07	NXPAS1	
08	NXCAS1	
09	NXBEG1	
10	NXBEG2	ANAME NSEED IRUM MODE FINTIM NIND DELT ISTOD PMA NA AREA BID
11	N\EVE1	
21	NXPAN1	IDYK CVAR AMP TREND CYCLIC START PRINT PREIS
22	NXPAN2	IDYK CHER IME CGAS
30	N\SEA1	SEASON
31	N\BUR1	AREA(1-3) BID(1-3)
32	NYPOL1	NWEAN MANDAT CCUL MCUL ICUL SWTF SWTM SAGEF SAGEM IFA NA IDEFLA OFRAT FREIS
33	N\CUL1	ICUL
34	NXSEL1	ISEL
35	NXWEA1	IWEA
36	N\BUY1	IBUY
37	N\FOR1	4REA ICOL
38	N\REF1	IREF
39	NXBUF1	IBUF
40	NYSYS1	NPAD VPAD

Note - refer to variable name list (Appendix B 2)

TABLE 5 DEFAULT VALUES OF USER-CHANGEABLE VARIABLES

Variable		Value	Where Set
CH(1-241)	capital costs by month, C\$	241*0	BLOCK DATA
CG(1-241)	direct costs by month, C\$	10000,240*0	BLOCK DATA
CVAR	direct costs per head, C\$	0	BLOCK DATA
NWEAN	min age at weaning, days	270	INLOOP
MANDAT	management dates 1 and 2	210, 330	INLOOP
CCUL	max cow age, years	12	INLOOP
MCUL	max no -ve preg tests	6	INLOOP
KCUL	max days since last conception	0 (not set)	INLOOP
SWTF	min wt at sale female, kg	0	INLOOP
SWTM	min wt at sale male, kg	0	INLOOP
SAGEF	min age at sale female, years	0	INLOOP
SAGEM	min age at sale male, years	0	INLOOP
DFRAT	milk offtake rate	0	Input File
PREIS	milk price c\$/kg	32	Input File
ACF	activity coefficients	12*1 0	Input File
VIP	faecal dm output/kglw/day	0 0094	Input File
DATE	start of run	0	Input File
WMAX	max tissue mobilisation, kg/day	1 4	Input File
MINWT	min wt of replacer heifers, kg	100	Input File
PF	adult wt / birth weight	15 0	Input File
AMF	price cycle amplitudes, /	11 2 12 7	Input File
TREND	price cycle trends, % / yr	0 0	Input File
CYCLIC	price cycle lengths, yr	6 6	Input File
START	price cycle starting point, yr	0 0	Input File
PRINIT	initial prices, C\$	109 109 109 132 109 132	Input File
DIGF	monthly DY, IRUM=0	43 45 46 48 44 44 45 46 45 46 43 40	Input File
CPF	monthly CP%, IRUM=0	9 6 10 4 9 1 9 6 9 8 9 4 8 4 8 7 8 2 9 1 10 1 10 0	Input File

Note - the variables set in BLOCK DATA or INLOOP can be reset using panels, the others can be altered directly through the input file

TABLE 6 INTERNALLY-SET PARAMETERS

Variable	Value and/or Comments
RATEMK	0 00275 rate of decline parameter, milk yield post-peak
DAYSFK	60 days to peak milk yield
PROPIN	1 0 proportion of ma, milk yield attained on day 1
-	80 day number for start of wet season
-	340 day number for start of dry season
DIGEN	15 185 digestible energy content of feed, KJ/kg
RATE	0 054 growth rate parameter
-	360 number of days in a year
WMM	1 3*WMM male adult wt = 1 3 * female adult wt
PREF1	0 0, 1 0, 1 0, 1 0, 0 0, 1 0, 1 0, 1 0 11100
PREF2	0 0, 1 0 1 0, 1 0, 0 0, 1 0, 1 0, 1 0 11010
PREF3	0 0, 1 0, 1 0, 1 0, 0 0, 1 0, 1 0, 1 0 11001
PREF4	0 0, 1 0, 1 0, 1 0, 0 0, 1 0, 1 0, 1 0 10110
PREF5	0 0, 1 0, 1 0, 1 0, 0 0, 1 0, 1 0, 1 0 10101
PREF6	0 0, 1 0, 1 0, 1 0 0 0, 1 0, 1 0, 1 0 10011
	None of the above is set, each record consists of 4 x-coords, then 4 y-coords to describe the linear segment functions
SAV1 DI	0 43 0 45 0 46 0 48 0 44 0 44 0 45 0 46 0 45 0 46 0 43 0 40
CR	9 6 10 4 9 1 9 6 9 8 9 4 8 4 8 7 8 2 9 1 10 1 10 0
AV	0 0 0 0 20 0 50 0 50 0 70 0 50 0 50 0 30 0 30 0 20 0 0 0
SA 2 DI	0 43 0 45 0 46 0 48 0 44 0 44 0 45 0 46 0 45 0 46 0 43 0 40
CR	9 6 10 4 9 1 9 6 9 8 9 4 8 4 8 7 8 2 9 1 10 1 10 0
AV	0 0 0 0 20 0 50 0 50 0 70 0 50 0 50 0 30 0 30 0 20 0 0 0
SAV3 DI	0 43 0 45 0 46 0 48 0 44 0 44 0 45 0 46 0 45 0 46 0 43 0 40
CR	9 6 10 4 9 1 9 6 9 8 9 4 8 4 8 7 8 2 9 1 10 1 10 0
AV	0 0 0 0 20 0 50 0 50 0 70 0 50 0 50 0 30 0 30 0 20 0 0 0
	Set to the same values as those in Table 5, monthly values of digestibility, crude protein and growth rate per day

[Table 6 -continued-]

Variable	Value and/or Comments
FLI	0 0, 2 0, 7 0, 7 0, 0 0, 4 5, 3 8, 3 8
FGI	0 0, 2 0, 7 0, 7 0, 0 0, 6 0, 5 0, 5 0
FLII	0 0, 3 0, 5 0, 5 0, 0 0, 17 0, 80 0, 80 0
FGII	0 0, 3 0, 6 0, 6 0, 0 0, 20 0, 100 0, 100 0
FLIII	0 0, 1 5, 4 0, 6 5, 0 0, 17 0, 73 0, 80 0
FGIII	0 0, 1 5, 4 0, 6 5, 0 0, 22 0, 90 0, 105 0
FLIV	0 0, 0 4, 1 0, 1 0, 1 0, 0 60, 0 0, 0 0
FGIV	0 0, 0 4, 1 0, 1 0, 0 0, 0 60, 1 0, 1 0
FLIVN	0 0, 1 0, 1 0, 1 0, 1 0, 0 0, 0 0, 0 0
FGIVN	0 0, 1 0, 1 0, 1 0, 0 0, 1 0, 1 0, 1 0
FV 1	0 0, 0 5, 1 0, 1 0, 0 0, 0 3, 1 0, 1 0
2	0 0, 0 4, 0 7, 1 0, 0 0, 0 25, 0 82, 1 0
3	0 0, 0 3, 0 75, 1 0, 0 0, 0 45, 0 65, 1 0
4	0 0, 0 5, 1 0, 1 0, 0 0, 0 6, 1 0, 1 0
5	0 0, 1 0, 1 0, 1 0, 0 0, 1 0, 1 0, 1 0
FLVII	61 0, 90 0, 330 0, 360 0, 0 0, 1 0, 1 0, 0 0
FGVII	61 0, 90 0, 330 0, 360 0, 0 0, 1 0, 1 0, 0 0
	Four x-coords, four y-coords, define each function
ELL	0 43 0 45 0 46 0 48 0 44 0 44 0 45 0 46 0 45 0 46 0 47 0 40
CLL	9 6 10 4 9 1 9 6 9 8 9 4 8 4 8 7 8 2 9 1 10 1 10 0
DGG	0 43 0 45 0 46 0 48 0 44 0 44 0 45 0 46 0 45 0 46 0 43 0 40
LGG	9 6 10 4 9 1 9 6 9 8 9 4 8 4 8 7 8 2 9 1 10 1 10 0
	Legume digestibility and protein content followed by the values for grass monthly figures
FACM	0 95, 0 94, 0 99, 0 94, 1 07 1 07 1 04 1 01, 0 99 0 92, 0 97, 0 97
FACF	0 97 0 95, 0 98, 1 03, 1 06, 1 05, 1 02, 1 00, 0 99, 1 00, 0 99, 0 97
	Monthly seasonal price adjustment factors, male and female
SDEV2	12 70 Standard deviation, female animal selling price
SDEV	12 70 Standard deviation, cattle buying price
CORR	0 70 Correlation between cattle sell and buy price

these is through re-compilation. Many are unchanged from the model of Kahn (1982), where a discussion of some of these values may be found.

The major decision rules built into the model are summarised below.

1) There are ten events of interest; with 3-letter codes as they appear in the calendar of events, these are as follows:

conception	[CON]
birth	[BTH]
weaning	[WND]
calf death	[D-C]
follower or breeder death	[D-A]
sale of a breeder or follower	[S-A]
sale of a calf	[S-C]
a follower becomes a breeder	[REP]
an abortion	[ABO]

2) The 23 physiological status groups are assigned to the 15 forage mobs using the following correspondence table:

VV(1,9) =	CORRES(1)	ICOD(14)	CORRES(13)	ICOD(14)
	2	1	14	2
	3	3	15	2
	4	5	16	4
	5	7	17	6
	6	9	18	6
	7	11	19	8
	8	1	20	8
	9	1	21	10
	10	3	22	12
	11	15	23	12
	12	15		

Mob 13 is reserved for heifers, defined as female breeders whose date of last conception and age at last breeding are both 0, and whose age is less than or equal to 4.0.

3) Management Rules

a weaning - an animal is weaned if age \geq NWEAN days. This is always carried out automatically, but can be carried out manually in addition.

b culling - is carried out on the basis of old age, or too many negative pregnancy tests (carried out at the management dates), or too many days elapsed since last conception.

c sell followers - on the basis of weight and age by sex, or, if none of these is set, at each management date.

d replace breeders - from the followers herd, the heaviest are chosen first, provided that weight \geq MINWT.

e buy breeders - if run mode allows, and if there are not enough replacers to be had from the followers herd, then animals are bought automatically from the array SPARE.

Note that b to e may be done up to twice a year automatically. Policies a to e and the activity "buy followers" can be done manually using the interactive system at any time. If this is done, then the automatic rules can be suppressed (with the exception of activity "wean") by setting IDEFLA to 1. Refer to Figure 1 for stock movement possibilities.

4) On adult death, any suckling calf is sold if age $<$ 4 months; if age is greater than this, it is initialised into the followers herd (i.e., enforced early weaning).

5) There exists a non zero probability of abortion at each dt for animals in the seventh, eighth and ninth months of pregnancy.

6) Initial forage mob assignments are made using the order "savanna type 1 - type 2 - type 3 - improved pasture"; the first of these to have an area greater than zero is assigned to all mobs at the start of any run.

7) Economic re-analyses when IRUM is set to 0 are not carried out. Space exists in subroutine PAN, however, to allow variables to be changed in such a situation; editing and recompilation would then be necessary.

Any of these built-in defaults can be changed with little difficulty as required.

5.2 Output File Explanations

It should be emphasised that the print-outs discussed arose from more than one run, in addition, the input data used are to be regarded as illustrative only, and should certainly not be regarded as meaningful

LOGICAL UNIT 6 (see Appendix B.5)

A run parameter table is printed first, with the values of major variables either as they were read from the input file or as they were entered using the interactive panels. This is followed by the contents of most of the data input file, annotated with variable names. A yearly herd composition table is then printed for year 0 (i.e. at the start of the run). This consists of all the animals in the breeding and followers herds, the latter can be distinguished from the former because their ID numbers are in excess of 100. Such a table is printed at the end of every year. The table for year 10 is shown next, note that there is one follower (ID 183), weaned just after day 330 (the last management date, when the followers herd was dispersed) and before day 360 (the date at which this was produced)

A monthly conception event table shows the total number of conceptions by month and by year. Following this is a pasture consumption table for adults and suckling calves, again by months and by years. The yearly production table shows various calculated or cumulated data for each year of the run, for each, an 8-character description is printed, and on the same line is given the mean and the sum of squares, and following this, the yearly values. These data are as follows

calf sls - cumulated kg, calf sales,
 cull sls - cumulated kg, cull sales,
 conceptions - number of conception events;
 b h feos - number of breeding herd females at day 360,
 no weand - number of calves weaned;
 wean wt - the average weaning weight that year,
 cow age - average breeding cow age at day 360;
 no repld - number of followers that became breeders;

dead ads - the number of adult (breeder + follower) deaths;
 dead cls - the number of suckling calf deaths
 rep age - the average age of any replacers at date of replacement;
 rep wt - the average weight of any replacers at replacement;
 12 mo wt - the average 12-month weight of all animals that attained this
 age during the year,
 surv 12 - the number of animals completing 12 months of life;
 surv 24 - the number of animals completing 24 months of life;
 24 mo wt - the average 24-month weight for animals attaining this age;
 no abs - the number of abortions,
 no bths - the number of births;
 age part - the average age at first parturition for relevant animals;
 con int - the average conception interval in days;
 wt/100 - inventory weight of all animals at day 360 / 100;
 no orfs - number of calves whose dams died before weaning;
 an units - the number of animal units in the breeding herd at day 360;
 fec fems - the number of fecund females (age > 2 yrs) at day 360,
 wt eods - average herd weight at the end of the dry season;
 wt eows - average herd weight at the end of the wet season;
 num buy - the number of animals bought during the year;
 milk off - average yearly milk production (excluding calf consumption)

True monthly average stock numbers follow this table, for the following
 categories all breeders, breeders under 2 years of age, all followers,
 followers less than a year old or greater than two years old, calves,
 followers older than two years, and the total number of animal units
 (where, in accordance with the ETES project (Vera and Sere, 1985), animals
 from 0 to 12 months = 0.6, from 13 to 24 months = 0.8, and over 24 months
 of age = 1 unit)

This is followed by a production summary, giving the following information
 conception percentage, weaning percentage, cow mortality, calf
 mortality, age at first calving, weaning weight, conception interval, 12-
 and 24-month weight, percentage first-year survival, meat production as
 sales per head, meat production as sales per animal unit, and meat
 production calculated, again as for ETES (Vera and Sere, 1985), as follows:

Production = [no of cows * weaning % * wt at 12 months +
no of yearlings * wt gain / yr] / animal units

This calculation is performed twice, with both yearly and monthly stock average numbers, stored in variables ETES and ETE2 respectively (these correspond to ETESPROD and ETES 2 in the printout)

There follows a weight-against-conception table for all animals, for heifers, and for dry and for lactating cows, giving the cumulative probability of conception in various weight quantiles. Finally, the calendar of events is printed, giving the date and details of the animal(s) involved for all significant events. This output file can be long - for 20 years and good quality forage (hence many events), it may run to 2000 records

LOGICAL UNIT 7

This contains the weight evolution of cow number 1 of the breeding herd. Each record contains the ID, the date (run day number, year and month), the weight, normative weight, liveweight change per day, and the metabolisable energy content of the feed ingested, the ME requirement for maintenance, and the ME balance for weight change. From the calendar for this run, it was seen that this animal first conceived on day 865, gave birth at day 1135 (note the heavy weight loss at this time - lactation combined with poor quality forage), and after producing two more calves, died on day 2835

LOGICAL UNIT 8

This is the debug file for the animal component, five animals variables are printed at each dt until the program is stopped, or until the user runs out of storage space, which does not take long with this option in effect (IPRDEL = 1). The variable names are listed below a sample print-out in the Appendix

LOGICAL UNIT 9

This is the general pasture output file. For the run illustrated, IRUM was set to 1, and there were specified to be 30 ha of savanna type 1 and 5 ha of improved pasture. The improved pasture was not fed until day 30 and then only to pregnant cows. Each record shows the run day number, the number of the relevant forage resource (for which AREA(1) > 0), the number of animal units assigned to that forage, the proportion it makes up of the diet, the digestibility, the available biomass per animal, the available biomass per hectare, the total intake by all animals grazing that resource over time dt , and the total intake of that resource by calves over the same period. Improved pasture was fed until day 330, when it was taken out of the simulation run by setting AREA(4) to zero.

LOGICAL UNIT 10

Unit ten contains the specialised output from subroutine PASMIP, the improved pasture simulator. The first line lists the options in effect for this run - initial biomasses, ungrazeable residues, the data output option (here, as often as possible, 1 e each dt), the fifth selection function is selected, and no non-spatial competition is to take place. There follows a listing of the functions used in the model - four x-coordinates, then four y-coordinates, each line making up one of the linear-segment functions. The order is I legume and grass, II legume and grass, III legume and grass, IV legume and grass, IV no competition legume and grass, V selection functions 1 to 5, VI and VII legume and grass (not user here).

Each record of what follows contains the day number, the biomass of the legume and the grass, the total biomass, actual growth rates, potential growth rates, proportion in the diet, leaf area indices, the competition factor, the rates of senescence, and the seasonal growth-modifying factor from function VII, for first the legume and then the grass.

LOGICAL UNIT 11

Cash flow output starts with a printout of the price parameters:

amplitudes, trends, cycle lengths, starting points, and initial prices. The cash flow is printed month by month, showing cull, calf and follower receipts, and capital and direct costs and cow purchases. The cash flow is then assembled into a yearly form, and net present values at various discount rates are printed. For the calculation of the internal rate of return neither by month nor by year does the cash flow appear to be well-conditioned, this is not very surprising, in view of the frequent changes of sign of the cash flow. A table of yearly average prices paid and received is then printed, and the prices pertaining at the very end of the run. If an entry here is zero, this implies that no transaction took place for that category during that year. No incremental analysis was performed for this run, but the output is very similar to that already described.

LOGICAL UNIT 13

The file on unit 13 can be useful for keeping a record of an interactive run. Table 7 shows the data printed from each interactive subroutine, from which it may be deduced that pregnant cows were fed improved pasture and savanna type 1 from day 30, and that they were taken off the improved pasture at day 330. Similarly, cow numbers 27 and 29 were culled on day 330, year 3 (note the two values of -2).

6 FUTURE DEVELOPMENTS

These notes have tried to set out the basic structure and operation of RUSMOB. There are two aspects to future work with the model - what the system is to be used for during the experimentation phase of the project, and, hand in hand with this process, what may be done to parts of the system to improve the model. The first of these is dealt with in full in another document (Thornton, 1987), and will not be touched on here.

There are a number of obvious problem areas, some of which would benefit from more attention. The major ones are as follows:

a) compensatory growth of the animal. Probably the only way to include

TABLE 7 OUTPUTS FROM THE INTERACTIVE SYSTEM TO UNIT 13

Subroutine	Code	Variables Printed	Printed From
	in File		
NXDAT1	DATE	ITIME JT ISTOP FINTIM DELT IWIT	NXMEN0
NXMAN	MAN	IWIT ILLN	NXMEN0
NXPAN1	PAN1	IDYI CVAR AMP(1-2) TREND(1-2) CYCLIC(1-2) START(1-2) PRINIT(1-6) PREIS	NXPAN1
NXPAN2	PAN2	IHE(1-20) IME(1-20) IGA(1-12)	NXPAN2
NXPOL1	POL	ITIME JY NWEAN MANDAT(1-2) CCUL MCUL KCUL SWTF SWTM SAGEF SAGEM KNA IDEFLA IWIT	NXPOL1
NXSEA1	SEA	ITIME JY IWIT SEASON(1-12)	NXROTO
NXBUR0	BUR	ITIME JY IWIT BID(1-5)	NXROTO
NXCULO	CUL	ITIME JY IWIT ICUL(1-NA)	NXROTO
NXSELO	SEL	ITIME JY IWIT ISEL(1-NUMFOL)	NXROTO
NXWEA0	WEA	ITIME JY IWIT IWEA(1-NA)	NXROTO
NXBUY1	BUY	ITIME JY IWIT IBUY(1-10,1-5)	NXROTO
NXPOL1	POL2	ITIME JY IEIT NWEAN CCUL MCUL KCUL MANDAT(1-2) SWTF SWTM SAGEF SAGEM KNA IDEFLA OFRAT PREIS	NXROTO
NXFOR1	FOR	ITIME JY IWIT AREA(1-5) BID(1-5) ICOD(1-14)	NXROTO
NXREPO	REF	ITIME JY OUT(JY,8) INA IWIT IREP(1-NUMFOL)	NXROTO
NXEUF1	PUF	ITIME JY NUMFOL IWIT IPUF(1-10,1-5)	NXROTO
NXSYS1	SYS	ITIME JY NPAD VPAD(1-5,1-4)	NXSYS0

Note - IWIT is an internally-used panel return code

- ILLN is the panel line number chosen from the management menu

- For all other names, see Appendix B 2

- For arrays IWEA, ICUL, ISEL and IREP, all elements are zero except for those animals selected, whose corresponding elements contain -1, -2, -3 and -4 respectively

its effect in a model of this level of resolution would be by the use of an empirical factor to increase either intake or the efficiency of utilisation at certain times of the year for particular classes of stock for varying lengths of time. Compensatory growth is undoubtedly important, but it may be best to ignore it at this stage, on the grounds that its inclusion would make use of an essentially arbitrary method, and that its effect over twenty-year simulations may not be significant vis-a-vis the precision of the rest of the model (although it is recognised that it is desirable to demonstrate this)

b) a savanna growth model. Tabular quantity and quality models have a number of problems, some of which were touched on in section 1. There are also problems with a PASMIP-type of approach: there are (again) no data, savanna is a multi-species resource, and the ungrazeable residue would have to be considered. Whilst availability *per se* is rarely limiting, the effect on voluntary intake can probably be satisfactorily represented through the seasonal changes in digestibility. Given the time constraint, work here is likely to be concentrated on imputing improved values to the growth and quality tables for the different types of savanna.

c) the effect of weather on primary production. How to obtain stochastic weather series, and how to model their effect on forage growth to allow some sort of risk analysis, are questions which will have to receive some attention. The first is much more simply answered than the second. Simple techniques exist for generating largely subjective outcome distributions amenable to risk analysis, and these may have to be resorted to if the constraints of time and lack of data prove to be overwhelming.

d) price generation. The current price generator was criticised in Section 4.3, but whether the utility of the system would be much enhanced with a more elegant (perhaps fully stochastic) price generator is debatable, in view of the variable precision of the constituent components.

e) preference functions. Field experiments are under way to generate a certain quantity of information for deriving such functions. There is little that can be done to speed this process, so until such data are available, the specification of preference functions will have to be

treated as an experiential variable, in effect. Similar remarks apply to the exact specification of subroutine PASMIP, in terms of growth, seasonal changes in the parameters, and quality. In other words, the structure of the system can be regarded as being reasonably complete, while the exact specification of some of the relationships within it awaits further research. It is hoped that the field experiments noted above will help to restore to a small extent the patent imbalance in knowledge that exists between the response of the animal to certain levels of nutrition and the nature of the forage responsible for those levels of nutrition.

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APPENDIX B 1 SUBROUTINE LIST

Name	Function	Common	Location
ACOUN1	CALCULATE CASH FOR A SALE/BUYING	ECO	*
AFGEN	LINEAR INTERPOLATION ROUTINE	/A/	*
ANALIZ	RE-ANALYSE BIOLOGICAL DATA FOR CASH FLOWS	BLK	*
ANLOOP	ANIMAL LOOP	BLK	*
BLKOUT	FILL A STRING WITH PLANKS	+	SAMM
CALMIX	CALF DIET MIXER	BLK	*
CHASET	EVALUATES TYPE OF A CHARACTER	+	SAMM
COMPAR	RETURNS 1 IF X1>X2, ELSE 0		*
CONCEP	COUNT CONCEPTIONS AND CALCULATE PERCENTAGES	BLK	*
DELAY	CALCULATE PREVIOUS VALUES OF AN X-Y TABLE		*
DIGGEN	CALCULATES IMPROVED PASTURE DIGESTIBILITY		*
ECONOM	CALCULATE MONTHLY CASH FLOWS ETC	BLK	*
FIXIN	CONVERT CHARACTER TO INTEGER		SAMM
FIXOUT	CONVERT INTEGER TO CHARACTER	+	SAMM
HERBIJ	HERBAGE GROWTH CONTROLLER	BLK	*
INCREM	SETS UP INCREMENTAL CASH FLOW ANALYSIS	ECO	*
INLOOP	TIMER LOOP	BLK	*
INSW	RETURNS X3 IF X1>0, ELSE X2		*
INTRAC	INTERACTIVE ROUTINE CONTROLLER	BLK	*
LEFJUC	LEFT-JUSTIFY A STRING		SAMM
LIMIT	CHECKS BOUNDS FOR AN X-Y TABLE		*
MAIN	MAIN PROGRAM	BLK	*
MARSAS	RANDOM NORMAL NUMBER GENERATOR		*
MIXER	MIX THE DIET FOR AN ANIMAL	BLK	*
MOBRAT	ASSIGN ANIMAL STATUS	BLK	*
MOBGR	ASSIGN ANIMAL TO A MOB	BLK	*
MOVE	FILL UP A STRING	+	SAMM
NUMPRT	STRIPS DEC PT, RETURNS INT FROM EBCDIC CHAR	+	SAMM
NXBEG0	INTERACTIVE CONTROLLER, PANELS 9,10		*
NXBEG1	INTERACTIVE CONTROLLER, PANEL 09		*
NXBEG2	INTERACTIVE CONTROLLER, PANEL 10		*
NXBUF1	INTERACTIVE CONTROLLER, PANEL 39		*
NXBUR0	INTERACTIVE CONTROLLER, PANEL 31		*
NXBUR1	INTERACTIVE CONTROLLER, PANEL 31		*
NXBUY1	INTERACTIVE CONTROLLER, PANEL 36		*
NXCAL0	INTERACTIVE CONTROLLER, PANEL 06	INT	*
NXCAL1	INTERACTIVE CONTROLLER, PANEL 06		*
NXCAS0	INTERACTIVE CONTROLLER, PANEL 08	/EC/F/	*
NXCAS1	INTERACTIVE CONTROLLER, PANEL 08		*
NXCUL0	INTERACTIVE CONTROLLER, PANEL 33	INT	*
NXCUL1	INTERACTIVE CONTROLLER, PANEL 33		*
NXDAT1	INTERACTIVE CONTROLLER, PANEL 02		*
NXEND1	INTERACTIVE CONTROLLER, PANEL 00		*
NXEVE0	INTERACTIVE CONTROLLER, PANEL 11		*
NXEVE1	INTERACTIVE CONTROLLER, PANEL 11		*
NXFOLO	INTERACTIVE CONTROLLER, PANEL 05	INT	*
NXFOL1	INTERACTIVE CONTROLLER, PANEL 05		*
NXFOR1	INTERACTIVE CONTROLLER, PANEL 37		*
NXHERO	INTERACTIVE CONTROLLER, PANEL 04	INT	*

[Subroutine List -continued-]

NXHER1	INTERACTIVE CONTROLLER, PANEL 04		*
NXMAN	INTERACTIVE CONTROLLER, PANEL 03		*
NXMENU	INTERACTIVE CONTROLLER, PANEL 01		*
NXMENO	INTERACTIVE CONTROLLER, PANEL 01		*
NXPANO	INTERACTIVE CONTROLLER, PANEL 21,22		*
NXPAN1	INTERACTIVE CONTROLLER, PANEL 21		*
NXPAN2	INTERACTIVE CONTROLLER, PANEL 22		*
NXPAS0	INTERACTIVE CONTROLLER, PANEL 07	BLK	*
NXPAS1	INTERACTIVE CONTROLLER, PANEL 07		*
NXPOL1	INTERACTIVE CONTROLLER, PANEL 32		*
NXREP0	INTERACTIVE CONTROLLER, PANEL 38	INT	*
NXREP1	INTERACTIVE CONTROLLER, PANEL 38		*
NXROTO	INTERACTIVE CONTROLLER, MGT ROUTINE	BLK	*
NXSEA1	INTERACTIVE CONTROLLER, PANEL 30		*
NXSELO	INTERACTIVE CONTROLLER, PANEL 34	INT	*
NXSEL1	INTERACTIVE CONTROLLER, PANEL 34		*
NXS150	INTERACTIVE CONTROLLER, PANEL 40	/E/	*
NXSYS1	INTERACTIVE CONTROLLER, PANEL 40		*
NXWEA0	INTERACTIVE CONTROLLER, PANEL 35	INT	*
NXWEA1	INTERACTIVE CONTROLLER, PANEL 35		*
PAN	SET NEW ECONOMIC PARAMETERS FOR REANALYSIS	ECO	*
PANEL2	SYSTEM PANEL CALLING ROUTINE	+	319 P
PASMIF	GROWTH ROUTINE, LEGUME/GRASS ASSOCIATION	BLK	*
PRICE	GENERATE PRICES FOR THIS DT	ECO	*
PIBINT	INTERACTIVE PARTB	BLK	*
RANDOM	GENERATE A NUMBER FROM U(0,1)		*
RANC	GENERATE A NUMBER FROM U(0,1) FOR MAPSAG		*
REALIN	CONVERT CHAR NUMBER TO A REAL NUMBER		*
RELEAS	RELEASE A PANEL	+	SAMM
ROTBRA	ROTATIONAL GRAZING SUBROUTINE	/E/	*
SAV1	GROWTH ROUTINE FOR SAVANNA TYPE 1	BLK	*
SAV2	GROWTH ROUTINE FOR SAVANNA TYPE 2	BLK	*
SAV3	GROWTH ROUTINE FOR SAVANNA TYPE 3	BLK	*
SEGLIN	LINEAR INTERPOLATION ROUTINE		*
STPING	FINDS VALUE OF A STRING	+	SAMM
TABLE	FIND REAL ADDRESSES OF PANEL FIELD DATA	+	SAMM
WAIT	CALCULATE NORMATIVE WEIGHT OF AN ANIMAL	BLK	*
ZERD10	ZERD 10 INTEGER SCALARS		BIT2
ZERD11	ZERD A 1-D INTEGER ARRAY		BIT2
ZERD12	ZERD A 2-D INTEGER ARRAY		BIT2
ZERD13	ZERD A 3-D INTEGER ARRAY		BIT2
ZERD10	ZERD 10 REAL SCALARS		BIT2
ZERD11	ZERD A 1-D REAL ARRAY		BIT2
ZERD12	ZERD A 2-D REAL ARRAY		BIT2
ZERD13	ZERD A 3-D REAL ARRAY		BIT2
ZIR	CALCULATES IRR OF A STREAM		*

 Note COMMON refers to named Common Blocks - BLK contains blocks A, B, C, D, E, F, EC, NX, LOGIX, and SCALES "+" implies an assembler, routine, all others are in FORTRAN 77 "Location" refers to text library name (SAMM, BIT2), system disk (319 P), or compiled text file of the same name (*)

APPENDIX B 2 RUSMOB VARIABLE NAME LIST

Name	Function	Type	Local or	
ABORT	ABORTION=YES FLAG	R	ANLOOP	
AC	ME REQS FOR ACTIVITY	R	ANLOOP	
ACC	CALF ME REQ FOR ACTIVITY	R	ANLOOP	
ACF	ACTIVITY ALLOWANCE FACTOR 0,1,2	R	B	
ACI	MONTHLY ACTIVITY FACTOR	R	SCALES	
AGE	COW AGE	R	SCALES	
AGR	ACTUAL GROWTH RATE 1 LEG 2 GRASS	R 2	PASHIP	
ALDM	ACTUAL DM INTAKE	KG	AN/DAY	R
AMP	% AMPLITUDE OF CYCLES	R 2	EC	
ANAME	VARIABLE NAMES IN AFGEN	C#B 13	A	
APDELT	SUCKLING FACTOR, RECONCEPTION DELAY	R	SCALES	
APTIME	NO OF DAYS POST-PARTUM (MAX 90)	R	ANLOOP	
ARE	AREA, OLD NDU, FOR IRUM=0	R	SCALES	
AREA	AREA OF FORAGE RESOURCES	R 5	E	
ASEX	TEXT SEX, MALE, FEMALE	C#4 3	ANLOOP	
AT	POST-PARTUM CLOCK INCREMENTOR	R	ANLOOP	
AUN	ANIMAL UNIT CALCULATION VARIABLE	F	INLOOP	
AVAU	TRUE AVERAGE ANIMAL UNITS	R	INLOOP	
AVDM	***	#	C	
BAL	BENEFITS - COSTS BY MONTH	R 241	F	
BALL	DM NEEDS - DM INTAKE CAPACITY	R	ANLOOP	
BALYR	CUMULATED YEARLY BALANCE, COSTS AND BENEFITS	R 22	ECONOM	
BEN	BENEFITS BY MONTH	R 241	F	
BIG	A LARGE NUMBER	R	PASHIP	
BIO	TOTAL BIOMASS	R 5	E	
BIOL	DM/HA TOTAL, FOR IRUM=0	R	E	
BL	INTERMEDIATE VARIABLE, CFLEV	R	ANLOOP	
BRAL	CUMULATIVE AS-YOU-GO BALANCE	R	F	
BREN	CUMULATIVE AS-YOU-GO BENEFITS	R	F	
BW	BIRTHWEIGHT RATIO TO 40Y6	R	ANLOOP	
BYR	YEARLY BENEFITS	R 22	ECONOM	
C	CPZ	R 5	E	
CA	CALF DIET CPZ	R	CALPIX	
CAGE	CALF AGE	R	SCALES	
CAPIT	BENEFIT FROM CAPITALISATION	R 241	ECONOM	
CARF	PESOS FROM CALVES BY MONTH	R 241	ECONOM	
CBUY	COST OF NEW COW BY MONTH	R 241	ECONOM	
CC	CONCEPTION 4	R	INLOOP	
CCUL	AGE AT WHICH CULLING IS AUTOMATIC, YEARS	R	F	
CCYC	PROB OF OESTRUS IN CYCLING COWS	R	ANLOOP	
CDELT	INTEGRATION STEP, CALVES	I	SCALES	
CFA	AGE REDUCTION FACTOR, CONCEPTION	R	ANLOOP	
CFAGE	MODIFYING FACTOR FOR PEST/PCON X AGE	R	ANLOOP	
CFDW	WEIGHT CHANGE REDUCTION, CONCEPTION	R	ANLOOP	
CFDMF	CONCEPTION PROBABILITY X WEIGHT INDEX	R 2,5	B	
CFL	LACTATION REDUCTION FACTOR, CONCEPTION	R	ANLOOP	
CFLEV	FEEDING LEVEL, MULTIPLE OF MAINT LEVEL	R	ANLOOP	
CFM	MATURITY REDUCTION FACTOR, CONCEPTION	R	ANLOOP	

[Variable Name List -continued-]

L 01	PESDS FROM FOLLOWERS BY MONTH	R 241	ECONOM
CF1	POST-PREIUM INTERVAL REDUCTION, CONCEPTION	F	ANLOOP
CFW	WEIGHT INDEX CORRECTION, CONCEPTION	R	ANLOC
CFW+	CONCEPTION PROB X WEIGHT INDEX	R 2,5	B
CG	INITIAL DEFAULT VALUE FOR CGAST	R 241	EC
CGAST	DIRECT COSTS BY MONTH	R 241	EC
CGR	CALF GROWTH RATE	R	ANLOOP
CH	INITIAL DEFAULT VALUES FOR CHEPD	R 241	EC
CHERBL	CUM CALF PASTURE CONSUMP IN DELTA, KG DM	R	SCALES
CHEPD	CAPITAL COSTS BY MONTH	R 241	EC
CLACT	ME CONTENT OF MILK AVAILABLE TO CALF	R	ANLOOP
CM	COW MORTALITY %	R	INLOOP
CMERC	ME CONTENT OF SUPP FEEDS INCLUDING CONCS	R	SCALES
CMOR	CALF MORTALITY (TOT DEATHS/TOT BIRTHS)	R	INLOOP
COF	FASTING METABOLISM COEFF 53=F 67=M	R	ANLOOP
CON	PERCENT REGROWTH CONTRIBUTION MADE BY 1 L 2 G	R 2	PASHP
CONCC	CONC CONSUMP, KG DM/DAY	R	ANLOOP
CONCME	ME VALUE OF CONC	R	ANLOOP
CONC	WEIGHT INDEX	R	ANLOOP
CONDRA	WEIGHT INDEX	R	ANLOOP
CONDRC	WEIGHT INDEX IN CALVES	R	ANLOOP
CONPRG	CONCEPTION % BY COW CLASS	R 4	CONCEP
CORR	COW BUY SALE PRICE CORRELATION	R	PRICE
CORRES	CONVERSION TABLE, VV(L,9) TO ICOD	I 20	NOBGR
COST	COSTS BY MONTH	R 241	F
CP	CPUDE PROTEIN OF PASTURE, IRUM=0	R	SCALES
CPA	WEIGHTED CPC OF TOTAL DIET	R	SCALES
CPC	CP CONTENT OF CALF DRY FEED	R	ANLOOP
CPF	MONTHLY CP OF PASTURE X TIME	R 2,14	B
CPL	MAX VOLUNTARY INTAKE LIMITED BY CP AND DIG	R	ANLOOP
CPLC	PHYSICAL LIMIT TO DM INTAKE FOR CALVES	R	ANLOOP
CR	SURVIVAL TO 12 MONTHS	R	INLOOP
CROS	CUMULATIVE AS-YOU-GO COSTS	R	F
CSEX	CALF SEX	I	SCALES
CSUPA	CALF CONC CONSUMPTION KG/DAY	R	ANLOOP
CSUPB	CALF RECYCLED FEED CONSUMF, KG/DAY	R	ANLOOP
CSUPT	RECYCLED DM CONSUMPTION, CALF	R	ANLOOP
CTIME	CALF AGE, DAYS	R	SCALES
CT2	CALF AGE CLOCK INCREMENTOR	R	ANLOOP
CULL	PESDS FROM CULL COWS BY MONTH	F 241	ECONOM
CVAR	DIRECT COST PER HEAD OF CATTLE	R	EC
CW	CALF WEIGHT	F	SCALES
CXPAGE	EXPONENT OF D TIME GROW H CURVE, CALVES 6MO	F	SCALE
CYCLIC	PRICE CYCLE LENGTHS, YEARS	R 2	EC
CYR	YEARLY COSTS	R 22	ECONOM
D	DIG	R 5	E
DA	CALF DIET DIG	R	CALMIX
DATE	DAY OF START, POST 1 JAN	I	SCALES
DAYSFK	NO OF DAYS TO PEAK MILK YIELD	R	ANLOOP
DDLACT	POT MILK YIELD DECP AS PROP OF PREVIOUS YLDS	R	ANLOOP
DED	ADULT DEATH PROBABILITY	R	ANLOOP
DELT	INTEGRATION TIME STEP, ADULTS	I	SCALES
DIG	DIG OF PASTURE, IRUM=0	R	SCALES

[Variable Name List -continued-]

DIGC	DIG OF DRY FEED OF CALVES	R	ANLOOP
DIGFN	FEED DIGESTIBLE ENERGY	R	SCALES
DIGF	MONTHLY DIG OF PASTURE X TIME	P 2,14	B
DIGPRO	DIGESTIBILITY PROPORTION FACTOR	R	SCALES
DIGS	DIG OF RECYCLED SUPP FEED WEIGHTED AVERAGE	R	ANLOOP
DIGT	WEIGHTED DIG OF TOTAL DIET	R	SCALES
DM	DM OF PASTURE, IRUM=0	R	SCALES
DMC	DM OF SOLID FEED IN CALVE	R	ANLOOP
DMF	PASTURE GROWTH RATE X TIME	R 2,14	B
DMLIM	DM LIMIT, PASTURE AVAILABLE	R	SCALES
DMLIML	DM INTAKE INCREASE X LACTATION STAGE	R 2,6	B
DMNEED	DM EQUIVALENT OF ENERGY NEEDS	R	ANLOOP
DMD	CALF DM AVAILABILITY LIMIT	R	CALMIX
DOWN	INTEREST RATE HALVINGS FOR ZIR	R	ZIR
DRATIO	30 / DELT	R	SCALES
E	AMOUNT EATEN PER ANIMAL	R 5	E
ECAR	KG DM EATEN BY ALL CALVES THIS DELTA T	R 5	E
ECOW	KG DM EATEN BY ALL COWS THIS DELTA T	R 5	E
EG	NET ENERGY FOR PRODUCTION	R	ANLOOP
EGC	NET ENERGY FOR GAIN IN CALVES MJ/DAY	R	ANLOOP
ENCON	ENERGY CONTENT OF 1 KG DRY DM, MJ	R	ANLOOP
EPS	CONVERGENCE CRITERION FOR ZIR 0 00001	R	ZIR
EPT	EXPONENT IN PREGNANCY EN REQ EQUATION	R	ANLOOP
EPTIME	ADJUSTED PTIME, + HALF A DELT	R	ANLOOP
ES	CUMULATIVE CONCEPTIONS BY WEIGHT CLASS	R 10,4	CONCEP
ESUM	AMOUNT EATEN OF RESOURCES, CUMULATIVE PER DT	R 5	E
ET	INTERMEDIATE VARIABLE, PREG EN REQ	R	ANLOOP
ETES	PRODUCTION /AU/YR, YEARLY AVERAGE HERD NOS	R	INLOOP
ETE2	PRODUCTION /AU/YR, MONTHLY AVERAGE HERD NOS	R	INLOOP
ETOT	AMOUNT EATEN PER RUN (GRAND TOTAL)	R 5	E
ETI	INTERMEDIATE VARIABLE, PREG EN REQ	R	ANLOOP
EVENT	EVENT ARRAY	C#4 9	MAIN
EVG	ENERGY VALUE OF GAIN MJ MC/KG GAIN	R	ANLOOP
EVB	EVB IN CALVES	P	ANLOOP
EXPAGE	EXPONENT OF OPTIMAL GROWTH CALC, ADULT	R	SCALES
EXPW	EXPONENT, ADULT CONDITION FACTOR CALC (FCUND)	R	ANLOOP
EXTRA	EXTRA CONC FEED FED TO HEIFER REPLACERS	R	SCALES
FACM	MALE SEASONAL PRICE ADJUSTER	R 12	PRICE
FACF	FEMALE SEASONAL PRICE ADJUSTER	R 12	PRICE
FCW	CALF WEIGHT, = CW	R	SCALES
FDAY	AGE CLOCK INCREMENTOR	R	ANLOOP
FDEP	PROBABILITY OF CALF DEATH	R	ANLOOP
FEET	CALF DIET RESOURCE INDICATION	R 4	CALMIX
FBI	X-Y TABLE LAI AS A FUNCTION OF V/1000, GRASS	R 4,2	PASMIP
FBII	X-Y TABLE PSM AS A FUNCTION OF V/1000, GRASS	R 4,2	PASMIP
FBIII	X-Y TABLE PGR AS A FUNCTION OF LAI, GRASS	R 4,2	PASMIP
FBIV	X-Y TABLE CON AS A FUNCTION OF PX(2), GRASS	R 4,2	PASMIP
FBIVN	X-Y TABLE NO-COMPETITION FUNCTION, GRASS	R 4,2	PASMIP
FBVII	X-Y TABLE AGR SEASONAL MODIFIER GRASS	P 4,2	PASMIF
FG4	X-Y TABLE SELECTED CON FUNCTION, GRASS	R 4,2	PASMIP
FINISH	OPTION TO ABORT RUN BEFORE FINTIM	I	SCALES
FINMAT 1	HERD PASTURE CONSUMPTION IN YEAR JY, MONTH JM	R	C
FINMAT 2	HERD RECYCLED FEED CONSUMPTION	R	C

[Variable Name List -continued-]

FINMPT 3	HEAD CONC CONSUMPTION	R	
FINMPT 4	CALF PASTURE CONSUMPTION	R	C
FINMPT 5	CUMULATIVE MJ ME IN CONC FEE 5	R	L
FINTIM	NO OF DAYS FOR MODEL RUN	I	SCALES
FL	FEEDING LEVEL AS A MULTIPLE OF MAINT REQS	R	ANLOOP
FLI	X-Y TABLE LAI AS A FUNCTION OF V/1000, LEGUME	R 4,2	PASMIP
FLII	X-Y TABLE PSM AS A FUNCTION OF V/1000, LEGUME	R 4,2	PASMIP
FLIII	X-Y TABLE P6- AS A FUNCTION OF LAI, LEGUME	R 4,2	PASMIP
FLIV	X-Y TABLE CON AS A FUNCTION OF PX(2), LEGUME	R 4,2	PASMIP
FLIVN	X-Y TABLE NO-COMPETITION FUNCTION, LEGUME	R 4,2	PASMIP
FLVII	X-Y TABLE AGR SEASONAL MODIFIER LEGUME	R 4,2	PASMIP
FL4	X-Y TABLE SELECTED CON FUNCTION, LEGUME	R 4,2	PASMIP
FM	FASTING METABOLISM	R	ANLOOP
FMB	FASTING METABOLISM, AGE > 6 MOS	R	ANLOOP
FMCB	FASTING METABOLISM COEFF, > 6 MOS	R	ANLOOP
FMCF	FAST MAINTENANCE X CALF AGE	R 2,14	B
FMCB	FASTING METABOLISM COEFF, < 6 MOS	R	ANLOOP
FMR	FASTING METABOLISM, AGE < 6 MOS	R	ANLOOP
FOPND	AU S ASSIGNED TO EACH RESOURCE (4=4 AND/OR 5)	R 4	E
FRAK	CP, CUMULATIVE CONCEPTION OCCURRENCES	R 10,4	CONCEP
FV	X-Y TABLE SELEC PD = F(PX), NO 1-5	R 4,2,5	PASMIP
FS	X-Y TABLE SELECTED SELECTION FUNCTION	R 4,2	PASMIP
GRNEED	ME REQ FOR GAIN IN CALVES	R	ANLOOP
GROWTH	DAILY GROWTH REQ, CALVES KG	R	ANLOOP
HEADER	OUTPUT FILE HEADER	C=40	A
HEADS	NO OF COWS BY PHYSIOLOGICAL CLASS	R 4	C
HERBDM	DM EQUIVALENT OF HERBEN	R	ANLOOP
HERBEN	MAX ME CONSUMPTION FROM DM	R	ANLOOP
HERBL	CALF DM CONSUMP KG DM/DAY	R	ANLOOP
HERBME	ME EQUIVALENT OF HERBL	R	ANLOOP
HS	***	R	SCALES
HSF	***	R	C
IA	ANIMAL NUMBER, ANIMAL LOOP	I	A
IAGE	INTEGER OF AGE	I	ANLOOP
IABR	COUNT FOR EACH COW CONSECUTIVELY BARPEN	I 100	D
IBUF	AGE,WT,WMA,SEX,ID OF (MAX 10) NEW FOLLOWERS	I 10,5	F
IBUY	AGE,WT,WMA,PTIME,ID OF (MAX 10) NEW BREEDERS	I 10,5	F
IC	COW NUMBER, EVENT FILE (L U 4)	I	MAIN
ICCC	AMOUNT OF CREEP CONC FED TO CALVES	I	SCALES
ICOD 1	FORAGE CODE P 1-3	I	F
ICOD 10	FORAGE CODE MALE 2-3	I	F
ICOD 11	FORAGE CODE L 7-9	I	F
ICOD 12	FORAGE CODE MALE 3+	I	F
ICOD 13	FORAGE CODE HEIFERS	I	F
ICOD 14	FORAGE CODE DRY-EMPTY	I	F
ICOD 15	FORAGE CODE CALF MOB	I	F
ICOD 2	FORAGE CODE FEM 0-2	I	F
ICOD 3	FORAGE CODE P 4-6	I	F
ICOD 4	FORAGE CODE FEM 2-3	I	F
ICOD 5	FORAGE CODE P 7-9	I	F
ICOD 6	FORAGE CODE FEM 3+	I	F
ICOD 7	FORAGE CODE L 1-3	I	F
ICOD 8	FORAGE CODE MALE 0-2	I	F

[Variable Name List -continued-]

ICDD 9	FORAGE CODE L 4-6	I	F
ICDM7	COMPETITION FUNCTION (0 1)	I	FASMI F
ICOM	COUNTER FOR VALID CONCEPT INTERVALS THIS YEAR	I	SCALES
ICUL	ID NUMBERS OF INTERACTIVE CULLINGS	I 100	F
ID	CURRENT DAY OF SIMULATION RUN	I	SCALES
IDAT	LENGTHS OF OLD CASH BALANCES IN UNIT 12	I 8	INCREM
IDCOW	COW ID NUMBER, = VV(,4)	I	ANLOOP
IDEFLA	SKIPS DEFAULT MANAGEMENT OPTIONS IN PART 1 r=1	I	F
IDELT	= DELT (>=6)	I	ANLOOP
IDYA	NO OF CURRENT ECONOMIC RE-ANALYSIS	I	EC
IEV	EVENT OUTPUT OPTION	I	SCALES
IFAIL	FLAG FOR IRR CALCULATION MES-UP (0 OK, ERR 1-4)	I	ZIR
IFIN	TOTAL RUN TIME + 1	I	MAIN
IFLAG	FLAG FOR SELECTING REPLACEMENTS	I 100	INLOOP
IFLAG	FIRST-CALL-TO-ROUTINE FLAG	I	PASMI P
IFUS	COUNTER FOR FIRST PARTURMS THIS YEAR	I	SCALES
IGA	MONTHLY VARIABLE COSTS, CONVERTED TO C6	I 12	NXPANO
IHE	YEARLY CAPITAL COSTS, CONVERTED TO CH	I 20	NXPANO
II	CURRENT MONTH NUMBER	I	INLOOP
IJK	REPLICATE COUNTER	I	SCALES
IM	CURRENT MONTH, JAN = 1	I	SCALES
IME	MONTH OF YEARLY CAPITAL COSTS, USE WITH IH	I 20	NXPANO
IOP	SWITCH USED IN BRE	I	SCALES
IPRDEL	CONTROLS LARGE OUTPUT 0,1	I	SCALES
IPREG	CONCEPTION FLAG	I	ANLOOP
IREP	ID NUMBERS OF INTERACTIVE REPLACEMENTS	I 200	F
IREFP	REPLACEMENT HEIFER COUNTER	I	INLOOP
IRUM	RUN TYPE (0=> KAHN ORIGINAL, 1=>OTHER)	R	SCALES
IRUN	0,1,2 CFM OR TAMU CFM - STERILE PROB FACTOR	I	ANLOOP
ISEL	ID NUMBERS OF INTERACTIVE BREEDER SELLINGS	I 200	F
ISELL	SELECTION FUNCTION TYPE (1-5)	I	PASMI P
ISTOD	ANNUAL STOP DATES, INTERACTIVE RUNS (JULIAN)	I 4	F
ISTOP	NEXT STOP DATE, INTERACTIVE RUN	I	F
ITIME	CURRENT DAY - 1	I	A
IUIT	INTERACTIVE FLAG (99=ABANDON)	I	F
IWEA	ID NUMBERS OF INTERACTIVE WEANINGS	I 100	F
INSWCH	SWITCH 0,1	I	SCALES
IY	CURRENT YEAR - 1	I	INLOOP
IYIND	MONTH NUMBER OF RE-ANALYSIS	I	ANALIZ
JA	ANIMAL NO , OUTPUT TO LU 7	I	SCALES
JDELT	DELT/CDELT	I	SCALES
JEV	EVENT DATA OUTPUT 0,1	I	SCALES
JHERD	HEFD DATA OUTPUT, 0,1	I	SCALES
JM	CURRENT MONTH, START = 1	I	SCALES
JONAT 1	AVERAGE AH FEMALES	R	INLOOP
JONAT 2	AVERAGE BH FEMALES >= 2 YEARS OLD	R	INLOOP
JONAT 3	AVERAGE FOLLOWERS	R	INLOOP
JONAT 4	AVERAGE FOLLOWERS >1, <=2 YEARS OLD	R	INLOOP
JONAT 5	AVERAGE CALVES	R	INLOOP
JONAT 6	AVERAGE FOLLOWERS > 2 YEARS OLD	R	INLOOP
JREP	ID NOS OF REPLACEMENT CALVES	I 50	D
JRUN	0,1,2 RUN TYPE	I	MAIN
JX	YEARS COMPLETED DURING RUN	I	INLOOP

(Variable Name List -continued-)

TY	CURRENT YEAR OF RUN	I	SCALES
YCOL	MO, NO DAYS SINCE LAST CALVING FOR AUTOCUL	I	F
YFA	REQUIRED HERD SIZE, INTERACTIVE	I	F
YM	VICDEF*(YM)	R	MIXER
YK	ENERGY REQ FOR MILK, MJ ME/KG FCM	R	ANLOOP
YKNA	DESIRED HERD SIZE	I	SCALES
YLACT	ME INVESTED IN MILK PRODUCTION MJ/DAY	R	SCALES
YLBAL	ENERGY BALANCE FOR LACTATION	R	ANLOOP
YLDEF	LACTATION REDUCTION FACTOR, FROM LDEF	R	ANLOOP
YLDEF	PREVIOUS MILK YIELD X LACTATION STAGE	R 2,3	B
YLDL	VOL INTAKE OF DM LIMITED BY CP, DIG, AVAIL	R	SCALES
YLDL1	ACTUAL LIMIT TO INTAKE OF SOLIDS, CALVES	R	ANLOOP
YLFAC	LACTATION STAGE FACTOR, TISSUE MOBILIZATION	R	ANLOOP
YLIA	WEANED ANIMAL NUMBER	I 300	MX
YLOL	PASSED PARAMETER (1 GROWTH, 2 POSTCONSUMPTION)	I	PASHIP
YLOMOS	LENGTH OF OLD (STORED) CASH FLOW IN MONTHS	I	INCREM
YLT	LACTATION STAGE CLOCK INCREMENTOR	R	SCALES
YLTIME	NO OF DAYS LACTATING	R	SCALES
YLY	CURRENT MONTH OF RUN (CUMULATIVE)	I	EC
YLYR	NO OF DAYS IN YEAR	I	SCALES
YMAINT	ENERGY REQ FOR MAINTENANCE	F	ANLOOP
YMAINTC	MAINT REQ OF CALVES	F	ANLOOP
YMANDAT	MANAGEMENT DATES (JULIAN) PER YEAR	I 2	F
YMCOD	PHYS STATE NUMBER ASSIGNED FOR ICOD (1 - 14)	I	MOBRAT
YMCUL	NO OF SUCC NEG PREG TESTS FOR AUTOCUL	I	F
YMDA	DAY NUMBER, PANEL VARIABLE	I	MXLOOP
YMECONV	ME EQUIVALENT OF WCONV	R	ANLOOP
YMEP	ME BALANCE FOR WEIGHT GAIN	R	ANLOOP
YMEPC	ME FOR GAIN IN CALVES	R	ANLOOP
YMEPWT	WT GAIN IN ADULTS AND WEANED CALVES	R	ANLOOP
YMER	ME OF DAILY FEED CONSUMED, ADULTS + W CS	R	ANLOOP
YMERC	ME OF DAILY FEED CONSUMED, CALVES	R	ANLOOP
YMFA	MALE INCREASED BTH WT FACTOR A, ADULTS (10%)	R	SCALES
YMFA	MULTIPLICITY FACTOR	F	ANLOOP
YMFA	MALE INCREASED BTH WT FACTOR A, CALVES (0%)	R	SCALES
YMF	MALE INCREASED BTH WT FACTOR B, ADULTS	R	SCALES
YMFCC	MALE INCREASED BTH WT FACTOR B, CALVES	R	SCALES
YMINT	INTEGER EAT CODE (= VV(IA,23))	I	MIXER
YMINT	MIN WT OF HEIFER CALVES AS REPLACERS	R	SCALES
YMLOP	NO OF COWS + FOLLOWERS, NA+MFOLS	I	INLOOP
YMMOS	NUMBER OF MONTHS IN RUN	I	EC
YMODE	RUN MODE 0-9 NO BUY 10-19 BUY IN	I	SCALES
YMO	DUIFUI PRINTED EACH MOF DAYS	I	PASHIP
YMORE	FLAG FOR EOF LUIS - CAN I BUY ANY MORE COWS	I	INLOOP
YMY	= TY, OR = TY-1 IF NO REPLACERS	I	INLOOP
YMYR	YEAR NUMBER, PANEL VARIABLE	I	MXLOOP
YMYRS	NUMBER OF YEARS OF RUN	I	EC
YNA	CUMULATIVE NO OF ANIMALS	I	MX----
YNB	NO OF FEMALE CALVES IN HERD	I	SCALES
YNC	LENGTH OF ARRAY CDF	I	SCALES
YNC	LENGTH OF ARRAY CFDF	I	SCALES
YNC	LENGTH OF ARRAY CFWF	I	SCALES
YNC	LENGTH OF ARRAY CPF	I	SCALES

[Variable Name List -continued]

NDIF	INTRODUCED FRINTOU) INT , INDIVIDUAL COWS	I	ANLOOP
NDIG	LENGTH OF ARRAY DIGF	I	SCALES
NDIGS	LENGTH OF ARRAY SUPG	I	MAIN
NDIS	terminal date display frequency, 30 or 36	I	main
NDM	LENGTH OF ARRAY DMF	I	SCALES
NDMLIM	LENGTH OF ARRAY DMLIML	I	MAIN
NEED	TOTAL ME REQS	R	ANLOOP
NFEM	NO OF FEMALES IN ANY YEAF	I	INLOOP
NFMC	LENGTH OF ARRAY FMCF	I	SCALES
NFOLS	NUMBER OF WEANED-UNSDLD-UNREPLACED ANIMALS	I	MX
NHDSUM	NO OF ANIMALS BY MONTH COWS, CALVES, FOLLS	I 241 3	EC
NHEAD 1	ANIMALS DRY EMPTY	I	C
NHEAD 10	ANIMALS PREG 4-6 LACT 7-9	I	C
NHEAD 11	MULL	I	C
NHEAD 12	CALVES MALE AGE < 1	I	C
NHEAD 13	CALVES FEMALE AGE < 1	I	C
NHEAD 14	FOLLOWERS FEMALE < 1	I	C
NHEAD 15	FOLLOWERS FEMALE 1-2	I	C
NHEAD 16	FOLLOWERS FEMALE 2-3	I	C
NHEAD 17	FOLLOWERS FEMALE 3-4	I	C
NHEAD 18	FOLLOWERS FEMALE > 4	I	C
NHEAD 19	FOLLOWERS MALE < 1	I	C
NHEAD 2	ANIMALS PREG 1-3	I	C
NHEAD 20	FOLLOWERS MALE 1-2	I	C
NHEAD 21	FOLLOWERS MALE 2-3	I	C
NHEAD 22	FOLLOWERS MALE 3-4	I	C
NHEAD 23	FOLLOWERS MALE > 4	I	C
NHEAD 24	TOTAL NUMBER OF COWS	I	C
NHEAD 25	TOTAL NUMBER OF CALVES	I	C
NHEAD 26	TOTAL NUMBER OF FOLLOWERS	I	C
NHEAD 3	ANIMALS PREG 2-6	I	C
NHEAD 4	ANIMALS PREG 7-9	I	C
NHEAD 5	ANIMALS LACT 1-3	I	C
NHEAD 6	ANIMALS LACT 4-6	I	C
NHEAD 7	ANIMALS LACT 7-9	I	C
NHEAD 8	ANIMALS PREG 1-3 LACT 3-6	I	C
NHEAD 9	ANIMALS PREG 1-3 LACT 7-9	I	C
NIND	INCREMENTAL ANALYSIS FLAG (0,1,99)	I	EC
NIT	NO OF ITERATIONS BEFORE CONVERGENCE	I	ZIR
NLD	LENGTH OF ARRAY LDEPF	I	SCALES
NNB	CUMULATIVE ANIMAL NO (=NA, POINTER FOR VV)	I	SCALES
NORIG	ORIGINAL NUMBER OF BREEDERS	I	MX
NPAV	NUMBER OF IMPROVED FRACTURE PRODUCTS	I	E
NREP	NO OF REPLACERS WANTED	I	SCALES
NRES	RESOURCE I EATEN OR NO (0,1)	I E	E
NSEED	RANDOM NUMBER SEED	I	SCALES
NSUP	LENGTH OF ARRAY SUPDMF	I	SCALES
NUM	MONTH NUMBERS	I 12	D
NUMFOL	ON-GOING NUMBER IN FOLLOWERS HERD	I	MX
NUM1	YEAR NUMBERS, 1 TO 20	I 20	D
NV	3,7 OLD COLUMN OUTPUT	I	ANLOOP
NWEAN	POLICY AGE AT WEANING, DAYS	I	F
OEST	TIME SINCE LAST OESTRUS	R	ANLOOP

[Variable Name List -continued-]

DFRAT	MILK OFFTAKE RATE 0 0 - 1 0	R	EC
DLBAL	0 0 BALANCE BY MONTH FROM LU 2	R 24,	INCEM
OUT 1,32	NO COWS BOUGHT IN YEAR TY	R	D
OUT 1,1	PAST CON, OLD PAST	R	D
OUT 1,10	MEAN WT, OLD AVCH	R	D
OUT 1,11	MEAN AGE, OLD AVCAGE	R	D
OUT 1,12	CON AGE, OLD AVAGE	R	D
OUT 1,13	NO REPLACED, OLD NNR&P	R	D
OUT 1,14	DEAD ADULTS, OLD NAD&D	R	D
OUT 1,15	DEAD CALVES, OLD NC&D	R	D
OUT 1,16	REP AGE, OLD REP&E	R	D
OUT 1,17	REP WT, OLD REP&T	R	D
OUT 1,18	12 MO WT, OLD YEAR&T	R	D
OUT 1,19	SURV TO 12 MONTHS, OLD SURV12	R	D
OUT 1,2	CONA CON, OLD CONA	R	D
OUT 1,20	SURV TO 24 MONTHS, OLD SURV24	R	D
OUT 1,21	24 MO WT, OLD YEAR&W	R	D
OUT 1,22	NO OF ABORTIONS, OLD NUM&BS	R	D
OUT 1,23	NO BIRTHS, OLD NUM&BS	R	D
OUT 1,24	AGE AT FIRST PARTUM, OLD F&SP&P	R	D
OUT 1,25	CONCEPTION INTERVAL, OLD CON&INT	R	D
OUT 1,26	HERD BIOMASS /100, OLD BIO	R	D
OUT 1,27	NO OF ORPHANS, OLD NP&R&W	R	D
OUT 1,28	NO OF ANIMAL UNITS IN HERD, OLD AUS	R	D
OUT 1,29	NUMBER OF COWS >= 2 YRS	R	D
OUT 1,3	CONB CON, OLD CONB	R	D
OUT 1,30	COW WT, DRY EMPTY, END OF DRY SEASON	R	D
OUT 1,31	COW WT, DRY EMPTY, END OF WET SEASON	R	D
OUT 1,32	NUMBER COWS BOUGHT	R	D
OUT 1,33	MILK OFFTAKE PRODUCTION	R	D
OUT 1,4	CONC MEJ, OLD MEJ	R	D
OUT 1,5	CALF SALES, OLD SA&L&C	R	D
OUT 1,6	CULL SALES, OLD SA&L&E	R	D
OUT 1,7	CON&P&C, OLD Y&P&E&E	R	D
OUT 1,8	B H FEMALES, OLD NF&E&M	R	D
OUT 1,9	NO WEANED OLD NOW&E&A&N	R	D
OUT 20,1	ARRAY OF OUTPUT DATA, 20 YEARS	R	D
OUT 21,1	SUM OF 20 YEARS DATA	R	D
OUT 22,1	NUMBER OF NON-ZERO YEARS	R	D
OUT 23,1	TRUE AVERAGE (EXCLUDES 0 IF NECESSARY)	R	D
OUT 24,1	SUM OF SQUARES	R	D
OUTNAM	PRODUCTION PARAMETERS ARRAY	C*8 3	INLOOP
P	P&P&P OF FEED IN DIET	R 5	E
PABO	PROB OF ABORTION	R	ANLOOP
PAV	AVERAGE PRICES PAID/RECEIVED PER KG PER YEAR	R 22,6	ECONOM
PCAL	PROPORTIONS IN CALF DIET	R 5	CALMIX
PCON	PROB OF CONCEPTION	R	ANLOOP
PCTIME	CTIME - CDELTA, PREVIOUS TIME INTERVAL, CALF	R	ANLOOP
PD	PROPORTION OF 1 L 2 6 IN DIET	R 2	P&M&I&P
PDELTA	CONCEPTION INTEGRATION PERIOD (IN EFFECT)	I	SCALES
PDM	PASTURE DM INTAKE	R	ANLOOP
PEST	PROB OF OESTRUS	R	ANLOOP
PESTCO	PROB ADJUSTER FOR INTEGRATION STEP	R	ANLOOP

[Variable Name List -continued-]

PGP	POTENTIAL GROWTH RATE 1 L 2 6	R 2	PASMIP
PHD	AVERAGE PRICES PAID/RECEIVED PER HEAD PER YEAR	F 22,6	ECONOM
PLACT	PREVIOUS MILK ENERGY YIELD	R	ANLOOP
FLUS	DELTA/2	R	ANLOOP
PMA	BREED LACTATION POTENTIAL KG FCM/DAY	R	SCALES
PMEXP	RATE OF DECLINE OF MILK YIELD	R	ANLOOP
PN	DISCOUNT RATES FOR NPVS	R 6	ZIR
PF	FRACTION OF COW ADULT WT REPRESENTING BIRTH WT	R	SCALES
PPDIF	SELECTS COWS WITH DIFFICULT PARTURITION (0 1)	R	ANLOOP
PPM	ENERGY CONTENT OF MILK YIELD	R	ANLOOP
PPT	EXPONENT, TOTAL WT INCREASE DUE TO PREGNANCY	R	ANLOOP
PRDM	***	*	C
PREF	PREFERENCE FUNCTION	R 4 2	MIXER
PREG	ME REQS FOR PREGNANCY	R	ANLOOP
PREGN	N ENERGY REQS FOR PREGNANCY	R	ANLOOP
PREGP	INTERMEDIATE VARIABLE, CALC OF WPREG	R	ANLOOP
PREIS	MILK PRICE, \$/LITRE	R	EC
PRI	CURRENT MONTH 5 PRICES FOR 6 CATEGORIES	R 6	EC
PRINIT 1	COST OF COW REPLACERS, \$/HEAD	R	EC
PRINIT 2	PRICE RECEIVED, CULL COWS, \$/KG	R	EC
PRINIT 3	PRICE RECEIVED, FEM CALVES, \$/KG	R	EC
PRINIT 4	PRICE RECEIVED, MALE CALVES, \$/KG	R	EC
PRINIT 5	PRICE RECEIVED, FEM FOLLOWER, \$/KG	R	EC
PRINIT 6	PRICE RECEIVED, MALE FOLLOWER, \$/KG	R	EC
PRL	ADJUSTS PTIME TO EPTIME, =270 IF LYR =360	R	ANLOOP
PROD	CUMULATIVE PASTURE GROWTH 1 L 2 6 3 TOT	R 3	PASMIP
PROP	PROP OF SUPP FEED IN DAILY INTAKE DM	R	ANLOOP
PROPD	INTERMEDIATE VARIABLE, SUP FEED CONSUMPTION	R	ANLOOP
PROPH	PROP OF SOLID ENERGY IN TOTAL FEED ENERGY	R	ANLOOP
PROPIN	PROP OF PMA ATTAINED ON DAY 0	R	ANLOOP
PROPL	PROP OF MILK ENERGY IN TOTAL CALF FEED CONSUMP	R	ANLOOP
PSM	SENESCENCE "GROWTH" RATE 1 L 2 6	R 2	PASMIP
PT	PREGNANCY CLOCK INCREMENTOR	R	ANLOOP
PTIME	NO OF DAYS PREGNANT	R	SCALES
PWML	PREVIOUS OPTIMAL CALF WEIGHT	R	ANLOOP
PX	PROPORTION OF 1 L 2 6 IN SWAND	R 2	PASMIP
PXPAGE	EXPONENT, PREVIOUS OPTIMAL CALF WT	R	ANLOOP
Q	EFFICIENCY OF ME UTE OF SOLID FEED FOR MAINT	R	ANLOOP
QA	DM/HA BEAST DAY	R 5	E
QB	DM/HA AVAILABLE TO ANIMALS	R 5	E
QF	EFFICIENCY OF ME UTE FOR TISSUE ANABOLISM	R	ANLOOP
QL	EFFICIENCY OF ME UTE FOR LACTATION	R	ANLOOP
QLACT	PREVIOUS VALL OF LACT - NOT USED	R	ANLOOP
QM	EFFICIENCY OF ME UTE FOR MAINTENANCE	R	ANLOOP
QMILK	KG MILK PER MONTH	R 241	ECONOM
QB	BIOMASS PER ANIMAL	R 5	E
RATE	GROWTH RATE PARAM (AMATZ=0.065, HERE=0.054)	R	SCALES
RATEM	RATE OF DECLINE OF MILK YIELD POST-PEAK	R	ANLOOP
RLAI	RESIDUAL LEAF AREA INDEX 1 L 2 6	R 2	PASMIP
R0	RANDOM NUMBER, CALF SEX	R	ANLOOP
R1	RANDOM NUMBER, STERILITY TRIGGER	R	ANLOOP
R2	RANDOM NUMBER, ABNORMAL PARTURITION	R	ANLOOP
R3	RANDOM NUMBER, ADULT MORTALITY	R	ANLOOP

[Variable Name List -continued-]

R4	RANDOM NUMBER, STERILITY	R	ANLOOP
R5	RANDOM NUMBER, CYCLIN-	R	ANLOOP
R6	RANDOM NUMBER, ABORTION	R	ANLOOP
R7	RANDOM NUMBER, DESIRUS	R	ANLOOP
R8	RANDOM NUMBER, CALF DEATH	R	ANLOOP
R9	RANDOM NUMBER, CONCEPTION	R	ANLOOP
SAGEF	FEMALE FOLLOWERS MINIMUM AGE AT SALE	R	F
SAGEM	MALE FOLLOWERS MINIMUM AGE AT SALE	R	F
SDAT	STOFE ARRAY, OLD CASH BALANCES IN UNIT 12	R 241,8	INCREM
SDEV	STANDARD DEVIATION, COW BUY PRICE	R	PRICE
SDEV2	STANDARD DEVIATION, COW SALE PRICE	R	PRICE
SEASON	BREEDING SEASON ? 0,1	R 12	C
SEX	OF WEANED ANIMAL 1=F 2=M	I	SCALES
SNUM	NO OF SAMPLES FOR CLASS NUMBERS	R	SCALES
SPARE	SPARE COS DATA ARRAYS, READ FROM UNIT 15	R 50,20	MX
STAPT	STARTING POINTS FOR PRICE CYCLES	R 2	EC
STER	STERILITY FACTOR, AGE	R	ANLOOP
STERB	STERILITY TRIGGER	R	ANLOOP
SUPA	EXTRA CONCS (EXTRA)	R	ANLOOP
SUPCP	CP OF RECYCLED SUPP FEED, WEIGHTED AVERAGE	R	ANLOOP
SUPCPF	SUP FEED CRUDE PROTEIN	R 2,40	C
SUPD16	SUP FEED DIGESTIBILITY X TIME	R 2,40	C
SUPDM	SUP FEED X TIME	R 2,40	C
SUPT	SUP RECYCLED FEED ALLOCATION	R	ANLOOP
SW	WEIGHT	R	INLOOP
SWTF	FEMALE FOLLOWERS MINIMUM SALE WT	R	F
SWTM	MALE FOLLOWERS MINIMUM SALE WT	R	F
TDLACT	CUMULATIVE POTENTIAL MILK PROD	R	SCALES
TDM	TOTAL PASTURE DM CONSUMPTION, LIFETIME	R	ANLOOP
THERBL	TOTAL CALF PASTURE CONSUMP TO WEANING	R	SCALES
TIME	CURRENT DAY - 1, = ITIME	P	SCALES
TIMT	DATE, DAYS POST 1 NOV	R	SCALES
TIMX	DATE, DAYS POST 1 JAN	R	SCALES
TITLE	TITLE OF RUM	C*25	MAIN
TLACT	TOTAL MILK ENERGY PRODUCTION, LIFETIME	R	ANLOOP
TM	DM CONTENT OF CONSUMED MILK	F	SCALES
TOOT	TOTAL NO OF CONCEPTIONS BY WEIGHT CLASS	R 4	CONCEP
TPDM	***	*	C
TPREG	ARRAY FOR STORING CONCEPTION OCCURRENCES	R 20,12	C
TPRO	MILY OFFTAKE SUMMER PER MONTH	R	EC
TRACT	ME REQS FOR TRACTIVE WORK	P	ANLOOP
TREN	TRACTIVE WORK 0,1,2	R	SCALES
TREN	LINER 2 INCREASE PER YEAR IN PRICE CYCLES	R 2	EC
TRIG	ADULT DEATH TRIGGER	R	ANLOOP
TRIGAE	ABORTION TRIGGER	R	ANLOOP
TRIBC	CALF DEATH TRIGGER	R	ANLOOP
TRIGP	CONCEPTION TRIGGER	R	ANLOOP
TSUPA	TOTAL CONC CONSUMPT, LIFETIME	R	ANLOOP
TSUFB	TOTAL RECYCLED FEED DM CONSUMP	R	ANLOOP
UANS	NOS, WTS, PESOS FOR 6 CATEGORIES EACH MONTH	R 6,3	EC
UP	INTEREST RATE HALVINGS FOR ZIR	R	ZIR
UTOT	CUMULATES UANS TO GET YEARLY AVERAGE PRICES	R 6,3	ECONOM
V	TOTAL BIOMASS 1 L 2 6	R 2	PASHIP

[Variable Name List -continued]

VF	V(1) AS T/HA (LEGUME)	R	PASMIP
V	V(2) AS T/HA (GRASS)	R	PASMI
VICOLF	= VIP	F	SCALES
VIF	PROF INCREASE IN VIP IN LACTATING COW	R	ANLOOP
VIP	DM INTAKE COEF, FAECAL DM OUTPUT/KG/LWT/DAY	F	SCALES
VM	TOTAL BIOMASS LEG+GRASS	R	PASMIP
VPAD 1,1	ROTATIONAL IP PADDocks - LEGUME BIOMAS	R 5,4	E
VPAD 1,2	GRASS BIOMA	R 5,4	E
VPAD 1,3	AREA	F 5,4	E
VPAD 1,4	DAYS OF OCCUPANCY	R 5,4	E
VF	BIOMASS - RESIDUAL UNGRAZEABLE 1 L 2 6	R 2	PASMIP
VRES		R 5	F
VV 1,1	SEX OF ITH ANIMAL 1=F 2=M	R	NI
VV 1,10	PREG STAGE DAYS (PTIME)	R	NI
VV 1,11	POST-PARTUM STAGE DAYS (APTIME)	R	NI
VV 1,12	CALF AGE DAYS (CTIME)	R	NI
VV 1,13	LACTATION STAGE, DAYS (LTIME)	R	NI
VV 1,14	WMC, CW	R	NI
VV 1,15	CALF SEX (CSEX)	R	NI
VV 1,16	TLACT	R	NI
VV 1,17	TDLACT	R	NI
VV 1,18	NO OF LIVE CALVES	R	NI
VV 1,19	THERBL	R	NI
VV 1,2	AGE IN YEARS	R	NI
VV 1,20	DATE (ITIME) OF LAST CONCEPTION	R	NI
VV 1,21	TSUPA	R	NI
VV 1,22	AGE AT LAST CALVING	R	NI
VV 1,23	EAT CODE FOR MOB GRAZING	R	NI
VV 1,24	NO OF ANIMAL UNITS	R	NI
VV 1,25	WMC	R	NI
VV 1,26	WM	R	NI
VV 1,27	CALF MOB CODE	R	NI
VV 1,3	COW MATURE WEIGHT	R	NI
VV 1,4	COW IDENTITY NUMBER	R	NI
VV 1,5	WEIGHT	R	NI
VV 1,6	TDM	R	NI
VV 1,7	TSUPB	R	NI
VV 1,8	DEST	R	NI
VV 1,9	PHYSIOLOGICAL STATUS	R	NI
W	WEIGHT, KG	R	SCALES
WA"	AVERAGE-WEIGHT-OF-COWS CUMULATOF	R	INLOOP
W DM"	MAX TISSUE MOBILISATION FOR LACTATION	R	ANLOOP
WFM	WT INDEX FACTOR FOR TISSUE MOBILISATION	R	ANLOOP
WM	POTENTIAL WEIGHT, KG	R	SCALES
WMA	MATURE WEIGHT	R	SCALES
WMAA	MAX BODY TISSUE MOBILISATION TO SUPPORT LACT	R	SCALES
WMB	MATURE WEIGHT, BULL	R	ANLOOP
WMBB	= WMB	R	ANLOOP
WMC	OPTIMAL WT OF CALF (=INITIAL WT)	R	SCALES
WMCC	MATURE WEIGHT OF CALF (M=1 3+F)	R	SCALES
WMC	ADULT FEMALE WT OF BREED	R	SCALES
WMP	AV WEIGHT OF MATURE MALES	R	SCALES
WMR	PROP OF ADULT WT ATTAINED MID-APRIL	R	ANLOOP

[Variable Name List -continued-]

WMX	V I EQUATION WEIGHT, = WM IF AGE < 75, ELSE W	R	SCAL C
Wf	COW LW INCLUDING PREG OR CALF LW INC BUT FILL	R	ANLOC
WFREG	WT INCREMENT DUE TO PREGNANCY	R	ANLOOP
WTDIF	DIFFERENCE BETWEEN OPTIMAL AND ACTUAL CALF WT	R	ANLOC
WH	WEANING %	R	ANLOOP
WWMF	MATURE WEIGHT, FEMALE	R	ANLOOP
WWT	REPLACEMENT WEIGHT LIMIT	R	INLOOP
YES	CONCEPTION OCCURRENCES BY WEIGHT CLASS	R 10,4	CONCEP
Z	WM/WMA	R	ANLOOP
ZBAL	INCREMENTAL BALANCE BY MONTH	R 241	INCREM
ZBALYR	INCREMENTAL BALANCE BY YEAR	R 22	INCREM
ZBUF	FLAG, ANY FOLLOWER BUYINGS THIS TIME	L	LOGIX
ZBUY	FLAG, ANY BUYINGS THIS TIME	L	LOGIX
ZCUL	FLAG, ANY CULLINGS THIS TIME	L	LOGIX
ZDIF	OLD BALANCE BY YEAR	R 22	INCPEN
ZINC	DELT/270	R	ANLOOP
ZJM	REAL JM	R	ANLOOP
ZJY	REAL JY	R	ANLOOP
ZM	PRODUCTION, KG/AM/YR	R	INLOOP
ZMILK	MILK OFFTAKE PPOD PER YEAR	R 241	ECONOM
ZN	PRODUCTION, YG/AM/YR ETES	R	INLOOP
ZREP	FLAG, ANY REPLACEMENTS THIS TIME	L	LOGIX
ZSEL	FLAG, ANY SELLINGS THIS TIME	L	LOGIX
ZWEA	FLAG, ANY WEANINGS THIS TIME	L	LOGIX
ZZ	INTERMEDIATE VARIABLE, SUPPLEMENT INTAKE	R	ANLOOP

Note Function - obsolete variables are indicated thus ***

Type - R is a real variable, I an integer, L a logical and A a character variable. For I*N, N is the size in bytes where this is non-standard, and an array of size N is shown as : M, where s the variable type

Location - if A, B, C, D, E, EC, r, SCALES, NX, LOGIX, this refers to a named Common Block. All other locations refer to FORTRAN subroutine names

This list is not exhaustive, neither does it include loop counters or many intermediate variables

APPENDIX B 3 INTERACTIVE PANELS (SEE TABLE 4)

Rusmob C0

JAN 1987RUSMOB V4 2
INTERACTIVE

CIAT PKT

RUN COMPLETE

OUTPUT IS STORED IN THE FOLLOWING FILES
 OUTPUT FT6 (ANIMAL PERFORMANCE)
 PASTO FT9 (FORAGE RESOURCES)
 CASHFLO FT11 (ECONOMIC ANALYSES)

_ee

PF1 - QUIT

Rusmob 01-----
JAN 1987RUSMOB V4 2
INTERACTIVE

CIAT PKT

JULIAN DATE (YF DAYS) _ee _eee
 MAIN MENU

-
 DISPLAY MONTHLY CASH FLOW
 DISPLAY BREEDING HERD
 DISPLAY FOLLOWERS HERD
 DISPLAY CALVES
 DISPLAY PASTURES
 DISPLAY LAST 12 MONTHS EVENT SUMMARY
 MANAGEMENT OPTIONS MENU
 SET NEXT HALT DATE

PF1 - ENTER OPTION

PF2 - CONTINUE RUN

PF9 - ABANDON

Rusmob 02

JAN 1987

RUSMOE V4 2
INTERACTIVE

CIAT PK1

JULIAN DATE (YR DAYS) _ee _eee

SELECT NEXT HALT DATE

YEAR _ee
JULIAN DAY NUMBER _eee

PF1 - MAIN MENU PF2 - ENTER PF9 - ABANDON

Rusmob 03

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIAT PK1

MANAGEMENT MENU
DATE (YR DAYS) _ee _eeeBUY BREEDERS
CULL BREEDERS
WEAN CALVES
BUY FOLLOWERS
SELL FOLLOWERS
SELECT REPLACERS
CHANGE FORAGE PRIORITIES
BURN SAVANNA
CHANGE BREEDING SEASON
CHANGE POLICY PARAMETERS

PF1 - MAIN MENU PF2 - ENTER PF9 - ABANDON

Rusmob C6

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIAT FKT

CALVES DISPLAYER PANEL _ee OF _ee

DAM ID	SE	WT	NORM WT	AGE (DAYS)
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				
_000				

FF1 - MAIN MENU FF2 - BACK PF4 - FORWARD PF4 - ABANDON

Rusmob 07

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIAT FKT

PASTURE STATUS

----SAVANNA----			---IMPROVED---	
1	2	3	LEGUME	GRASS

AREA HA	_eeeee	_eeeee	_eeeee	_eeeee	_eeeee
BIDMASS YG DM / HA	_eeeee	_eeeee	_eeeee	_eeeee	_eeeee
RESIDUE KG / HA	_eeeee	_eeeee	_eeeee	_eeeee	_eeeee
PERCENT DIGESTIBILITY	_ee	_ee	_ee	_ee	_ee
PERCENT CRUDE PROTEIN	_ee	_ee	_ee	_ee	_ee
AVAILABILITY KG / AU	_eeeee	_eeeee	_eeeee	_eeeee	_eeeee

PF1 - MAIN MENU PF9 - ABANDON

Rusmob 09

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIAT F11

CASHFLOW DISPLAYER PANEL_00 OF_00

YEAR	MONTH	SALES	COSTS	BALANCE
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0
_	0	0	0	0

CUMULATIVE TO DATE _00

PF1 - MAIN MENU PF2 - BACK 1 YR PF4 - FORWARD 1 YR PF9 - ABANDON

Rusmob 09

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIAT PKT

RRRFRR	U	U	SSSSSS	M	M	0000	BBBBB	
R R	U	U	S	MM	MM	0 0	B B	
RRRRRR	U	U	SSSS	M	MM	M	0 0	BBBBB
R R	U	U	S	M	M	0 0	B B	
R R	UUUU		SSSSSS	M	M	0000	BBBBB	

AN ANIMAL PRODUCTION SIMULATION MODEL FOR EXTENSIVE RANCHING SYSTEMS IN THE LLANOS ORIENTALES OF COLOMBIA BUILT AROUND THE READING UNIVERSITY MODEL OF H E KAHN BY P K THORNTON

_e

PF1 - START RUN PF9 - ABANDON

Rusmob 10

JAN 1987

RUSMOB 142
SEMI BATCH

CIAT PFI

RUN NAME _____

RUN CONTROLS

RANDOM NUMBER SEED (NSEED) _eeee
RUN TYPE (IRUM) _e
RUN MODE (MODE) _ee
RUN LENGTH, DAYS (FINTIM) _eeee
CASH FLOW FLAG (NIND) _e
TIME STEP, DAYS (DELT) _ee
ANNUAL STOP DAY NOS (ISTOD) _eee

eee
eee

HERD CONTROLS

POTENTIAL MILK YIELD (PMA) _eeee
INITIAL HERD SIZE (NA) _ee

FORAGE (IRUM=1)

----SAVANNA---- IMPROVED PASTURE
1 2 3 GRASS LEGUME
AREAS _eeeeee _eeeeee _eeeeee _eeeeee
BIOMASS _eeeeee _eeeeee _eeeeee _eeeeee

PF1 - START RUN PF9 - ABANDON

Rusmob 11

JAN 1987

RUSMOB V42
INTERACTIVE

CIAT PKT

EVENT DISPLAYER PANEL _ee OF _ee

DAY YR MO EVENT ANIMAL SEX AGE W Wh DAM-ID AGE W WM
_000
_000
_000
_000
_000
_000
_000
_000
_000
_000
_000
_000
_000
_000
_000
_000

PF1 - MAIN MENU PF2 - BACK PF4 - FORWARD PF9 - ABANDON

Rusmob 21

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIA1 PKT

ADDITIONAL ECONOMIC ANALYSIS NUMBER _00

VARIABLE COSTS PER HEAD (\$)	_0000	
PRICE CYCLE AMPLITUDES (PERCENT)	_0000	_0000
ANNUAL PRICE TRENDS (PERCENT)	_0000	_0000
PRICE CYCLE LENGTHS (YEARS)	_0000	_0000
PRICE CYCLE STARTING POINTS	_0000	_0000
INITIAL PRICES	_0000000	
COWS BOUGHT (\$/HD)	_0000000	
CULL COWS (\$/KG)	_00000	
CALVES SOLD (\$/KG)	F_00000	M_00000
FOLLOWERS SOLD (\$/KG)	F_00000	M_00000
MILK PRICE (\$/LITRE)	_0000	

PF1 - PERFORM ANALYSIS PF2 - NEXT PANEL PF3 - QUIT PF9 - ABANDON

Rusmob 22

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIA1 : PKT

ADDITIONAL ECONOMIC ANALYSIS NUMBER _00

CAPITAL COST SCHEDULE				MONTHLY VARIABLE COSTS	
YR	MO	YR	MO	MO	
1	_0000000	11	_000000	1	_000000
2	_000000	12	_000000	2	_000000
3	_000000	13	_000000	3	_000000
4	_000000	14	_000000	4	_000000
5	_000000	15	_000000	5	_000000
6	_000000	16	_000000	6	_000000
7	_000000	17	_000000	7	_000000
8	_000000	18	_000000	8	_000000
9	_000000	19	_000000	9	_000000
10	_000000	20	_000000	10	_000000
				11	_000000
				12	_000000

PF1 - PERFORM ANALYSIS PF2 - PREVIOUS PANEL PF3 - QUIT PF9 - ABANDON

Rusmob 3f

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIAT F11

CHANGE BREEDING SEASON BY MONTH
DATE (YR DAYS) _00 _000

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CURRENT	_0	_0	_0	_0	_0	_0	_0	_0	_0	_0	_0	_0
CHANGE TO	_0	_0	_0	_0	_0	_0	_0	_0	_0	_0	_0	_0

(1 = BULL ACCESS, 0 = NO BULL ACCESS)

PF1 - MANAGEMENT MENU PF2 - ENTER PF9 - ABANDON

Rusmob 3i

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIAT PKT

BURN SAVANNA (TYPES 1, 2 AND/OR 3)
DATE (YR DAYS) _00 _000

	SAVANNA 1	SAVANNA 2	SAVANNA 3
AREA HA	_00000	_00000	_00000
UNBURNT BIOMASS KG/HA	_00000	_00000	_00000
BURNT BIOMASS KG/HA	_00000	_00000	_00000
BURN	_1	_2	_

TO BURN, PLACE CURSOR ON RELEVANT NUMBER THEN HIT PF4
BURNT BIOMASS MAY THEN BE CHANGED

PF1 - MANAGEMENT MENU PF2 - ENTER PF9 - ABANDON

Rusmob 32

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIAT PKT

POLICY CHANGES
DATE (YR DAYS) _## _###

MINIMUM AGE AT WEANING, DAYS		_###
DEFAULT ANNUAL MANAGEMENT DATES	_###	_###
MINIMUM AGE OF BREEDERS, YEARS		#####
MAX NO OF NEGATIVE PREGNANCY TESTS		_##
MAX NO OF DAYS SINCE LAST CONCEPTION		_###
MINIMUM SALE WEIGHT, FEMALE, KG		_###
MINIMUM SALE WEIGHT, MALE, KG		_###
MINIMUM SALE AGE, FEMALE, MONTHS		_##
MINIMUM SALE AGE, MALE, MONTHS		_##
NUMBER OF BREEDERS WANTED		_##
FLAG (0,1) TO OVERRIDE DEFAULTS BAR WEANING		_e
MILK OFFTAK RATE (0 0 TO 1 0)		_#####
FIXED MILK PRICE, \$/LITRE		_#####

PF1 - MANAGEMENT MENU PF2 - ENTER PF9 - ABANDON

Rusmob 33

JAN 1987

RUSMOB V4 2
INTERACTIVE

CIAT : PKT

BREEDING HERD CULL PANEL_## OF_##

	D	AGE	WT	NOFM	WT	DAYS	PREG	DAYS	LACT	AGE	LAST	CALF
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
_	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000

TO CULL AN ANIMAL, PLACE CURSOR ON RELEVANT LINE AND PRESS ENTER
PF1 - MANAGEMENT MENU PF2 - BACK PF4 - FORWARD PF9 - ABANDON

Rusmob 36

JAN 1987 RUSMOB V4 2 CIAT PF1
INTERACTIVE

NEW BREEDING ANIMALS BUY _ee ANIMALS IN HERD

AGE WEIGHT MAX WT DAYS PREG HERD ID
_00
_00
_00
_00
_00
_00
_00
_00
_00
_00
_00
_00
_00
_00
_00

==> COW AGE (MOS)_ee WEIGHT_eee MATURE WEIGHT_eee DAYS PREGNANT_ee
TO BUY, ENTER RELEVANT INFORMATION ON DATA ENTRY LINE, THEN HIT ENTER
PF1 - MANAGEMENT MENU PF9 - ABANDON

Rusmob 37

JAN 1987 RUSMOB V4 2 CIAT PF1
INTERACTIVE

PASTURE MANAGEMENT DATE (YRS DAY) _ee _eee

CHANGE PASTURES

AREA SAVANNAS _eeeeee _eeeeee _eeeeee IMPROVED _eeeeee
BIOMASS _eeeeee _eeeeee _eeeeee LEGUME _eeeeee GRASS _eeeeee

CHANGE MOB CODES

BREEDERS - (MOS) FOLLOWERS (YRS)
PREGNANT 1-3 _eeeeee FEMS TO 2 _eeeeee
4-6 _eeeeee 2-3 _eeeeee
7-9 _eeeeee 4+ _eeeeee
LACTATING 1-3 _eeeeee MALES TO 2 _eeeeee
4-6 _eeeeee 2-3 _eeeeee
7-9 _eeeeee 4+ _eeeeee
HEIFERS _eeeeee
DRY EMPTY _eeeeee
CALVES _eeeeee

MOB CODES 1---- WHERE - IS 0 (FORAGE NOT IN DIET) OR 1 (FORAGE IN DIET)
PF1 - MANAGEMENT MENU PF2 - ENTER PF8 - SYSTEM PANEL PF9 - ABANDON

Rusmob 40

JAN 1987RUSMOB V4 2
INTERACTIVE

CIAT FIT

IMPROVED PASTURE GRAZING SYSTEM DATE (YR DAY) _@@ _@@@

NUMBER OF PADDOCKS (1-5) _e

	PADDOCK	1	2	3	4	5
INITIAL BIOMASS, LEGUME		_ @@@@	_ @@@@	_ @@@@	_ @@@@	_ @@@@
INITIAL BIOMASS, GRASS		_ @@@@	_ @@@@	_ @@@@	_ @@@@	_ @@@@
AREA OF EACH PADDOCK		_ @@@@	_ @@@@	_ @@@@	_ @@@@	_ @@@@
DAYS, ANIMAL OCCUPANCY		_ @@@	_ @@@	_ @@@	_ @@@	_ @@@

NOTE CHANGES TAKE EFFECT IMMEDIATELY AREAS AND OCCUPANCY PERIODS
MAY DIFFER BETWEEN PADDOCKS SIMULATION RUNS WITH ROTATIONAL
GRAZING MAY BE VOLATILE, SO CHECK PASTURE/ANIMAL STATUS OFTEN

FF1 - LAST PANEL

PF2 - ENTER CHANGES

PF9 - ABANDON

Notes - a standard data entry field in a panel is indicated thus _@@ where the
number of @ s indicates the length of the field Fields may hold either
real or integer variables, and some are protected (i.e., they cannot be
changed by the user)

- other panels have, in addition long data fields indicated thus _000
This is done to improve the efficiency of loading these panels On
display, many of the field positions hold blanks

APPENDIX B 4 DATA INPUT FILE (REDDAT FT15)

Refer to Table 3 for a record-by-record explanation of variables

5177 0 2 0 STANDARD SAVANNA												
DIGF	CPF	DMF	CFWF	CFDWF	DMLIM	LEFF	COF	FMCF				
SUPDMF	SUPDIG	HSF	SUPCPF	SEASON								
2	2	2	2	2	2	2	2	2	2	2	2	2
1	1	1	1	1	1	1	1	1	1	1	1	1
5 0	0094	1 4	100	15	1	0	1040000	0				
3600	5	5	1	1	0	30	400	0	1	5	0	
0 0	0 0	0 0	0 0	0 0	0 0	0000	0	0 0	0 0	000 0	000 0	000 0
11 2	12 7	0 0	0 0	6 0	6 0	0 0	0 0					
109 2	109 2	109 2	132 1	109 2	132 1							
270	210	330	12 0	6 000	000 0	000 0	00 0	00 0	0 0	000	00 0	
14	14	12	5	5	6	3	6	5	2B			
0	43	30	45	60	46	90	48	120	44	150	44	
180	45	210	46	240	45	270	46	300	43	330	40	
360	43	390	45									
0	9 6	30	10 4	60	9 1	90	9 6	120	9 8	150	9 4	
180	8 4	210	8 7	240	8 2	270	9 1	300	10 1	330	10 0	
360	9 6	390	10 4									
0	0	30	0	60	20	90	50	120	50	150	70	
180	50	210	50	240	30	270	70	700	20	360	0	
0	0 0	50	0 0	65	05	0 80	1 0	1 0	1 0			
-3	001	-1 50	001	-1	100	0 0	1 0	3	1			
0	1 0	60	1 14	90	1 2	150	1 24	240	1 14	300	1 00	
0	0 0	240	1 0	360	1 0							
10	15	70	15	75	15	80	8	90	3	1	1	
0	58	30	58	90	56	180	52	360	46			
0	29	30	59	60	74	75	89	90	209	210	239	
240	269	270	299	300	329	330	359	360	380	390	400	
410	424	425	440									
0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00
0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00
0 00	0 00	0 00	0 00									

[data input file REDDAT FT15 -continued-]

0	29	30	59	60	74	75	89	90	209	210	239
240	269	270	299	300	329	330	359	360	380	390	400
410	424	425	440								
000	000	000	000	000	000	000	000	000	000	000	000
000	000	000	000	000	000	000	000	000	000	000	000
000	000	000	000								
0	29	30	59	60	74	75	89	90	209	210	239
240	269	270	299	300	329	330	359	360	380	390	400
410	424	425	440								
000	000	000	000	000	000	000	000	000	000	000	000
000	000	000	000	000	000	000	000	000	000	000	000
000	000	000	000								
0	29	30	59	60	74	75	89	90	209	210	239
240	269	270	299	300	329	330	359	360	380	390	400
410	424	425	440								
000	000	000	000	000	000	000	000	000	000	000	000
000	000	000	000	000	000	000	000	000	000	000	000
000	000	000	000								
1	1	0	75	129	450	0	0	0	0	0	0
2	1	1	0	160	448	0	0	0	0	0	0
3	1	1	0	150	447	0	0	0	0	0	0
4	1	1	0	155	448	0	0	0	0	0	0
5	1	2	0	200	450	0	0	0	0	0	0
6	1	2	0	215	449	0	0	0	0	0	0
7	1	2	0	195	448	0	0	0	0	0	0
8	1	2	0	210	449	0	0	0	0	0	0
9	1	2	0	205	448	0	0	0	0	0	0
10	1	2	0	185	449	0	0	0	0	0	0
11	1	3	0	270	450	0	0	0	0	0	0
12	1	3	0	250	445	0	0	0	0	0	0
13	1	3	0	260	443	0	0	0	0	0	0
14	1	3	0	280	442	180	0	0	0	0	-90
15	1	3	0	290	452	210	0	0	0	0	-60
16	1	3	0	285	441	210	0	0	0	0	-60
17	1	4	0	300	440	0	0	0	0	0	0

[data input file REDDAT FT15 -continued-]

18	1	4	0	310	449	0	0	0	0	0	0	0
19	1	4	0	300	446	150	0	0	0	0	0	-120
20	1	4	0	305	447	180	0	0	0	0	0	-90
21	1	4	0	310	458	0	0	0	0	0	0	0
22	1	5	0	340	447	180	0	0	0	0	1	-90
23	1	5	0	290	446	210	0	0	0	0	1	-60
24	1	5	0	335	442	0	0	0	0	0	1	0
25	1	5	0	340	442	0	0	0	0	0	1	0
26	1	6	0	285	445	120	0	0	0	0	1	-150
27	1	6	0	350	447	150	0	0	0	0	1	-120
28	1	6	0	345	449	0	0	0	0	0	1	0
29	1	6	0	320	446	0	0	0	0	0	1	0
30	1	7	0	305	449	120	0	0	0	0	1	-150
31	1	7	0	310	458	0	0	0	0	0	1	0
32	1	7	0	340	447	0	0	0	0	0	1	0
33	1	8	0	320	446	0	0	0	0	0	1	0
34	1	9	0	335	442	0	0	0	0	0	1	0
35	1	6	0	340	442	0	0	0	0	0	0	0
36	1	6	0	285	445	0	0	0	0	0	0	0
37	1	6	0	350	447	0	0	0	0	0	0	0
38	1	6	0	345	449	0	0	0	0	0	0	0
39	1	6	0	360	446	0	0	0	0	0	0	0
40	1	6	0	295	449	0	0	0	0	0	0	0
41	1	7	0	310	458	0	0	0	0	0	0	0
42	1	7	0	340	447	0	0	0	0	0	0	0
43	1	7	0	290	446	0	0	0	0	0	0	0
44	1	7	0	335	442	0	0	0	0	0	0	0
45	1	7	0	340	442	0	0	0	0	0	0	0
46	1	8	0	265	445	0	0	0	0	0	0	0
47	1	8	0	350	447	0	0	0	0	0	0	0
48	1	9	0	345	449	0	0	0	0	0	0	0
49	1	9	0	330	446	0	0	0	0	0	0	0
50	1	10	0	360	446	0	0	0	0	0	0	0

APPENDIX B 5 SAMPLE EDITED DATA OUTPUT FILES - UNITS 6, 7, 8, 9, 10, 11 & 13

Log call Unit 6

RUSMCB V4 2 IP ALL 10 YRS

 * LU6 MAIN HERD OUTPUT *

RUN PARAMETER TABLE

```

-----
NSEED = 6421      IRUM = 1      MODE = 0      NIND = 0      FINTIM = 3600
PMA = 5 00      DELT = 5      CDELT = 5      PDELT = 5      BIOL = 40000
AREA = 400 0      JEV = 1      JHEPD = 1      DATE = 0      NA = 30
IPRDEL = 0      JA = 1
AREAS =      0 00      0 00      0 00      60 00      60 00
BIOMAS =      0 00      0 00      0 00      1000 00      1000 00
-----
  
```

```

VIP      WMAX      MINWT      PP      WHP      EXTRA APDELT SUPROP ICCO
0 0094   1 40   100 00   15 00   1 00   0 00 10 0   0 0   0
  
```

```

NWEAN MANDAT(1) MANDAT(2) CCUL MCUL KCUL SWTF SWTH SAGEF SAGEM IDEFLA
270   210   330      12 0 6      0 0 0   0 0 0 0 0 0 0
  
```

```

OFRAT PREIS
0 000 32 0
NDIS NCF NDH NCFh NLf NDHLIM NLP NCF NFMG NSUF NDICS
14 14 12 5 5 6 3 6 5 2E 0
  
```

```

ACF
2 00 2 00 2 00 2 00 2 00 2 00 2 00 2 00 2 00 2 00 2 00
SEASON
1 00 1 00 1 00 1 00 1 00 1 00 1 00 1 00 1 00 1 00 1 00
DIGF
0 00 43 00 30 00 45 00 60 00 46 00 90 00 48 00 120 00 44 00
150 00 44 00 180 00 45 00 210 00 46 00 240 00 45 00 270 00 46 00
300 00 43 00 330 00 40 00 360 00 43 00 390 00 45 00
CPF
0 00 9 60 30 00 10 40 60 00 9 10 90 00 9 60 120 00 9 80
150 00 9 40 180 00 8 40 210 00 8 70 240 00 8 20 270 00 9 10
300 00 10 10 330 00 10 00 360 00 9 60 390 00 10 40
DMF
0 00 0 00 30 00 0 00 60 00 20 00 90 00 50 00 120 00 50 00
150 00 70 00 180 00 50 00 210 00 50 00 240 00 30 00 270 00 30 00
300 00 20 00 360 00 0 00
  
```

[Unit 6 -continued-]

CFWF	0 00	0 00	0 50	0 00	0 65	0 05	0 80	1 00	1 00	1 00
CFDWF	-3 00	0 00	-1 50	0 00	1 00	0 10	0 00	1 00	3 00	1 00
DMLIM	0 00	1 00	60 00	1 14	90 00	1 20	150 00	1 24	240 00	1 14
	300 00	1 00								
LEFF	0 00	0 00	240 00	1 00	360 00	1 00				
CDF	0 10	15 00	0 70	15 00	0 75	15 00	0 83	8 00	0 90	3 00
	1 00	1 00								
F4CF	0 00	0 58	30 00	0 58	90 00	0 56	180 00	0 52	360 00	0 46

YEARLY HERD COMPOSITION TABLE FOR YEAR 0

NO	ID	SEX	AGE	WEIGHT	PTIME	CTIME	LTIME	CALF WT	CALF SEX
1	1	FEM	0 75	129 00					
2	2	FEM	1 00	160 00	0 00	0 00	0 00	0 00	
3	3	FEM	1 00	150 00	0 00	0 00	0 00	0 00	
4	4	FEM	1 00	155 00	0 00	0 00	0 00	0 00	
5	5	FEM	2 00	200 00	0 00	0 00	0 00	0 00	
6	6	FEM	2 00	215 00	0 00	0 00	0 00	0 00	
7	7	FEM	2 00	195 00	0 00	0 00	0 00	0 00	
8	8	FEM	2 00	210 00	0 00	0 00	0 00	0 00	
9	9	FEM	2 00	205 00	0 00	0 00	0 00	0 00	
10	10	FEM	2 00	185 00	0 00	0 00	0 00	0 00	
11	11	FEM	3 00	270 00	0 00	0 00	0 00	0 00	
12	12	FEM	3 00	250 00	0 00	0 00	0 00	0 00	
13	13	FEM	3 00	260 00	0 00	0 00	0 00	0 00	
14	14	FEM	3 00	280 00	180 00	0 00	0 00	0 00	
15	15	FEM	3 00	290 00	210 00	0 00	0 00	0 00	
16	16	FEM	3 00	285 00	210 00	0 00	0 00	0 00	
17	17	FEM	4 00	300 00	0 00	0 00	0 00	0 00	
18	18	FEM	4 00	310 00	0 00	0 00	0 00	0 00	
19	19	FEM	4 00	300 00	150 00	0 00	0 00	0 00	
20	20	FEM	4 00	305 00	180 00	0 00	0 00	0 00	
21	21	FEM	4 00	310 00	0 00	0 00	0 00	0 00	
22	22	FEM	5 00	340 00	180 00	0 00	0 00	0 00	
23	23	FEM	5 00	290 00	210 00	0 00	0 00	0 00	
24	24	FEM	5 00	335 00	0 00	0 00	0 00	0 00	
25	25	FEM	5 00	340 00	0 00	0 00	0 00	0 00	
26	26	FEM	6 00	285 00	120 00	0 00	0 00	0 00	
27	27	FEM	6 00	350 00	150 00	0 00	0 00	0 00	
28	28	FEM	6 00	345 00	0 00	0 00	0 00	0 00	
29	29	FEM	6 00	320 00	0 00	0 00	0 00	0 00	
30	30	FEM	7 00	305 00	120 00	0 00	0 00	0 00	

[Unit 6 -continued-]

FORAG MOB CODES TIME- 0 0
 10001 '0000' 10000' 10001 10001 '0001 10001 10001 1000 10001
 10001 '0001 10001 10001 10001

YEARLY HERD COMPOSITION TABLE FOR YEAR 10

NO	ID	SEX	AGE	WEIGHT	PTIME	CTIME	LTIME	CALF WT	CALF SEX
1	34	FEM	8 92	348 69	205 00	260 00	260 00	126 68	FEM
2	35	FEM	8 92	346 43	220 00	0 00	0 00	0 00	
3	36	FEM	8 33	303 79	180 00	200 00	200 00	108 09	FEM
4	38	FEM	7 62	335 18	0 00	75 00	75 00	68 07	FEM
5	39	FEM	7 29	312 16	0 00	5 00	5 00	28 36	FEM
6	40	FEM	6 92	321 78	0 00	20 00	20 00	39 34	MALE
7	41	FEM	6 89	340 43	205 00	0 00	0 00	0 00	
8	43	FEM	6 50	356 86	0 00	0 00	0 00	0 00	
9	44	FEM	6 07	320 87	245 00	0 00	0 00	0 00	
10	45	FEM	5 92	305 72	5 00	100 00	100 00	80 96	MALE
11	46	FEM	5 90	320 73	230 00	240 00	240 00	122 56	MALE
12	47	FEM	5 87	328 12	220 00	0 00	0 00	0 00	
13	48	FEM	5 86	328 00	215 00	0 00	0 00	0 00	
14	49	FEM	5 61	331 67	220 00	0 00	0 00	0 00	
15	50	FEM	5 25	333 49	165 00	0 00	0 00	0 00	
16	51	FEM	5 12	337 40	225 00	0 00	0 00	0 00	
17	52	FEM	5 11	293 06	0 00	20 00	20 00	33 17	MALE
18	53	FEM	4 89	326 39	75 00	0 00	0 00	0 00	
19	54	FEM	4 92	321 84	170 00	0 00	0 00	0 00	
20	55	FEM	4 79	350 40	235 00	0 00	0 00	0 00	
21	56	FEM	3 82	319 83	195 00	0 00	0 00	0 00	
22	57	FEM	3 78	297 90	165 00	0 00	0 00	0 00	
23	58	FEM	3 75	301 02	170 00	0 00	0 00	0 00	
24	59	FEM	3 14	238 29	0 00	105 00	105 00	68 89	MALE
25	60	FEM	3 03	295 43	195 00	0 00	0 00	0 00	
26	61	FEM	2 92	284 55	215 00	0 00	0 00	0 00	
27	62	FEM	2 64	263 09	205 00	0 00	0 00	0 00	
28	63	FEM	2 58	273 78	105 00	0 00	0 00	0 00	
29	64	FEM	2 06	230 70	10 00	0 00	0 00	0 00	
30	65	FEM	1 00	154 61					
31	73	MALE	0 81	138 72					
32	74	MALE	0 78	137 16					
33	75	FEM	0 78	131 48					
34	76	FEM	0 78	133 74					

[Unit 6 -continued-]

MONTHLY CONCEPTION EVENT TABLE

YR	1	2	3	4	5	6	7	8	9	10	11	12	TOT
1 1	5	1	2	3	8	3	2	2	0	1	2	5	34
1 2	2	0	1	6	5	1	4	1	1	2	1	1	25
1 3	0	1	1	4	4	5	2	2	1	2	1	0	23
1 4	0	2	4	0	7	4	3	2	1	1	0	0	24
1 5	1	2	1	2	4	7	2	2	2	3	0	0	26
1 6	0	4	1	0	3	5	3	4	1	0	2	0	23
1 7	0	3	2	2	3	3	4	2	3	0	1	0	23
1 8	0	1	2	2	8	4	2	1	0	1	1	1	23
1 9	0	2	1	7	5	4	1	1	1	1	0	2	25
1 10	1	0	3	1	8	5	5	0	1	1	0	2	27

MONTHLY CONSUMPTION TABLE (here months 1 to 10 only)

YR	1	2	3	4	5	6	7	8	9	10
1 PAS	6064	6360	6740	6934	6998	7107	7095	6951	6786	6416
CPS	0	0	0	758	587	1170	1616	1911	2188	1245
YR	91662 2	AV	113719 2							
2 PAS	7089	7746	8447	8738	8794	8851	8954	7791	7654	7375
CPS	1674	1633	1954	2262	2530	2995	2721	2143	1956	2118
YR	121392 3	AV	113719 2							
3 PAS	6947	7528	8079	8348	8580	8974	9363	7657	7524	7406
CPS	1997	1722	2286	2650	2809	1925	2207	1920	2275	2545
YR	122326 4	AV	113719 2							
4 PAS	7214	7741	8370	8505	8722	8540	8544	7466	7020	6979
CPS	1485	1547	1992	2011	2253	2562	3002	2434	2565	2801
YR	119362 7	AV	113719 2							
5 PAS	7105	7558	8196	8472	8312	8407	855	7673	7472	6646
CPS	1731	1233	1539	1842	1810	1452	2023	2090	2364	2321
YR	113939 9	AV	117719 2							
6 PAS	6813	7394	8039	7902	8003	7856	7880	6652	6585	6210
CPS	2748	1954	885	1048	1788	2026	1464	1451	1868	2097
YR	105790 8	AV	113719 2							

[Unit 6 -continued-]

12 MO W ^R										161 41	260713 0c
154 92 157 95 161 03 171 97 161 82 162 23 162 28 159 49 164 30 157 47											
SURV 12										8 60	860 00
4 00 9 00 7 00 7 00 11 00 14 00 12 00 10 00 10 00 2 00											
SURV 24										4 40	218 00
6 00 4 00 3 00 3 00 3 00 5 00 8 00 3 00 5 00 4 00											
24 MO WT										236 02	530131 12
201 67 236 97 226 66 233 65 241 13 233 83 235 30 228 82 233 34 234 85											
ND ABS										1 50	39 00
3 00 0 00 0 00 2 00 0 00 1 00 2 00 2 00 4 00 1 00											
ND BTHS										20 40	4278 00
17 00 24 00 21 00 24 00 20 00 26 00 20 00 18 00 16 00 24 00											
AGE PART										3 03	93 18
3 97 3 42 2 91 2 90 2 72 2 84 2 76 3 02 2 92 2 86											
CON INT										379 89	1448629 00
331 67 402 05 395 25 382 37 379 13 347 94 368 57 392 63 410 26 389 05											
WT /100										96 32	92952 19
96 86 95 01 99 90 100 31 90 80 90 44 98 06 95 16 92 23 104 39											
ND DRFS										2 60	133 00
1 00 3 00 0 00 5 00 4 00 6 00 2 00 3 00 2 00 0 00											
AN UNITS										35 42	12604 98
36 20 36 40 35 40 36 40 33 40 34 20 38 00 35 20 31 60 37 40											
FEC FEMS										24 70	6165 00
24 00 25 00 27 00 25 00 21 00 26 00 26 00 24 00 26 00 29 00											
WT EODS										239 19	585848 69
226 50 198 36 199 46 295 82 257 75 188 97 217 48 295 73 259 99 251 82											
WT EOWS										227 04	524956 69
227 99 183 87 265 79 241 26 175 24 203 20 266 66 211 19 247 14 248 05											
NUM BUY										0 00	0 00
0 00 0 00 0 00 0 00 0 00 0 00 0 00 0 00 0 00 0 00											
MILK OFF										0 00	0 00
0 00 0 00 0 00 0 00 0 00 0 00 0 00 0 00 0 00											
TRUE AVERAGES	BH FEMS	>=2	FOL <1,>=2	CALVES	FOLS>2	AU 5					
	29 07	25 75	4 64	1 64	13 59	0 00				39 62	

PRODUCTION SUMMARY

CONCEP %	84 62	WEAN %	58 82	CONMORT%	11 04
AGEICALF	3 03	WEAN WT	147 64	CON INT	379 89
12 MO WT	161 41	24 MO WT	236 02	1YR SUR%	96 57
KG/AN/YR	81 00	KG/AU/YR	68 37	ETESPROD	76 33
CALFMORT	3 43	ETES 2	70 7		

[Unit 6 -continued-]

WEIGHT AGAINST CONCEPTION

WT *	ALL NO	CP	* HLF NO	CP	* SEC NO	CP	* LAC NO	CP
220 0	0	0 00	0	0 00	0	0 00	0	0 00
240 0	13	0 05	12	0 23	0	0 00	1	0 01
260 0	18	0 12	16	0 54	0	0 00	2	0 02
280 0	31	0 24	15	0 83	1	0 04	15	0 10
300 0	34	0 38	5	0 92	3	0 17	26	0 25
320 0	75	0 67	3	0 98	4	0 33	68	0 63
340 0	57	0 90	0	0 98	11	0 79	46	0 89
360 0	23	0 99	1	1 00	3	0 92	19	0 99
380 0	3	1 00	0	1 00	2	1 00	1	1 00
400 0	0	1 00	0	1 00	0	1 00	0	1 00
	B 739		6 187		3 330		13 230	
	254		52		24		178	
	3517		1017		872		1628	

CALENDAR OF EVENTS (CHRONOLOGICAL)

TIM	Y	MO	EVENT	*	NO	SEX	AGE	WT	N WT	NO	AGE	WT	N WT
5	1	1	CON	*	18	FEM	4 01	311	418				
5	1	1	CON	*	24	FEM	5 01	336	426				
5	1	1	CON	*	28	FEM	6 01	346	441				
10	1	1	CON	*	25	FEM	5 03	341	426				
15	1	1	CON	*	29	FEM	6 04	323	438				
35	1	2	CON	*	11	FEM	3 10	278	394				
60	1	3	BTH	*	15	MALE	0 00	28	35	15	3 17	276	398
60	1	3	BTH	*	16	FEM	0 00	25	29	16	3 17	270	39
60	1	3	BTH	*	23	FEM	0 00	24	30	23	5 17	285	431
70	1	3	CON	*	17	FEM	4 19	318	413				
80	1	3	CON	*	13	FEM	3 22	285	392				
90	1	4	BTH	*	14	FEM	0 00	25	29	14	3 25	277	397
90	1	4	BTH	*	20	FEM	0 00	25	30	20	4 25	306	421
90	1	4	BTH	*	22	MALE	0 00	29	33	22	5 25	338	433
110	1	4	CON	*	16	FEM	3 31	270	393				
110	1	4	CON	*	21	FEM	4 31	346	432				
115	1	4	CON	*	27	FEM	5 22	335	434				
120	1	5	CON	*	6	FEM	2 33	258	357				
120	1	5	CON	*	8	FEM	2 33	254	357				
120	1	5	CON	*	12	FEM	3 33	295	397				
120	1	5	BTH	*	19	FEM	0 00	26	30	19	4 33	312	421
120	1	5	CON	*	23	FEM	5 33	290	433				
120	1	5	BTH	*	27	MALE	0 00	29	33	27	6 33	356	440

Logical Unit 7

1	0	1	1	126	00	193	59	-0	177	20	846	20	901	-3	151
1	30	1	2	126	45	207	07	0	027	24	165	20	432	0	711
1	60	1	3	128	38	219	84	0	114	26	731	20	554	3	096
1	90	1	4	133	26	231	94	0	228	30	560	20	886	6	476
1	120	1	5	138	13	243	40	0	076	27	298	21	782	2	201
1	150	1	6	140	79	254	26	0	104	28	516	22	062	3	075
1	180	1	7	144	72	264	55	0	167	30	896	22	372	5	051
1	210	1	8	150	42	274	30	0	221	33	353	22	855	6	888
1	240	1	9	156	53	283	54	0	181	33	113	23	579	5	777
1	270	1	10	162	60	292	29	0	230	35	540	24	079	7	558
1	300	1	11	167	86	300	58	0	103	32	366	24	933	3	404
1	330	1	12	169	55	308	43	-0	008	29	350	25	448	-0	167
1	360	2	1	171	17	315	87	0	136	34	013	25	262	4	643
1	390	2	2	176	41	322	92	0	227	37	713	25	546	7	934
1	420	2	3	183	71	329	60	0	266	40	077	26	132	9	536
1	450	2	4	192	73	335	93	0	348	44	262	26	745	12	892
1	480	2	5	200	59	341	93	0	150	38	348	27	968	5	566
1	510	2	6	205	10	347	61	0	150	38	985	28	387	5	676
1	540	2	7	210	17	352	99	0	194	41	225	28	725	7	456
1	570	2	8	216	49	358	09	0	234	43	541	29	170	9	175
1	600	2	9	222	82	362	92	0	180	42	385	29	873	7	164
1	630	2	10	228	75	367	50	0	221	44	685	30	267	8	928
1	660	2	11	233	58	371	84	0	082	40	040	31	112	3	322
1	690	2	12	234	47	375	94	-0	057	35	775	31	621	-1	473
1	720	3	1	234	93	379	84	0	098	40	901	31	231	4	032
1	750	3	2	238	98	383	53	0	186	44	791	31	307	7	748
1	780	3	3	245	03	387	02	0	224	47	059	31	694	9	484
1	810	3	4	252	77	390	33	0	306	51	430	32	074	13	289
1	840	3	5	259	39	393	47	0	108	44	128	33	224	4	680
1	870	3	6	262	61	396	44	0	103	44	462	33	500	4	510
1	900	3	7	266	21	399	25	0	143	46	628	33	655	6	322
1	930	3	8	270	95	401	92	0	178	48	871	33	903	7	978
1	960	3	9	275	53	404	45	0	117	47	234	34	439	5	276
1	990	3	10	279	38	406	84	0	142	49	469	34	605	6	474
1	1020	3	11	281	55	409	11	-0	038	44	054	35	259	-1	091
1	1050	3	12	277	20	411	26	-0	298	39	136	35	375	-8	692
1	1080	4	1	269	14	413	30	-0	245	44	504	34	210	-6	908
1	1110	4	2	260	36	415	23	-0	395	48	493	33	157	-10	788
1	1140	4	3	245	63	417	05	-0	271	51	303	31	745	-7	057
1	1170	4	4	238	75	418	79	-0	107	59	686	30	871	-2	701
1	1200	4	5	234	32	420	43	-0	136	54	225	31	037	-3	464
1	1230	4	6	230	81	421	98	-0	095	56	949	30	724	-2	397
1	1260	4	7	230	62	423	45	0	105	60	499	30	569	3	190
1	1290	4	8	235	87	424	85	0	254	63	770	30	895	7	802
1	1320	4	9	242	03	426	17	0	142	59	781	31	575	4	453
1	1350	4	10	247	10	427	42	0	204	60	692	31	873	6	480
1	1380	4	11	249	92	428	61	-0	024	52	076	32	553	-0	654
1	1410	4	12	249	88	429	74	0	043	40	894	32	999	1	898
1	2790	8	10	326	40	448	31	-0	363	54	511	38	407	-11	604
1	2820	8	11	308	83	448	40	-0	612	48	847	37	513	-19	048

EOD

Logical Unit 8

=	0	1	0	0	0	0	0
-	1 000	0 000	0 000	0 000	0 00	160 000	0 000
=	0 000	0 000	0 000	0 000	0 000	0 000	0 000
=	0 000	3 193	0 000	0 000	0 000	0 000	0 000
=	0 000	0 000	0 000	0 000	0 000	29 000	0 000
=	0 000	0 000	0 000	15 963	0 000	0 000	0 000
=	0 000	0 430	0 096	3 193	3 193	0 000	0 000
=	0 000	0 000	193 592	0 009	0 000	0 000	0 000
=	0 000	0 000	0 000	0 000			
=	0	2	0	0	0	0	0
=	1 000	0 000	0 000	0 000	0 000	160 000	0 000
=	0 000	0 000	0 000	0 000	0 000	0 000	0 000
=	0 000	3 808	0 000	0 000	0 000	0 000	0 000
=	0 000	0 000	0 000	0 000	0 000	29 000	0 000
=	0 000	0 000	0 000	35 003	0 000	0 000	0 000
=	0 000	0 430	0 096	3 808	3 808	0 000	0 000
=	0 000	0 000	270 909	0 009	0 000	0 800	0 000
=	0 000	0 000	0 000	0 000			

Variables Printed Here

ITIME	IA	NRES(1)	NRES(2)	NRES(3)	NRES(4)	NRES(5)
P(1)	P(2)	P(3)	P(4)	P(5)	QB(1)	QB(2)
QB(3)	QB(4)	QB(5)	D(1)	D(2)	D(3)	D(4)
D(5)	E(1)	E(2)	E(3)	E(4)	E(5)	BID(1)
BID(2)	BID(3)	BID(4)	BID(5)	***	FORND(1)	FORND(2)
FORND(3)	FORND(4)	FORND(5)	ESUM(1)	ESUM(2)	ESUM(3)	ESUM(4)
ESUM(5)	D16X	CPA	LDM	ALDM	HERBDM	CPLC
LDM1	WMC	WMX	VICDEF	VV(IA,23)	VV(IA,24)	QA(1)
QA(2)	QA(3)	QA(4)	QA(5)			

Logical Unit 9

RUMDP V4 2 IP ALL 10 YRS

* LU9 PASTURE OUTPUT *

APENS 0 00 0 00 0 00 60 00 60 00

DAY NO	BID	FORNO	P	D	ESUM	BB	BC	ECDW	ECAR	BA
0 4	992 21	29 00	0 468	0 500	467 36	468 11	1131 27	467 36	0 00	468 11
0 5	991 15	29 00	0 532	0 440	530 95	531 80	1285 20	530 95	0 00	531 80
5 4	1115 69	29 00	0 468	0 504	468 29	464 90	1123 50	468 29	0 00	464 90
5 5	1267 14	29 00	0 532	0 443	531 86	528 00	1276 00	531 86	0 00	528 00
10 4	1218 61	29 00	0 440	0 509	442 46	507 30	1225 99	442 46	0 00	507 30
10 5	1552 95	29 00	0 560	0 446	563 86	646 49	1562 35	563 86	0 00	646 49
15 4	1302 03	29 00	0 414	0 515	419 83	541 67	1309 03	419 83	0 00	541 67
15 5	1843 48	29 00	0 586	0 450	594 42	766 92	1853 39	594 42	0 00	766 92
20 4	1355 31	29 00	0 390	0 519	397 25	563 56	1361 93	397 25	0 00	563 56
20 5	2121 76	29 00	0 610	0 453	621 90	882 26	2 32 13	621 90	0 00	882 26
25 4	1379 92	29 00	0 367	0 524	376 04	573 59	1386 18	376 04	0 00	573 59
25 5	2387 71	29 00	0 633	0 456	649 58	990 84	2394 54	649 58	0 00	990 84
30 4	1381 62	29 00	0 344	0 530	355 93	574 16	1387 55	355 93	0 00	574 16
30 5	2630 78	29 00	0 656	0 460	677 73	1093 27	2642 07	677 73	0 00	1093 27
35 4	1368 84	29 00	0 323	0 537	337 04	568 74	1374 45	337 04	0 00	568 74
35 5	2864 11	29 00	0 677	0 464	705 21	1190 01	2875 86	705 21	0 00	1190 01
40 4	1345 76	29 00	0 304	0 545	320 00	559 07	1351 09	320 00	0 00	559 07
40 5	3084 22	29 00	0 696	0 469	733 39	1281 29	3096 44	733 39	0 00	1281 29
45 4	1314 76	29 00	0 285	0 555	304 60	546 14	1319 83	304 60	0 00	546 14
45 5	3291 64	29 00	0 715	0 475	762 59	1367 32	3304 35	762 59	0 00	1367 32
50 4	1277 80	29 00	0 268	0 562	288 57	530 73	1282 60	288 57	0 00	530 73
50 5	3487 06	29 00	0 732	0 479	757 45	1449 35	3501 18	757 49	0 00	1448 35
55 4	1236 44	29 00	0 252	0 570	274 11	517 52	1241 01	274 11	0 00	513 52
55 5	3669 49	29 00	0 748	0 484	813 49	1524 02	3683 05	813 49	0 00	1524 02
60 4	1192 23	29 00	0 237	0 580	261 33	495 14	1196 58	261 33	0 00	495 14
60 5	3834 98	29 00	0 763	0 490	840 62	1592 69	3848 99	840 62	0 00	1592 69
65 4	1148 84	35 60	0 224	0 589	248 26	388 64	1152 98	248 26	0 00	388 64
65 5	3984 96	35 60	0 776	0 491	861 14	1348 08	3999 31	861 14	0 00	1348 08
70 4	1107 63	35 60	0 212	0 601	236 95	374 69	1111 58	236 95	0 00	374 69
70 5	4120 77	35 60	0 788	0 493	881 55	1 93 98	4135 46	881 55	0 00	1 93 98
75 4	1068 38	35 60	0 201	0 615	217 11	361 40	1072 16	217 11	0 00	361 40
75 5	4243 64	35 60	0 799	0 495	902 09	1435 51	4258 68	902 09	0 00	1435 51
80 4	1030 92	35 60	0 191	0 624	217 51	348 72	1034 55	217 51	0 00	348 72
80 5	4354 83	35 60	0 809	0 496	918 80	1473 08	4370 14	918 80	0 00	1473 08
85 4	995 11	35 60	0 183	0 636	209 05	336 61	998 60	209 05	0 00	336 61
85 5	4455 43	35 60	0 817	0 498	936 00	1507 09	4471 03	936 00	0 00	1507 09
90 4	960 77	35 60	0 174	0 650	203 84	325 00	964 17	201 57	2 27	325 00

Logical Unit 10

RUSM74 V4 2 IF ALL 10 YRS

* LU10 PASMDD DUMP *

V=1000 001000 00 VR= 0 00 0 00 IOP= 1 SELEC=5 COMP=0

0 00	2 00	7 00	7 00	0 00	4 50	3 80	3 80
0 00	2 00	7 00	7 00	0 00	6 00	5 00	5 00
0 00	3 00	5 00	5 00	0 00	17 00	80 00	80 00
0 00	3 00	6 00	6 00	0 00	20 00	100 00	100 00
0 00	1 50	4 00	6 50	0 00	17 00	73 00	80 00
0 00	1 50	4 00	6 50	0 00	22 00	90 00	105 00
0 00	0 40	1 00	1 00	1 00	0 40	0 00	0 00
0 00	0 40	1 00	1 00	0 00	0 60	1 00	1 00
0 00	1 00	1 00	1 00	1 00	0 00	0 00	0 00
0 00	1 00	1 00	1 00	0 60	1 00	1 00	1 00
0 00	0 55	1 00	1 00	0 00	0 45	1 00	1 00
0 00	0 40	0 70	1 00	0 00	0 25	0 82	1 00
0 00	0 50	0 75	1 00	0 00	0 45	0 65	1 00
0 00	0 50	1 00	1 00	0 00	0 35	1 00	1 00
0 00	1 00	1 00	1 00	0 00	1 00	1 00	1 00
0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00
60 00	90 00	300 00	330 00	1 00	1 00	1 00	1 00
60 00	90 00	300 00	330 00	1 00	1 00	1 00	1 00

DAY	B104	B105	BTOT	---AGR---	---PGR---	---PD---	---RLAI---	---COMP---	---PSH---	---GRMOD---
0	992 2	991 2	1983 4	30 70 66 06 30 70 66 06	0 47 0 53	2 11 3 12	0 32 0 68	6 27 8 18	1 00 1 00	
5	1115 7	12 7 1	2782 8	30 74 66 09 30 74 66 09	0 47 0 53	2 11 3 12	0 32 0 68	6 23 8 12	1 00 1 00	
10	1218 6	1553 0	2771 6	26 65 62 27 28 69 62	0 44 0 56	1 92 3 25	0 28 0 72	6 83 10 02	1 00 1 00	
15	1302 0	1843 5	3145 5	24 72 60 24 20 72 60	0 41 0 59	1 82 3 36	0 25 0 75	8 27 12 97	1 00 1 00	
20	1355 3	2121 8	3477 1	21 40 75 31 21 40 75 31	0 39 0 61	1 70 3 46	0 22 0 78	12 03 19 03	1 00 1 00	
25	1379 9	2383 7	3763 6	18 81 77 92 18 81 77 93	0 37 0 63	1 58 3 56	0 19 0 81	14 77 24 71	1 00 1 00	
30	1381 6	2630 8	4012 4	16 69 80 48 16 69 80 48	0 34 0 66	1 47 3 65	0 17 0 83	16 68 30 03	1 00 1 00	
35	1368 8	2864 1	4232 9	15 55 82 89 15 55 82 89	0 32 0 68	1 37 3 74	0 16 0 84	17 99 35 06	1 00 1 00	
40	1345 8	3084 2	4430 0	14 51 85 14 14 51 85 14	0 30 0 70	1 28 3 82	0 15 0 85	18 86 39 82	1 00 1 00	
45	1714 8	3291 6	4606 4	13 55 87 27 13 55 87 27	0 27 0 71	1 20 3 91	0 1 0 87	19 36 44 31	1 00 1 00	
50	1277 8	3487 1	4764 8	12 66 89 19 12 66 89 19	0 27 0 73	1 12 3 97	0 12 0 88	19 58 46 55	1 00 1 00	
55	1236 4	3669 5	4905 9	11 84 90 23 11 84 90 23	0 25 0 75	1 04 4 04	0 12 0 88	19 56 52 52	1 00 1 00	
60	1192 2	3835 0	5027 2	11 09 90 61 11 09 90 61	0 24 0 76	0 98 4 10	0 11 0 89	19 20 56 12	1 00 1 00	
65	1148 8	3985 0	5133 8	10 42 90 95 10 42 90 95	0 22 0 78	0 92 4 16	0 10 0 90	18 11 59 39	1 00 1 00	
70	1107 6	4120 8	5228 4	9 82 91 25 9 82 91 25	0 21 0 79	0 87 4 21	0 10 0 90	17 13 62 36	1 00 1 00	
75	1068 4	4243 6	5312 0	9 29 91 52 9 29 91 52	0 20 0 80	0 82 4 25	0 09 0 91	16 25 65 05	1 00 1 00	
80	1030 9	4354 8	5385 7	8 82 91 76 8 82 91 76	0 19 0 81	0 78 4 29	0 09 0 91	15 46 67 49	1 00 1 00	

Logical Unit 11

RUSKOB '74 2 IF ALL 10 YRS

 * LU11 ECONOMIC SUMMARY *

ANALYSIS PARAMETERS (AMP TRE CYC START PRINTS*6 OFRAT PREIS)

11 2 12 7 0 0 0 0 6 0 6 0 0 0 0 0 109 2 109 2 109 2 132 1 109 2 132 1 0 000 32 0

CASH FLOW DETAILS

MO	TOT +	TOT -	BAL	CULSLS	CRFSL	FOLSLS	HERDCAP	CAPCOST	CONBUY	VARCOS	MILK
1	0	7488	-7488	0	0	0	0	0	0	7488	0
2	0	7488	-7488	0	0	0	0	0	0	7488	0
3	0	7649	-7649	0	0	0	0	0	0	7649	0
4	0	7810	-7810	0	0	0	0	0	0	7810	0
5	0	7917	-7917	0	0	0	0	0	0	7917	0
6	0	7970	-7970	0	0	0	0	0	0	7970	0
7	0	7899	-7899	0	0	0	0	0	0	7899	0
8	14845	7827	7017	0	0	14845	0	0	0	7827	0
9	0	7827	-7827	0	0	0	0	0	0	7827	0
10	0	7952	-7952	0	0	0	0	0	0	7952	0
11	0	7952	-7952	0	0	0	0	0	0	7952	0
12	0	8024	-8024	0	0	0	0	0	0	8024	0
13	0	8291	-8291	0	0	0	0	0	0	8291	0
14	0	8648	-8648	0	0	0	0	0	0	8648	0
15	0	8826	-8826	0	0	0	0	0	0	8826	0
16	0	8934	-8934	0	0	0	0	0	0	8934	0
17	0	9041	-9041	0	0	0	0	0	0	9041	0
18	0	9041	-9041	0	0	0	0	0	0	9041	0
19	0	9023	-9023	0	0	0	0	0	0	9023	0
20	183050	8577	174473	0	0	183050	0	0	0	8577	0
21	0	8826	-8826	0	0	0	0	0	0	8826	0
22	0	8898	-8898	0	0	0	0	0	0	8898	0
23	0	8951	-8951	0	0	0	0	0	0	8951	0
24	199377	8149	191228	0	0	199377	0	0	0	8149	0
25	0	8745	-8745	0	0	0	0	0	0	8745	0
116	86859	8398	78461	0	0	86859	0	0	0	8398	0
117	0	8505	-8505	0	0	0	0	0	0	8505	0
118	0	8648	-8648	0	0	0	0	0	0	8648	0
119	0	8737	-8737	0	0	0	0	0	0	8737	0
120	1231412	8202	1223209	41697	0	141058	1048657	0	0	8202	0

 3935210 1015718 2919491

[Unit 11 -continued]

BALANCE BY YEAR

YR	TOT +	TOT -	BAL
0	0	7488	-7488
1	14845	86316	-71471
2	382426	105204	277222
3	407847	104080	303766
4	259150	101440	157710
5	291147	102439	188708
6	247740	100405	147335
7	303657	101690	201968
8	355968	103420	252548
9	354169	101190	252979
10	1318271	102047	1216224

BY MONTH

NPV @	0%	5%	10%	15%	20%	25%	100%
	2919477 0	131643 1	-4708 2	-29254 4	-32909 2	-31610 4	-14995 2

IRR = 199 08 0 0955915 0 095590 24

BY YEAR

NPV @	0%	5%	10%	15%	20%	25%	100%
	2919500 0	2050045 0	1490580 0	1118437 0	863052 3	682613 2	86354 3

IRR = 275 54 2 7553892 2 7553883 24

AVERAGE PRICES PAID/RECEIVED

YR	(\$/HD) COW-BUY	(\$/HD) CULLCOWS	(\$/HD) CALVES-F	(\$/HD) CALVES-M	(\$/HD) FOLLOWERS-F	(\$/HD) FOLLOWERS-M
1	0 00	0 00	0 00	0 00	0 00	147 80
2	0 00	0 00	0 00	0 00	106 84	124 85
3	0 00	0 00	0 00	0 00	94 12	119 28
4	0 00	0 00	95 44	125 79	99 18	122 08
5	0 00	0 00	113 03	0 00	112 57	135 69
6	0 00	0 00	121 97	152 43	120 56	148 36
7	0 00	0 00	127 72	0 00	116 11	147 80
8	0 00	109 03	0 00	132 29	109 03	127 58
9	0 00	93 47	102 91	126 01	94 68	118 18
10	0 00	99 25	0 00	0 00	99 20	121 94
END	97 97	99 23	99 23	119 75	99 23	119 75

Unit 13 -continued 3

MENU

50 0

MENU

0 13

MENU

0 8

MENU

0 15

DATE

30 4 3540 3600 5 50

MENU

50 0

MENU

0 9

MENU

50 0

MENU

50 0

APPENDIX B & RUMTEST EXEC

```
GLOBAL TXTLIB EUDSTXT USERLIB VFORTLIB VALTLIB SAMM FORTMOD2 BIT2
CP SET EMSG OFF
ERASE AA4 FT4 A
CP SET EMSG TEXT
FILEDEF FT04F001 DISK AA4 FT4 A (DISP MOD
FILEDEF FT06F001 DISK OUTPUT FT6 A
FILEDEF FT07F001 DISK ANIMAL FT7 A
FILEDEF FT08F001 DISK DUMP FT8 A
FILEDEF FT09F001 DISK PASTO FT9 A
FILEDEF FT10F001 DISK PASDUMF FT10 A
FILEDEF FT11F001 DISK CASHFLO FT11 A
FILEDEF FT12F001 DISK INCFLO FT12 A1 (XTENT 242
FILEDEF FT13F001 DISK N\OUT FT13 A
FILEDEF FT15F001 DISK REDDAT FT15 A1
MAC GEN FORBITS BLK
GLOBAL MACLIB FORBITS
LOAD PARTA PARTB PARTC PARTD PARTEC
START
FLIST
```

-

Note - this exec runs RUSMOB, having first set up the necessary file definitions

APPENDIX B 7 SUBROUTINE CALL LIST, WITH LOGICAL UNIT CONNECTIONS

#	Routine	Contains Calls To	Reads From #	Writes To #
1	ACOUNT			
2	AFGEN			6
3	ANALIZ	1 12 70 73	4	11
4	ANLOOP	1 2 8 9 10 18 21 23 75 86 91		4 6 7 8
5	BLKOUT			
6	CALMIX	92		
7	CHASET			
8	COMPAR			
9	CONCEP	21		6
10	DELAY			
11	DIGGEN			
12	ECONOM	16 73 92 93 95		11
13	FIXIN	7 28 84		
14	FIXOUT			
15	HERBIJ	2 72 78 80 81 82 93		9
16	INCREM	88 92 93 94	12	11 12
17	INLOOP	1 4 15 18 19 21 24 26 73 74 86 88 92		4 6
18	INSW			
19	INTRAC	29 43 53 54 77 88		6
20	LEFJUS	27 84		
21	LIMIT			
22	MAIN	3 9 17 19 88 89 92 93 94	4 15	5 6 7
23	MARSAG	76		
24	MIXER	18 83		
25	MOB6RA			6
26	MOBRAT			
27	MOVE			
28	NUMPRT			
29	NXPBGO	30 31		
30	NXBEG1	5 71 84 85		
31	NXPBGO	5 13 14 20 27 71 76 84 85		
32	NXBUF1	5 13 14 20 27 71 84 85		
33	NXBUR0	34		
34	NXBUR1	5 13 14 20 27 71 84 85		
35	NXBUY1	5 13 14 20 27 71 84 85		
36	NXCALO	37		
37	NXCAL1	5 14 71 84 85		
38	NXCAS0	39		
39	NXCAS1	5 14 71 84 85		
40	NXCULO	41		
41	NXCUL1	5 13 14 20 27 71 84 85		
42	NXDAT1	5 13 14 20 27 71 84 85		
43	NXEND1	5 71 84 85		
44	NXEVE0	45 89		
45	NXEVE1	5 14 71 84 85		
46	NXF0LO	47 89		
47	NXF0L1	5 14 71 84 85		
48	NXF0R1	5 13 14 20 27 66 71 76 84 85		

#	Routine	Contains Calls To	Reads From #	Writes To #
49	NXHEFO	50 89		
50	NXHER1	5 14 71 84 85		
51	NXMAN	5 14 27 71 84 85		
52	NXMENU	5 14 27 71 84 85		
53	NXMENO	36 38 42 44 46 49 51 52 57 62 77		13
54	NXPANU	55 56		
55	NXPAN1	5 13 14 20 27 71 76 83 85		13
56	NXPAN2	5 13 14 20 27 71 84 85		13
57	NXPASO	58 89		
58	NXPAS1	5 14 71 84 85		
59	NXPOL1	5 13 14 20 27 71 76 84 85		13
60	NXREPO	61 89		
61	NXREP1	5 13 14 20 27 71 84 85		
62	NXROTO	32 33 35 40 48 59 60 63 64 68 77 89		13
63	NXSEA1	5 13 14 20 27 71 84 85		
64	NXSELO	65 89		
65	NXSEL1	5 13 14 20 27 71 84 85		
66	NXSYSO	67		13
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92	ZEROR1			
93	ZEROR2			
94	ZEROR3			
95	ZIR	92		11