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.

Contents

List of Figures and Tables

Figures

Tables

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 8.2. 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 imputed. 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 resumen 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,

$$I = VICOEF * WM / (1-DIG),$$

where WM = normative weight, DIG = DM digestibility, and VICOEF, 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,

$$I = DDM / DIG,$$

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,

$$MENEED = (MAINT + AC + PREG + LACT),$$

FIGURE 1 RUSMOB HERD DYNAMICS

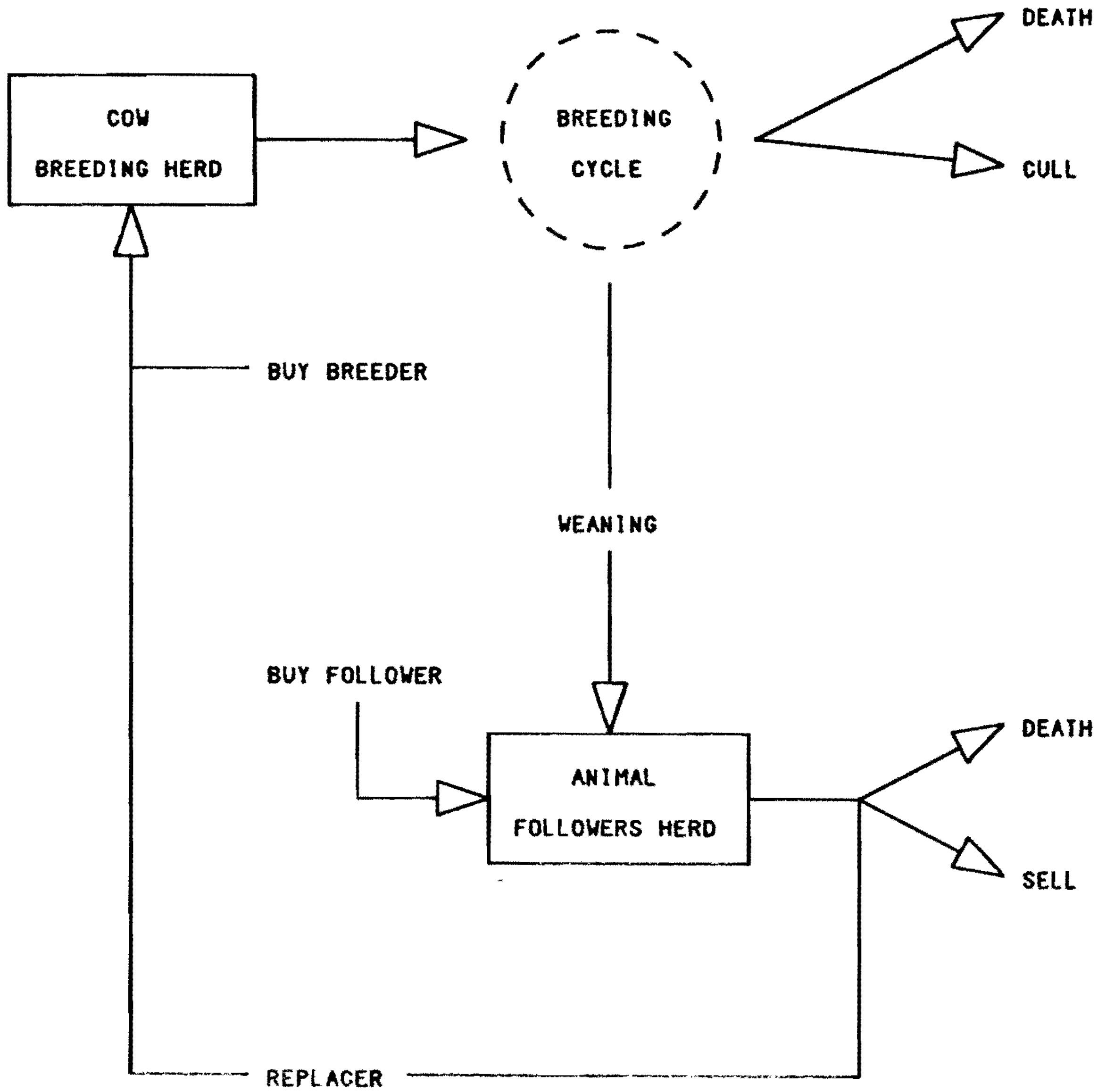


FIGURE 2 GENERAL EVENT SEQUENCE, BEEF MODEL

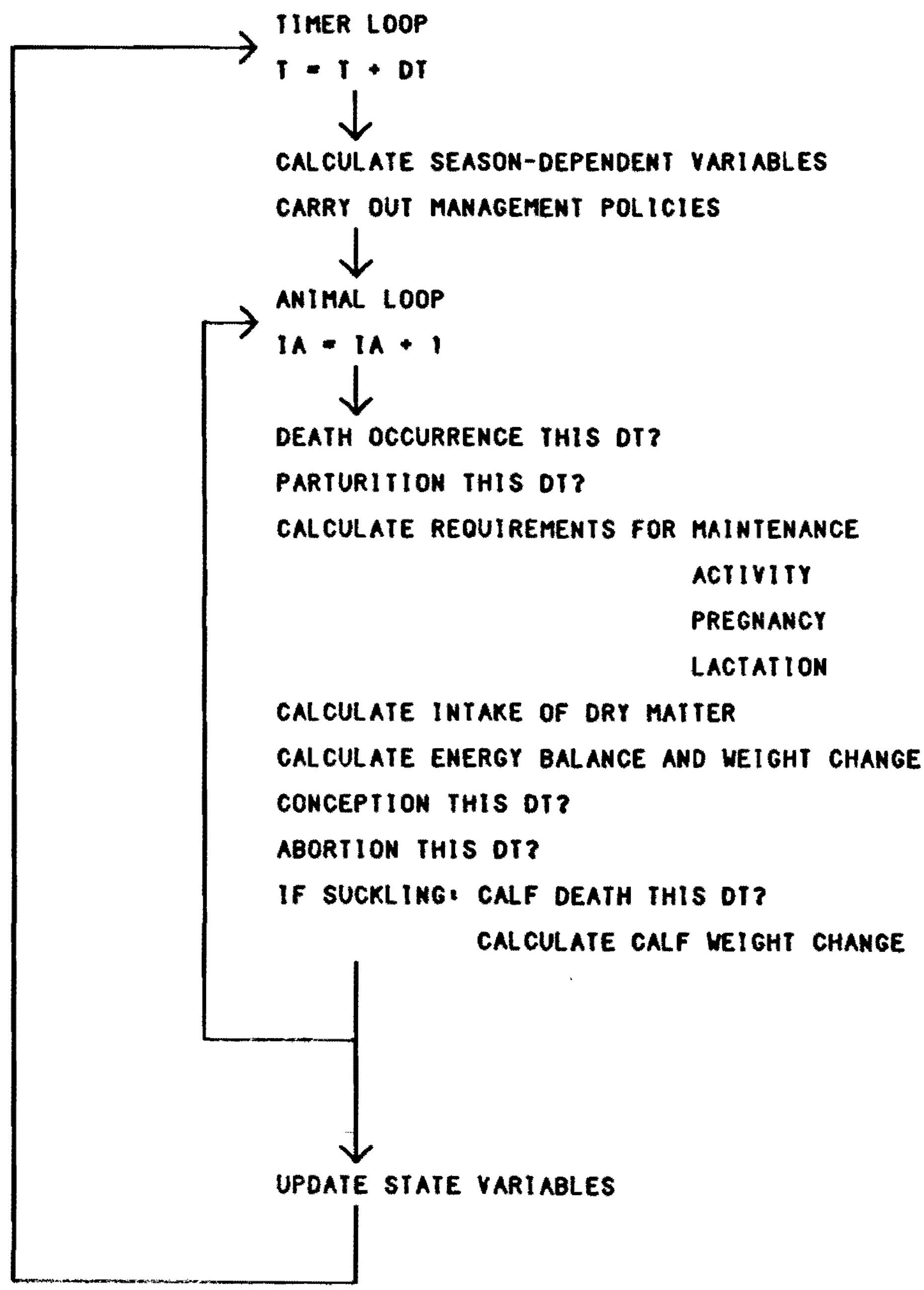
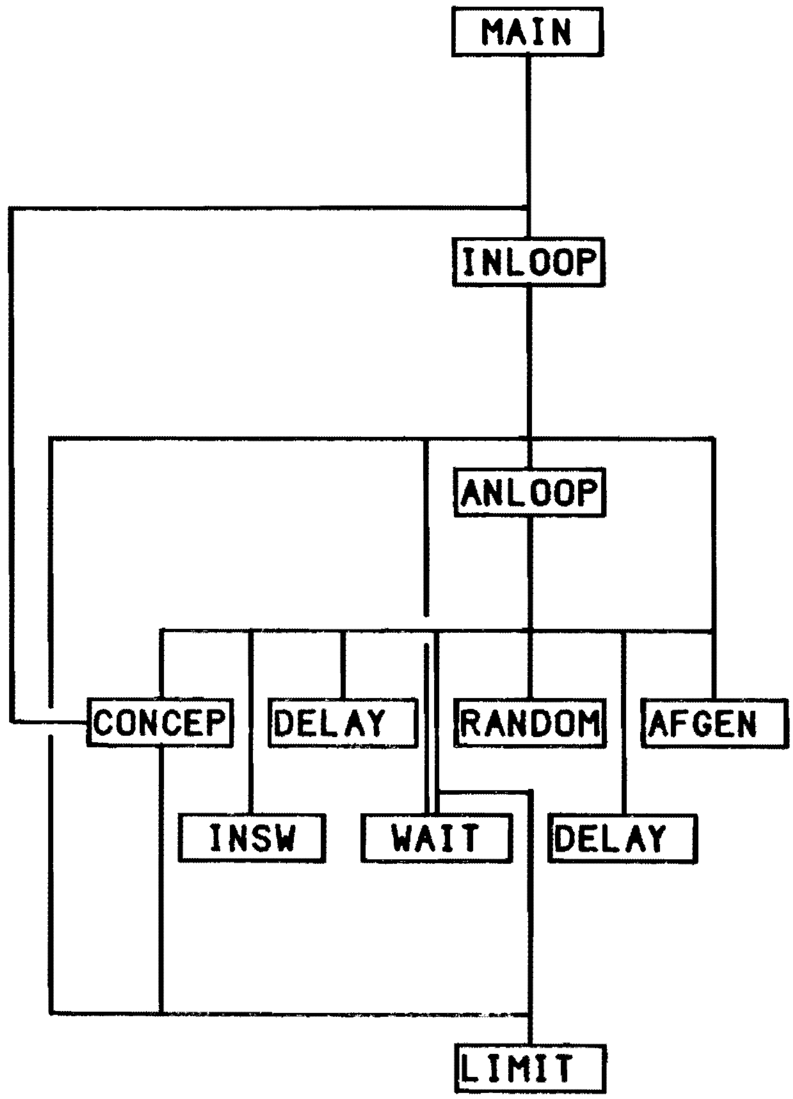


FIGURE 3 RUSMOB V3.0 PROGRAM STRUCTURE



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:

MAINT = FM / KM,

= COF * ((W/1.08)**0.67)/(DIG*0.81*0.35 + 0.503).

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

AC = 0.012 * W * F,

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

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.

LACT = PPM/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,

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

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 PMEXP = the rate of decline post- peak. The daily amount so calculated is reduced by two factors:

- age,

CFA = 1.0 + 0.01*(AGE-7) - 0.01*(AGE-7)**2, 0 <= CFA <= 1,

- previous under-nutrition,

LDEP = LTIME/240, 0 <= LDEP <= 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

WCONV = WFAC * MFAC * LFAC,

where WFAC = WMAX-8*exp(-3*W/WM), MFAC = WMAX-3*exp(-2*WM/WMA), LFAC = (270-LTIME)/270 if LTIME <= 270 or 0 if LTIME > 270, WM is normative weight, +MA = 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

$$PEST = PESTCO * CFT * CFM * CFW * CFDW * CFAGE,$$

$$CCYC = CFW ** 0.1 * CFDW ** 0.1,$$

$$PCON = 0.75 * CFT**0.5 * CFM**0.2 * CFDW**0.2 * CFAGE**0.5 * SEASON,$$

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:

- $$CFT = 1 - 1/\exp(9.E-7*(APTIME-APDELT)**3.9)\ , \quad 0.001 <= CFT <= 1,$$

a correction factor for time since calving, where APTIME = no of days post-partum, APDELT = 10, a suckling factor;

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

a correction factor for animal maturity;

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

a correction factor for condition;

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

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

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

a correction factor for age.

PESTCO = 1.0 - 0.15**(DELT/30) to adjust for values of *dt* other than 30, where DELT = *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

$$STER = 1 - CFA,$$

where CFA = 1 + 0.01*(AGE-9)-0.01*(AGE-9)**2, 0.001 <= CFA <= 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 indeces (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 indeces 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 indeces 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

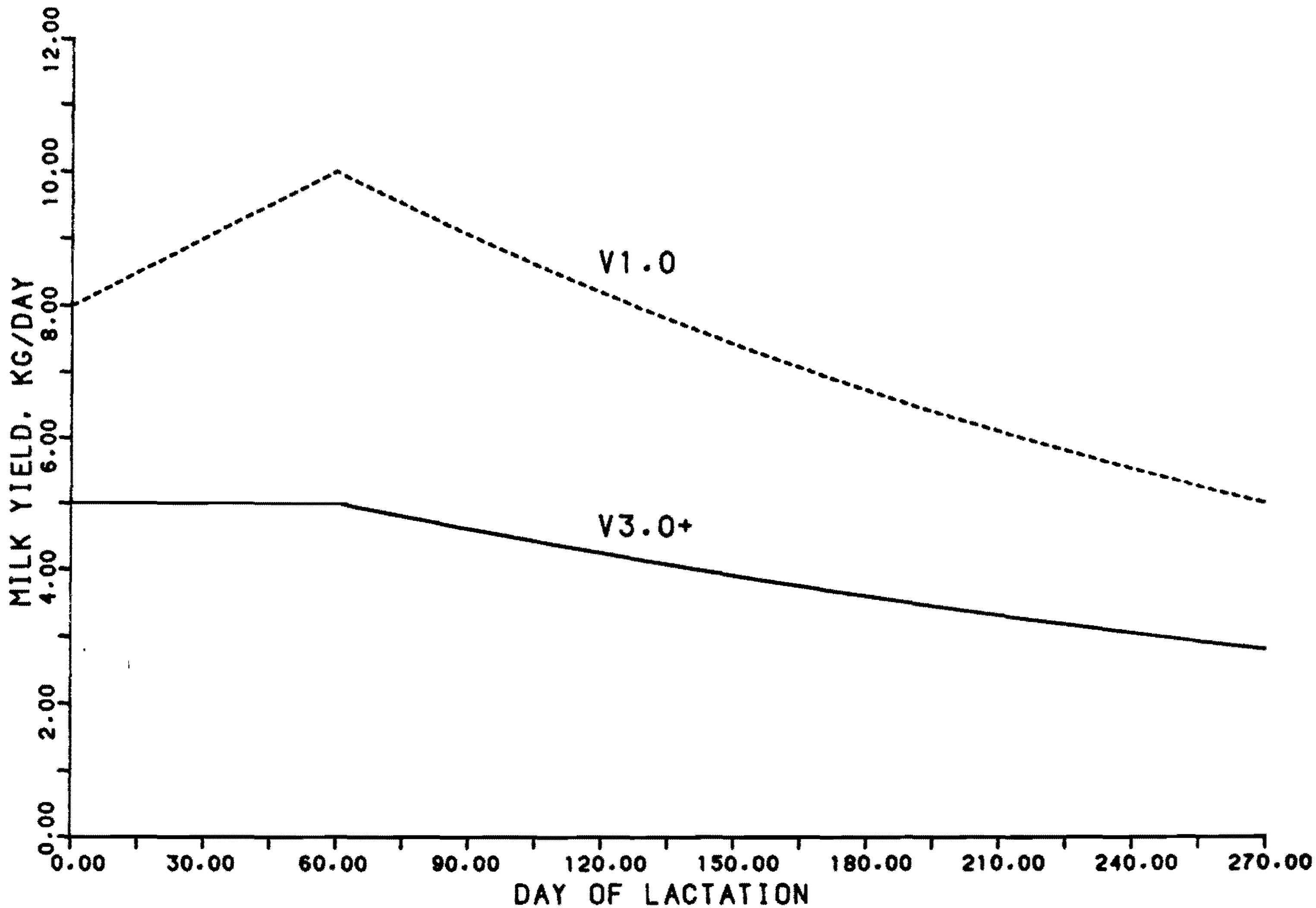


FIGURE 5 TISSUE MOBILIZATION

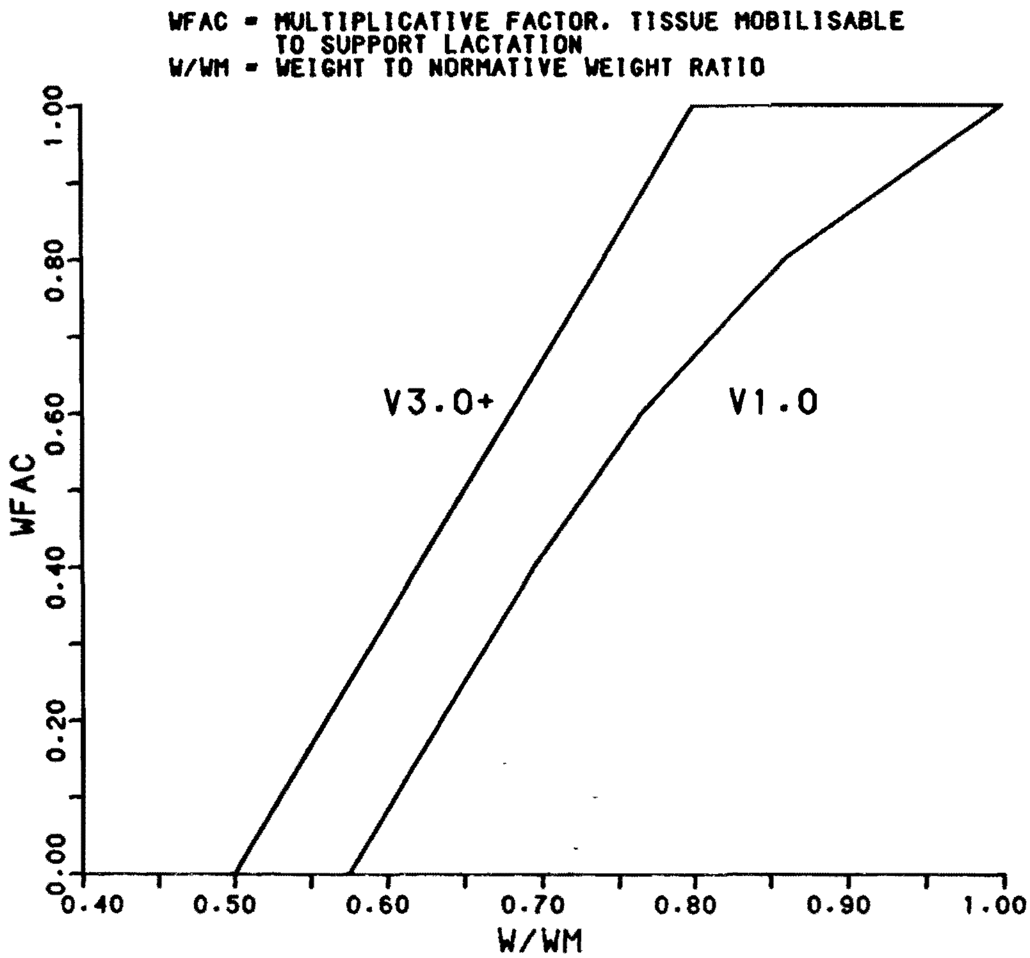
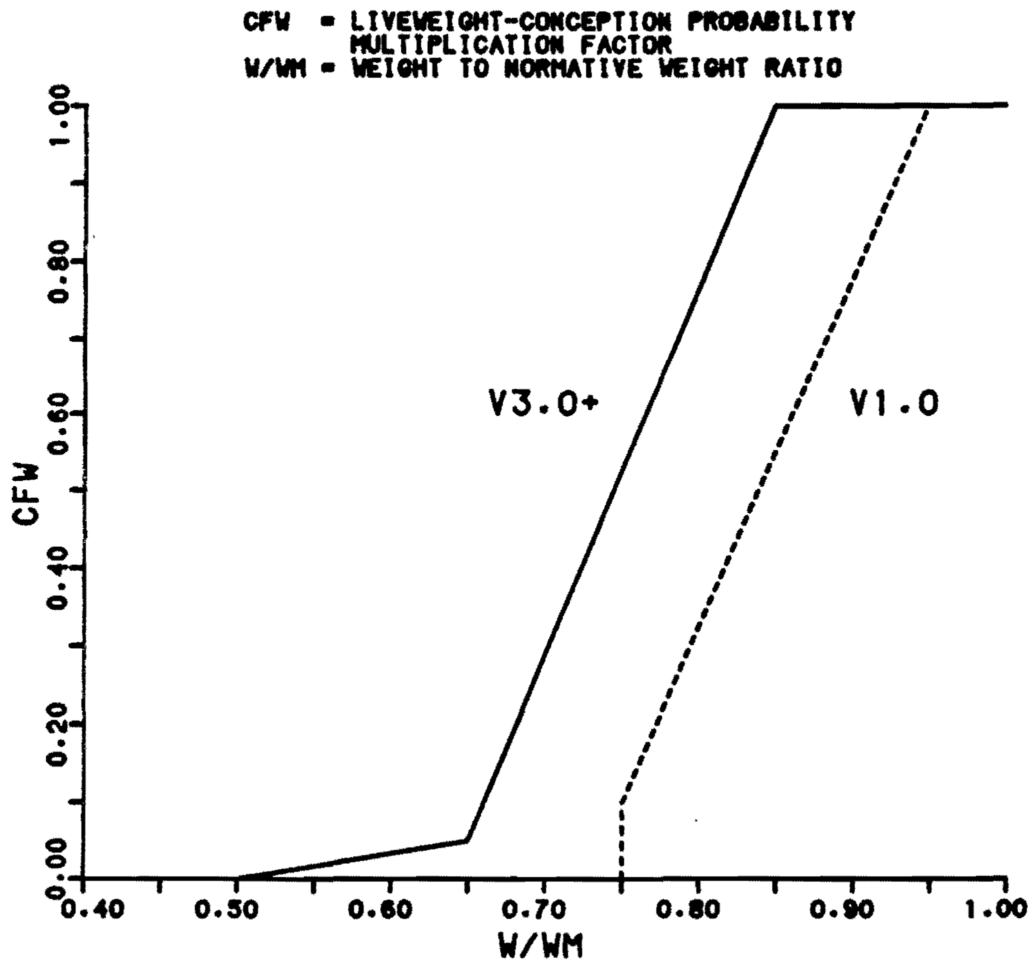


FIGURE 6 CONCEPTION CHANGES I



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/WMA 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).

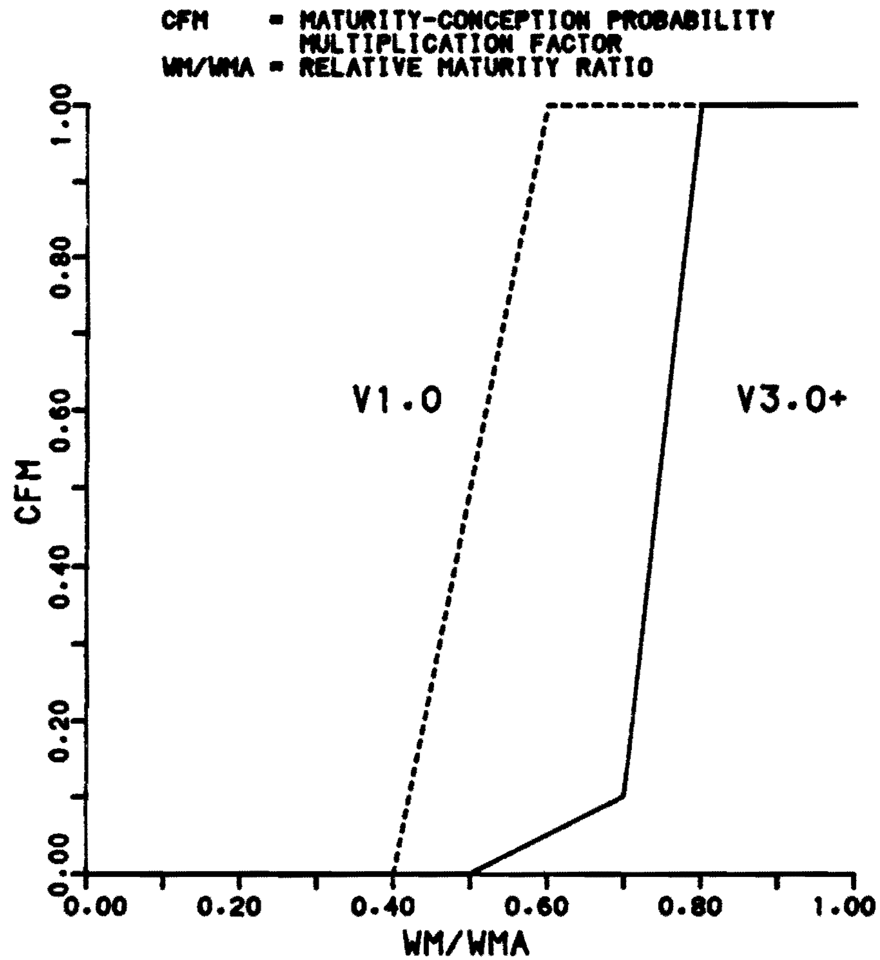
For weaning weights, it was concluded that it is possible that plane of nutrition acts on milk production potential (and hence weaning weight) in a way not explicitly accounted for in the model, when diverse production systems are considered. In effect, this parameter may be seen as a measure of genetic 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



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.

PASMOD

At this stage PASMOD 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 Carimagua, 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 PASMOD model used six basic functions, five of which are shown in Figure 8. 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(Biomass)

II Senescence Rate = f(Biomass)

III Potential Growth Rate = f(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 (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(Proportion of legume available).

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

VI Intake kgDM/100kgLW = f(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

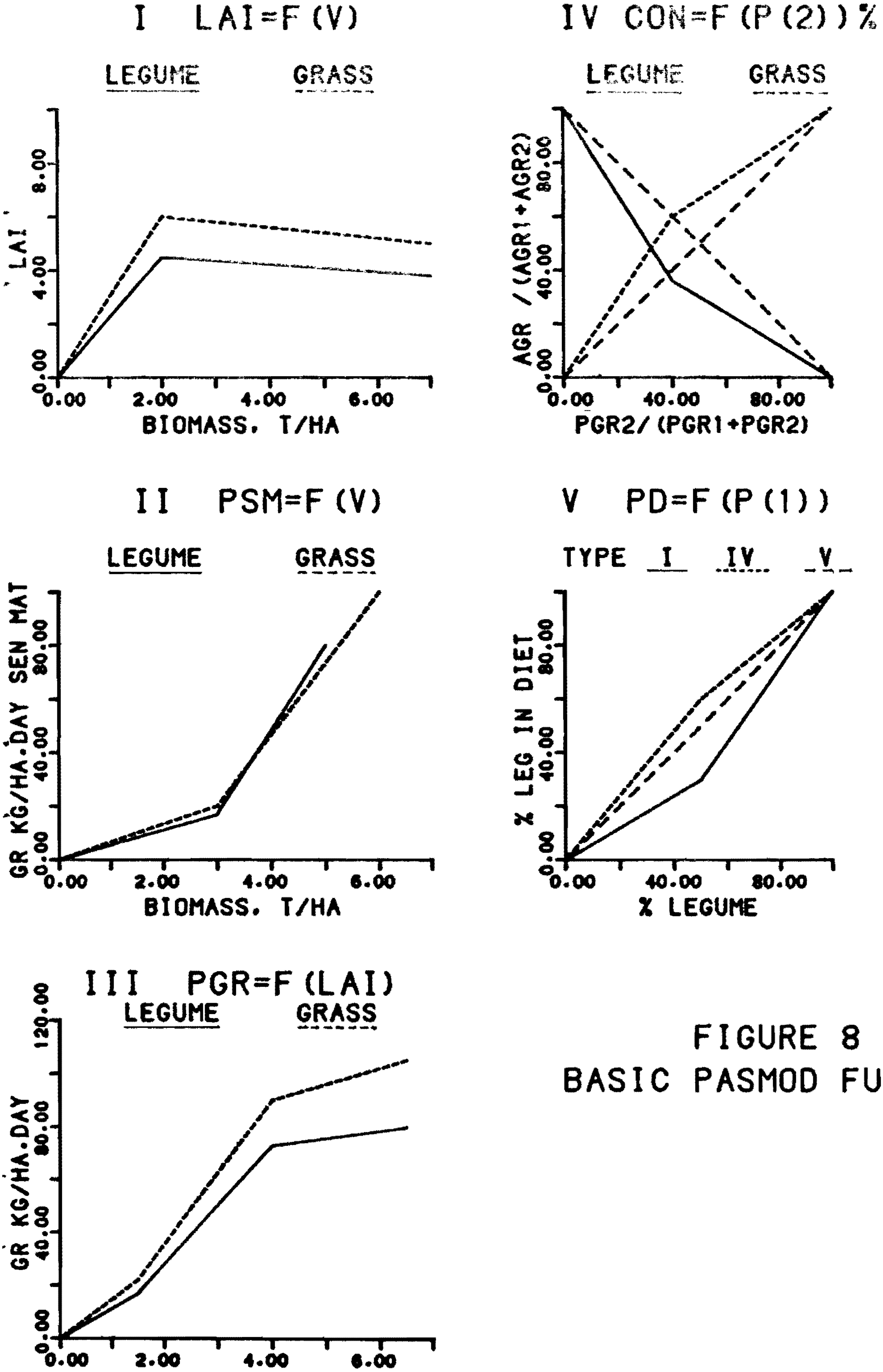


FIGURE 8
BASIC PASMOD FUNCTIONS

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 PASMOD 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 PASMOD 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 unlimiting. 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 BIO(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(i,23), where _i_ 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(i,9).
- the number in each group in any month is stored in array NHEAD(i).
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,

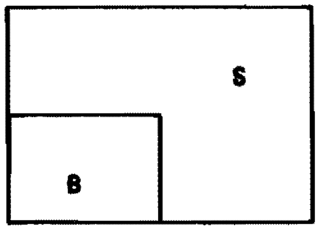
11001	savanna + improved pasture
10101	
10011	

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).

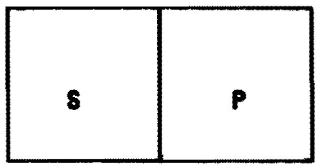
FIGURE 9 EXAMPLES OF RUSMOB GRAZING SYSTEMS

TYPE I



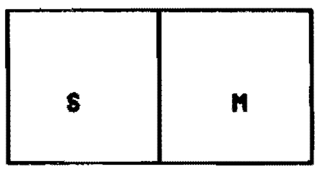
FREE ACCESS OR STRATEGIC
DIET = S (+B)
PREFERENCE FUNCTIONS NEEDED

TYPE II



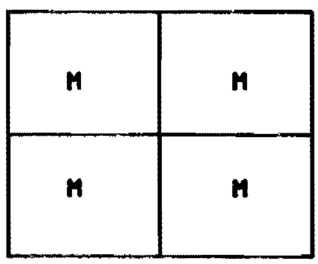
ROTATIONAL OR STRATEGIC
DIET = S OR P
NO PREFERENCE FUNCTIONS

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 PASMIP) 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:

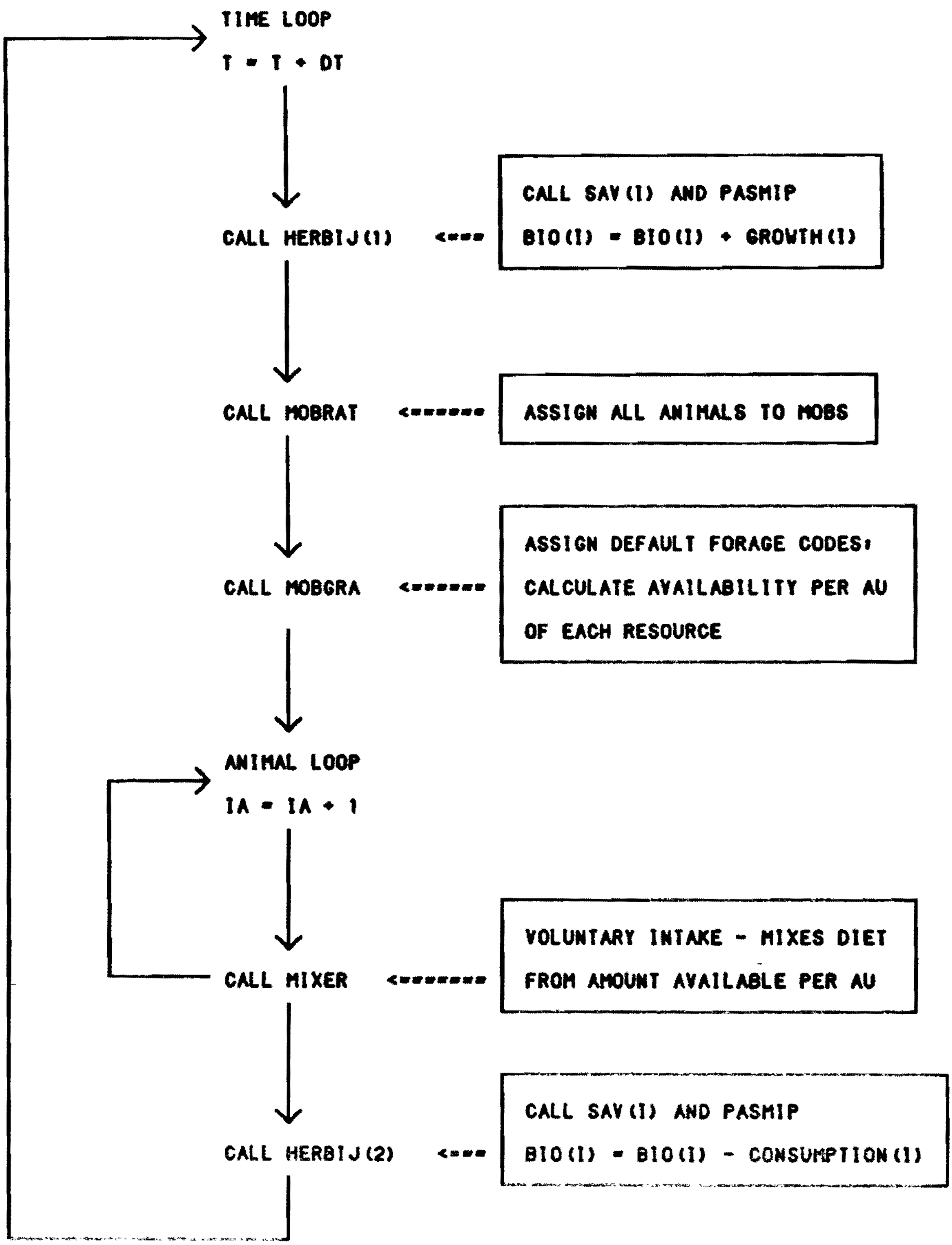
DAY 100		BIO(1) = 4230
	+ net growth	day 101 = 4270
	+	day 102 = 4312
	+	day 103 = 4356
	+	day 104 = 4402
	+	day 105 = 4450

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 ESUM(1) = 5 * 32 * V.I.
If V.I. = 6.0 (and V.I. <= QQ(I), else availability is

FIGURE 10 HERBAGE EVENT SEQUENCE



limiting), ESUM(1) = 960 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 QQ(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:

i=1	cows bought	$/kg
2	cull cows sold	$/kg
3	female calf sold	$/kg
4	male calf sold	$/kg
5	female follower 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:

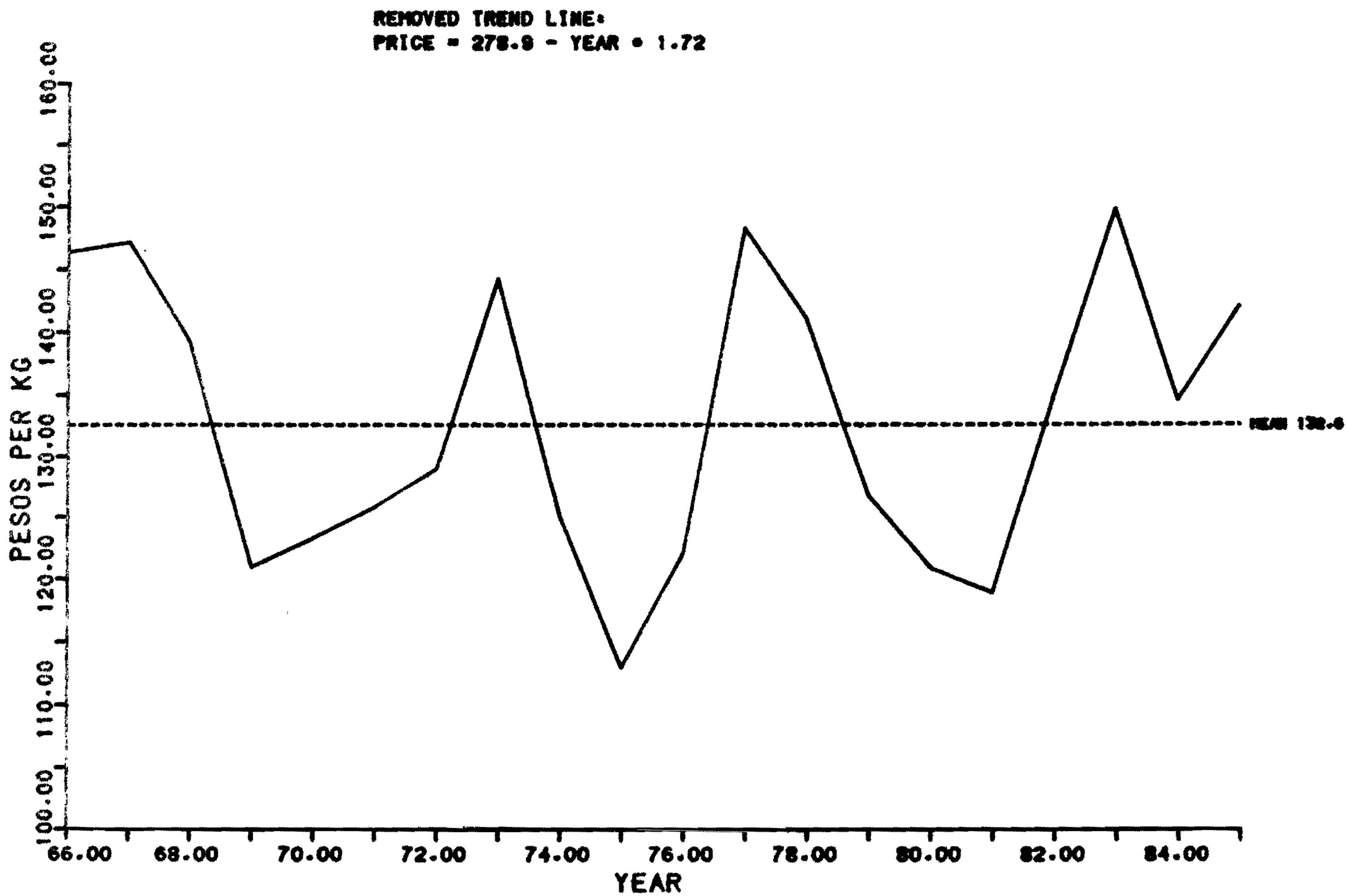
$$BP = (SP - SP_o/s_1) * CORR + ((1.0 - CORR^2)*RNN)^{0.5} * s_2 + BP_o$$

where

BP = buying price at time t,

SP = selling price at time t,

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



SP_o = mean selling price,

s_1 = standard deviation of the selling price,

CORR = theoretical correltaion coefficient between SP and BP,

RNN = a randon mormal number,

s_2 = standard deviation of the buying price, and

BP_o = 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(i) = BEN(i) - COST(i)

where BEN(i) = CULL(i) + CARF(i) + CFOL(i) + CAPIT(i) + ZMILK(i) and

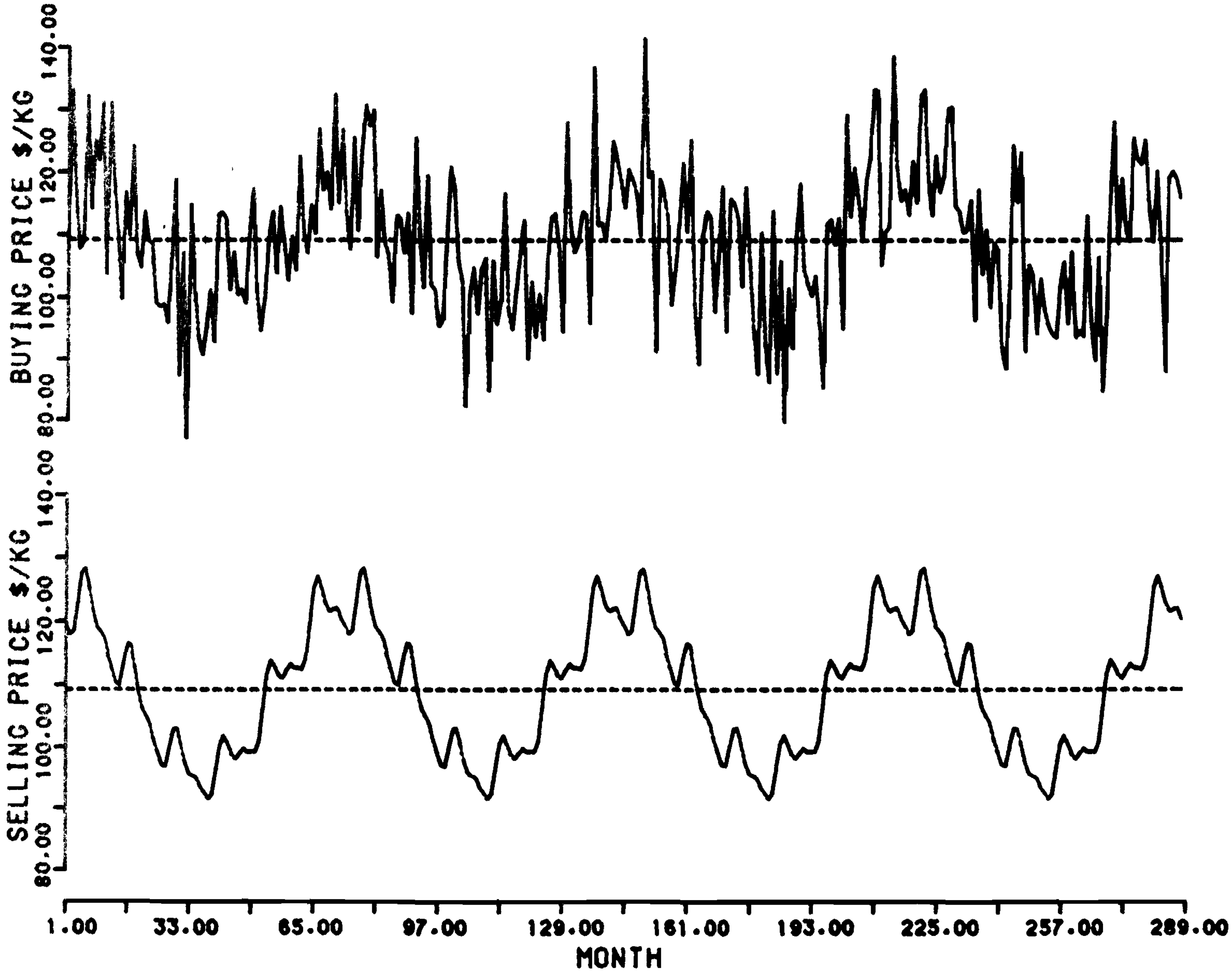
COST(i) = CHERD(i) + CBUY(i) + CGAST(i)

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

CGAST(i) = CVAR * number of animals + CGAST(i),

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

FIGURE 11B 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.

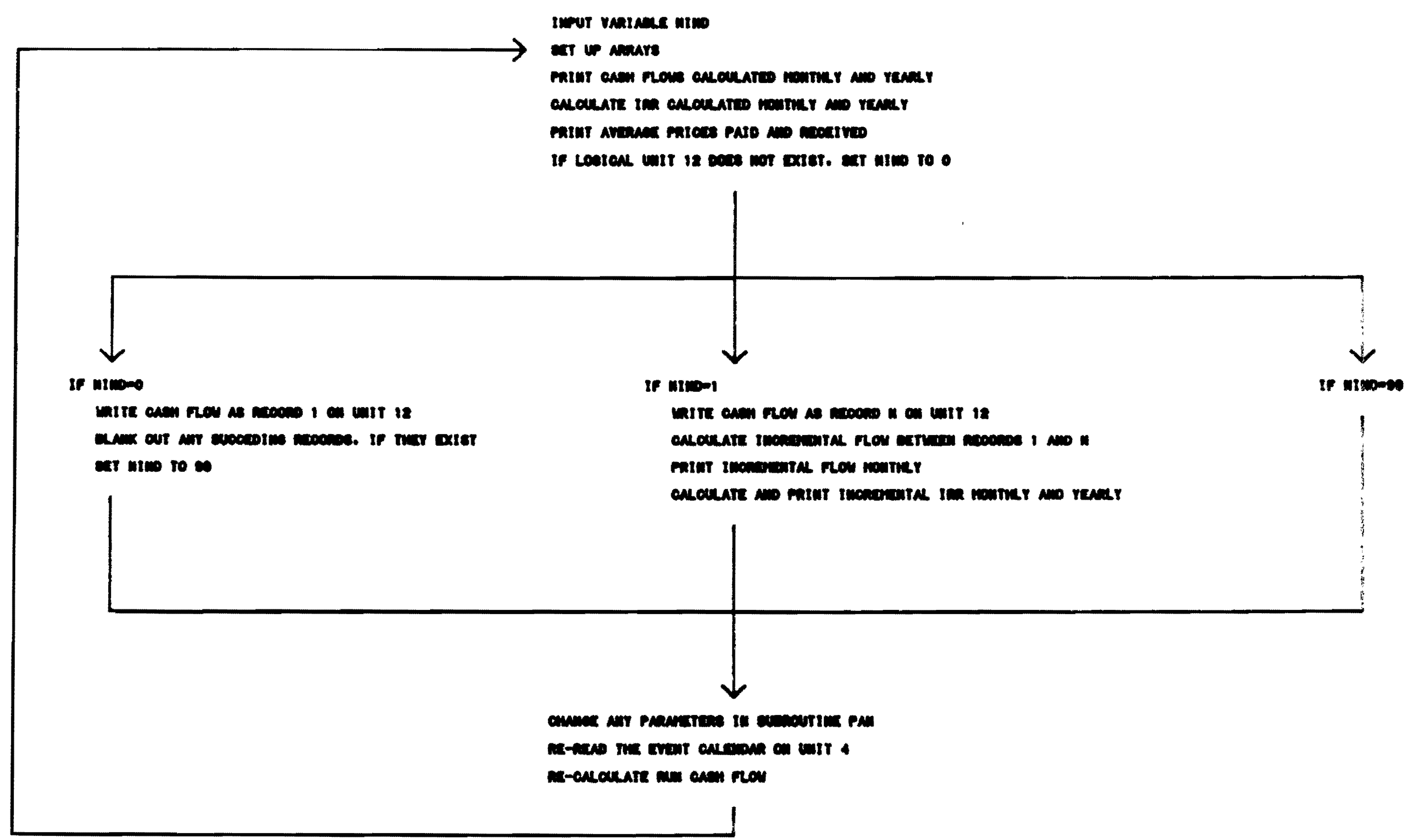
The next task is the calculation of the incremental flow and subsequent calculations. This is controlled by a variable NIND, whose operation is described in Figure 12. The possibilities are as follows:

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 RUSMOB. (Refer to Appendix B.2 for variable name list). It should be noted that there are as yet no data checking routines in RUSMOB 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 de-bugging tasks.

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

TABLE 2 RUSMOB EXTERNAL FILES

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

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

(*) assumed to exist if NIND=1; if not, NIND is set to 0.

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(i,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.

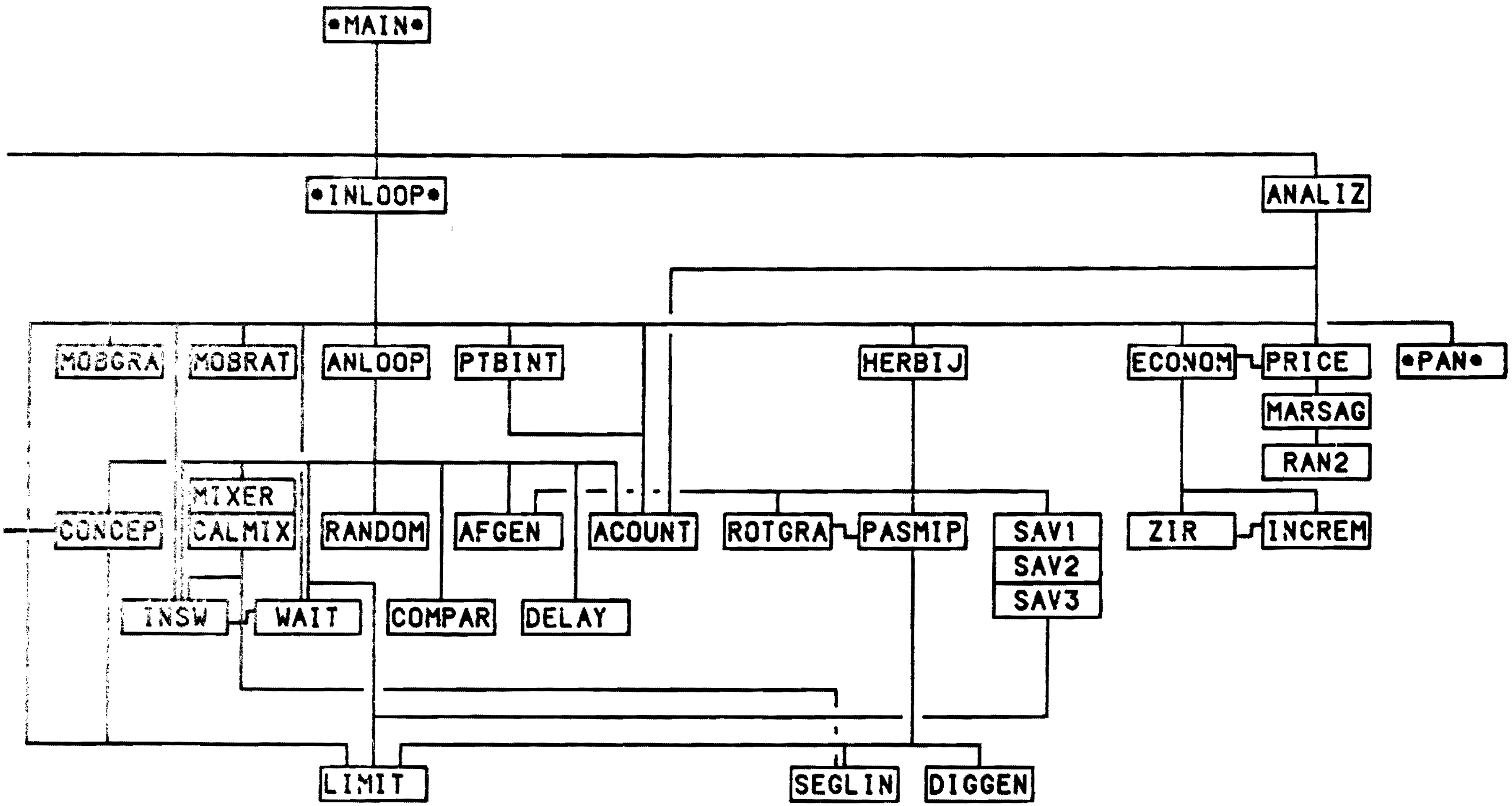
MODE = 2 or 12 results in full interactive mode. The user can set four (default) annual stop dates, and when these occur, or at any other time the user wishes, the simulation stops, and animal numbers, weights, sex and status can be displayed, pasture status can be investigated, the cash flow to date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

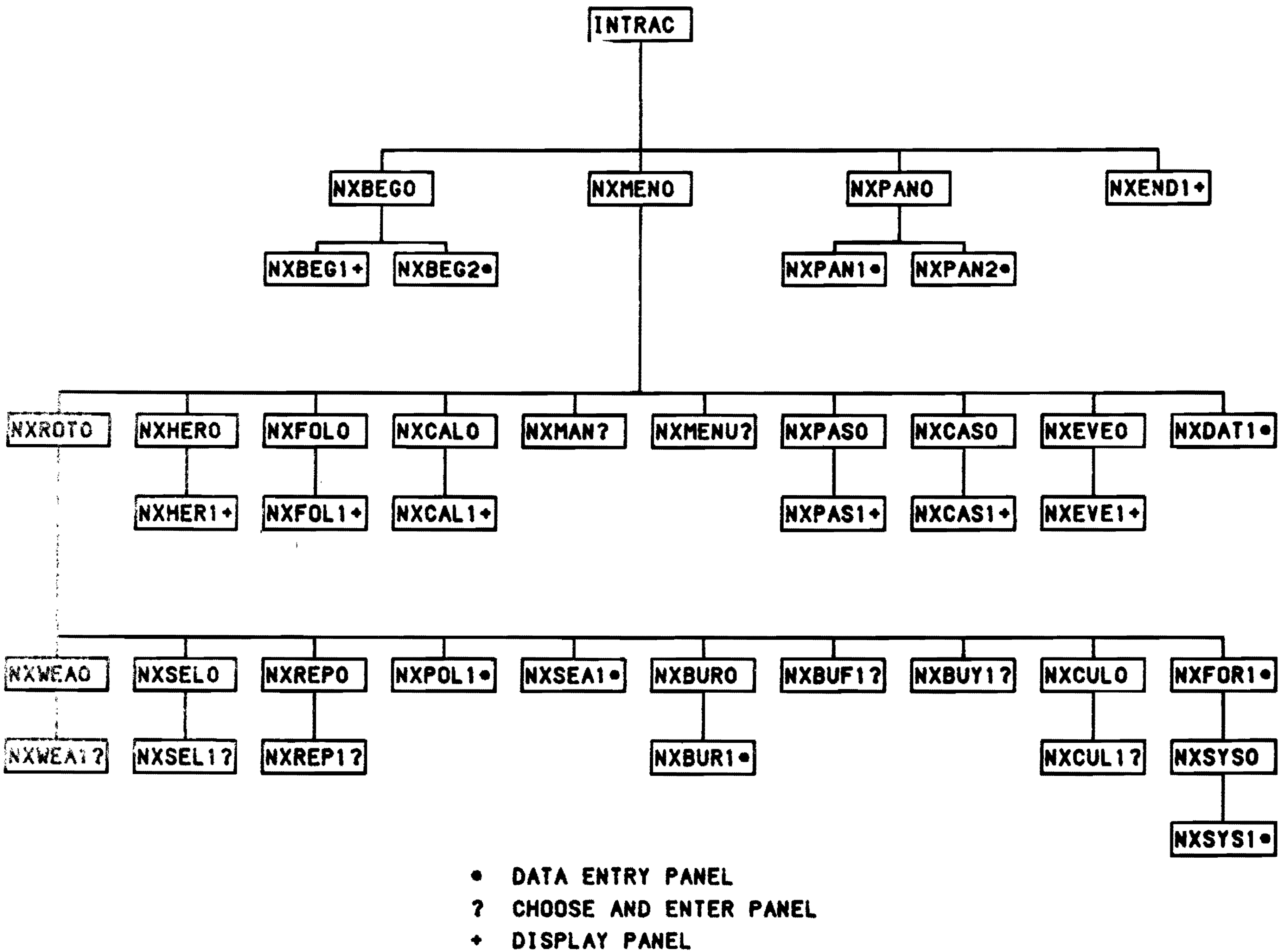
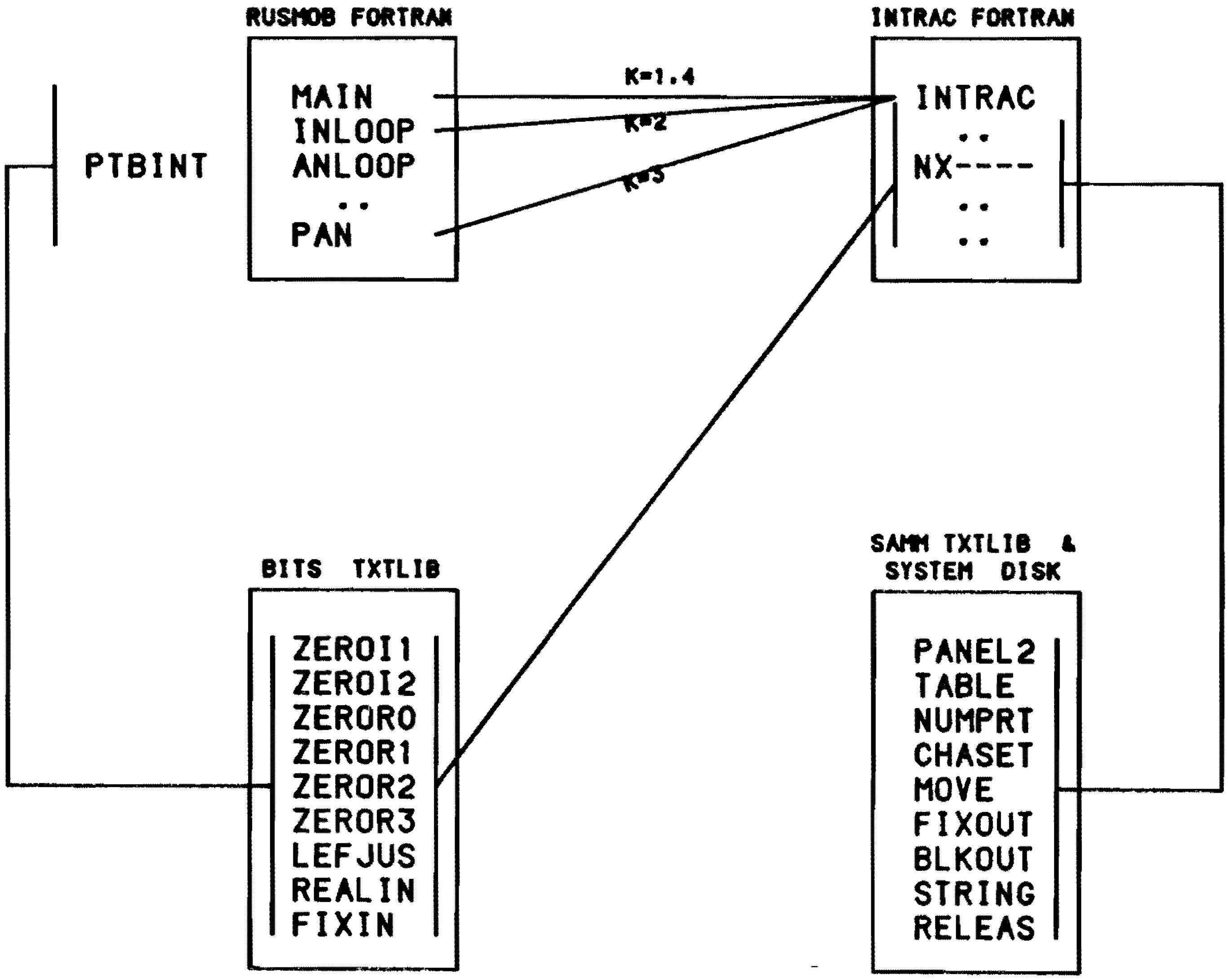


FIGURE 15 RUSMOB V4.1 PHYSICAL LAYOUT OF PROGRAM



- K IS A PASSED PARAMETER TO DETERMINE THE POINT OF ENTRY TO INTRAC
- THE BLACK BOXES 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 unlimiting. 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 NXMFNU), 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 NXFOL0, NXFOL1) - 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 NXMAN).

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 + ISTOD(2))	
5	900	(720 + ISTOD(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 NXROTO:

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 animals ID number. As many may be culled as required.

c) wean calves (subroutines NXWEAO, NXWEA1) - 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 followers (subroutine NXBUF1) - this is the same as for buying breeders, except pregnant followers can not be bought, but sex may be specified. Again, a limit of 10 per stop date exists.

e) sell followers (subroutines NXSEL0, NXSEL1) - displays ID number, sex, weights and age, and the mechanism is the same as for culling animals.

f) select followers as replacers (subroutines NXREP0, 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 (OFRAT) can be changed, and the constant price recieved 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 NXPAN0, NXPAN1 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 male 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; PF2 may be used to switch back and forth between the two economic data panels. The arrays CGAST (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,

CHERD(i) = 0,
and CGAST(i) = constant, n
or = n + CVAR * no. of animals, if CVAR > 0.

To change these for subsequent analysis:

- capital costs, enter a quantity X for each year (1 to 20), stored as IHE(i), and then a month M, IME(i). 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 CGAST(i), 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, CGAST(i) and CHERD(i) 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(i) as 99; this will over-ride everything without exception, and CGAST(i) and CHERD(i) will be set as per the block data segment in subroutine ECONOM, 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 ACOUNT 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, RUSMOB is run using the command RUMTEST, which runs an executive file of the same name (listed in Appendix 8.6). 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 Lebdosoekojo (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 WMAX MINWT PP WMR EXTRA APDELT BIOL SUPROP	12F6.0
7	FINTIM DELT CDELT JEV JHERD DATE NA IAREA IPRDEL JA PDELT ICCC	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
13-15	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	FMCF(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	SUPCPF(1-2,1-28)	(12F6.0)
45-50	HSF(1-2,1-28)	(12F6.0)
51-100	VV(i,n), n=4 1 2 5 3 10 12 13 14 15 18 20	*

Note - refer to variable name list (Appendix 8.2), some of the variables are obsolete;
- number of cows' records read must be greater than NA+1.

TABLE 4 INTERACTIVE PANELS AND DATA ENTRY

RUSMOB PANEL#	Calling PRogram	User-Changeable Variables
00	NXEND1	
01	NXMENU	
02	NXDAT1	MYR MDA
03	NXMAN	
04	NXHER1	
05	NXFOL1	
06	NXCAL1	
07	NXPAS1	
08	NXCAS1	
09	NXBEG1	
10	NXBEG2	ANAME NSEED IRUM MODE FINTIM NIND DELT ISTOD PMA NA AREA BIO
11	NXEVE1	
21	NXPAN1	IDYK CVAR AMP TREND CYCLIC START PRINIT PREIS
22	NXPAN2	IDYK CHER IME CGAS
30	NXSEA1	SEASON
31	NXBUR1	AREA(1-3) BIO(1-3)
32	NXPOL1	NWEAN MANDAT CCUL MCUL KCUL SWTF SWTM SAGEF SAGEM KFA NA IDEFLA OFRAT PREIS
33	NXCUL1	ICUL
34	NXSEL1	ISEL
35	NXWEA1	IWEA
36	NXBUY1	IBUY
37	NXFOR1	AREA ICOD
38	NXREP1	IREP
39	NXBUF1	IBUF
40	NXSYS1	NPAD VPAD

Note - refer to variable name list (Appendix 8.2)

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
OFRAT	milk offtake rate	0	Input File
PREIS	milk price c$/kg	32	Input File
ACF	activity coefficients	12*1.0	Input File
VIP	faecal dm output/kglw/day	0.0094	Input File
DATE	start of run	0	Input File
WMAX	max tissue mobilisation, kg/day	1.4	Input File
MINWT	min wt of replacer heifers, kg	100	Input File
PP	adult wt / birth weight	15.0	Input File
AMP	price cycle amplitudes, %	11.2 12.7	Input File
TREND	price cycle trends, % / yr	0 0	Input File
CYCLIC	price cycle lengths, yr	6 6	Input File
START	price cycle starting point, yr	0 0	Input File
PRINIT	initial prices, C$	109 109 109 132 109 132	Input File
DIGF	monthly D%, 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
DAYSPK	60	days to peak milk yield
PROPIN	1.0	proportion of max 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*WMF	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.	

Variable													
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
SAV2	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.
DLL	0.43 0.45 0.46 0.48 0.44 0.44 0.45 0.46 0.45 0.46 0.43 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	0.95,0.94,0.99,1.04,1.07,1.07,1.04,1.01,0.99,0.98,0.97,0.97
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 orice 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(i,9) = CORRES(1) ICOD(14)

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 >= 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 >= 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 8.5)

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;
conceps - number of conception events;
b h fems - 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(i) > 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, i.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 indeces, 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 in File	Variables Printed	Printed From
NXDAT1	DATE :	ITIME JT ISTOP FINTIM DELT IWIT	NXMENO
NXMAN	MAN :	IWIT ILLN	NXMENO
NXPAN1	PAN1 :	IDYK 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
NXBURO	BUR :	ITIME JY IWIT BIO(1-5)	NXROTO
NXCULO	CUL :	ITIME JY IWIT ICUL(1-NA)	NXROTO
NXSELO	SEL :	ITIME JY IWIT ISEL(1-NUMFOL)	NXROTO
NXWEAO	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 DFRAT PREIS	NXROTO
NXFOR1	FOR :	ITIME JY IWIT AREA(1-5) BIO(1-5) ICOD(1-14)	NXROTO
NXREPO	REP :	ITIME JY OUT(JY,8) KNA IWIT IREP(1-NUMFOL)	NXROTO
NXBUF1	BUF :	ITIME JY NUMFOL IWIT IBUF(1-10,1-5)	NXROTO
NXSYS1	SYS :	ITIME JY NPAD VPAD(1-5,1-4)	NXSYSO

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 8.2
- 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 experimental 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 8.1 SUBROUTINE LIST

Name	Function	Common	Location
ACOUNT	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 BLANKS	+	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	*
LEFJUS	LEFT-JUSTIFY A STRING		SAMM
LIMIT	CHECKS BOUNDS FOR AN X-Y TABLE		*
MAIN	MAIN PROGRAM	BLK	*
MARSAG	RANDOM NORMAL NUMBER GENERATOR		*
MIXER	MIX THE DIET FOR AN ANIMAL	BLK	*
MOBRAT	ASSIGN ANIMAL STATUS	BLK	*
MOBGRA	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		*
NXFOL0	INTERACTIVE CONTROLLER, PANEL 05	INT	*
NXFOL1	INTERACTIVE CONTROLLER, PANEL 05		*
NXFOR1	INTERACTIVE CONTROLLER, PANEL 37		*
NXHER0	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		*
NXROT0	INTERACTIVE CONTROLLER, MGT ROUTINES	BLK	*
NXSEA1	INTERACTIVE CONTROLLER, PANEL 30		*
NXSEL0	INTERACTIVE CONTROLLER, PANEL 34	INT	*
NXSEL1	INTERACTIVE CONTROLLER, PANEL 34		*
NXSYS0	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
PASMIP	GROWTH ROUTINE, LEGUME/GRASS ASSOCIATION	BLK	*
PRICE	GENERATE PRICES FOR THIS DT	ECO	*
PTBINT	INTERACTIVE PARTB	BLK	*
RANDOM	GENERATE A NUMBER FROM U(0,1)		*
RAN2	GENERATE A NUMBER FROM U(0,1) FOR MARSAG		*
REALIN	CONVERT CHAR NUMBER TO A REAL NUMBER		*
RELEAS	RELEASE A PANEL	+	SAMM
ROTGRA	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		*
STRING	FINDS VALUE OF A STRING	+	SAMM
TABLE	FIND REAL ADDRESSES OF PANEL FIELD DATA	+	SAMM
WAIT	CALCULATE NORMATIVE WEIGHT OF AN ANIMAL	BLK	*
ZEROI0	ZERO 10 INTEGER SCALARS		BIT2
ZEROI1	ZERO A 1-D INTEGER ARRAY		BIT2
ZEROI2	ZERO A 2-D INTEGER ARRAY		BIT2
ZEROI3	ZERO A 3-D INTEGER ARRAY		BIT2
ZEROR0	ZERO 10 REAL SCALARS		BIT2
ZEROR1	ZERO A 1-D REAL ARRAY		BIT2
ZEROR2	ZERO A 2-D REAL ARRAY		BIT2
ZEROR3	ZERO 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 8.2 RUSMOB VARIABLE NAME LIST

Name	Function	Type	Location
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	PASMIP
ALDM	ACTUAL DM INTAKE	KG	AN/DAY R
AMP	% AMPLITUDE OF CYCLES	R 2	EC
ANAME	VARIABLE NAMES IN AFGEN	C*8 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	R	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	PASMIP
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 40KG	R	ANLOOP
BYR	YEARLY BENEFITS	R 22	ECONOM
C	CP%	R 5	E
CA	CALF DIET CP%	R	CALMIX
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 COWS BY MONTH	R 241	ECONOM
CC	CONCEPTION %	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
CFDWF	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-]

CFOL	PESOS FROM FOLLOWERS BY MONTH	R 241	ECONOM
CFT	POST-PARTUM INTERVAL REDUCTION, CONCEPTION	R	ANLOOP
CFW	WEIGHT INDEX CORRECTION, CONCEPTION	R	ANLOOP
CFWF	CONCEPTION PROB. X WEIGHT INDEX	R 2,5	B
CG	INITIAL DEFAULT VALUES FOR CGAST	R 241	EC
CGAST	DIRECT COSTS BY MONTH	R 241	EC
CGR	CALF GROWTH RATE	R	ANLOOP
CH	INITIAL DEFAULT VALUES FOR CHERD	R 241	EC
CHERBL	CUM. CALF PASTURE CONSUMP IN DELTA, KG DM	R	SCALES
CHERD	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	PASMIP
CONCC	CONC CONSUMP, KG DM/DAY	R	ANLOOP
CONCME	ME VALUE OF CONC	R	ANLOOP
COND	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(i,9) TO ICOD	I 23	MOBGRA
COST	COSTS BY MONTH	R 241	F
CP	CRUDE 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 CONSUMP, 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	PESOS FROM CULL COWS BY MONTH	R 241	ECONOM
CVAR	DIRECT COST PER HEAD OF CATTLE	R	EC
CW	CALF WEIGHT	R	SCALES
CXPAGE	EXPONENT OF OPTIMAL GROWTH CURVE, CALVES>6MOS	R	SCALES
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
DAYSPK	NO OF DAYS TO PEAK MILK YIELD	R	ANLOOP
DDLACT	POT MILK YIELD DECR. 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
DIGEN	FEED DIGESTIBLE ENERGY	R	SCALES
DIGF	MONTHLY DIG OF PASTURE X TIME	R 2,14	B
DIGPRO	DIGESTIBILITY PROPORTION FACTOR	R	SCALES
DIGS	DIG OF RECYCLED SUPP FEED, WEIGHTED AVERAGE	R	ANLOOP
DIGX	WEIGHTED DIG OF TOTAL DIET	R	SCALES
DM	DM OF PASTURE, IRUM=0	R	SCALES
DMC	DM OF SOLID FEED IN CALVES	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
DMO	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 DIG 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
ET1	INTERMEDIATE VARIABLE, PREG. EN. REQ.	R	ANLOOP
EVENT	EVENT ARRAY	C*4 9	MAIN
EVG	ENERGY VALUE OF GAIN MJ NE/KG GAIN	R	ANLOOP
EVGC	EVG IN CALVES	R	ANLOOP
EXPAGE	EXPONENT OF OPTIMAL GROWTH CALC , ADULT	R	SCALES
EXPW	EXPONENT, ADULT CONDITION FACTOR CALC (FCOND)	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
FDED	PROBABILITY OF CALF DEATH	R	ANLOOP
FEET	CALF DIET RESOURCE INDICATOR	R 4	CALMIX
FGI	X-Y TABLE: LAI AS A FUNCTION OF V/1000, GRASS	R 4,2	PASMIP
FGII	X-Y TABLE: PSM AS A FUNCTION OF V/1000, GRASS	R 4,2	PASMIP
FGIII	X-Y TABLE: PGR AS A FUNCTION OF LAI, GRASS	R 4,2	PASMIP
FGIV	X-Y TABLE: CON AS A FUNCTION OF PX(2), GRASS	R 4,2	PASMIP
FGIVN	X-Y TABLE: NO-COMPETITION FUNCTION, GRASS	R 4,2	PASMIP
FGVII	X-Y TABLE: AGR SEASONAL MODIFIER, GRASS	R 4,2	PASMIP
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-]

FINMAT 3	HERD CONC CONSUMPTION	R	C
FINMAT 4	CALF PASTURE CONSUMPTION	R	C
FINMAT 5	CUMULATIVE MJ ME IN CONC. FEEDS	R	C
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: PGR 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
FMCR	FASTING METABOLISM COEFF, < 6 MOS	R	ANLOOP
FMR	FASTING METABOLISM, AGE < 6 MOS	R	ANLOOP
FORNO	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
F5	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
IBAR	COUNT FOR EACH COW, CONSECUTIVELY BARREN	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-]

ICOD 9	FORAGE CODE: L 4-6	I		F
ICOMF	COMPETITION FUNCTION (0, 1)	I		PASMIP
ICON	COUNTER FOR VALID CONCEP 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 PARTB IF=1	I		F
IDELT	= DELT (>=6)	I		ANLOOP
IDYK	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		PASMIP
IFUS	COUNTER FOR FIRST PARTUMS THIS YEAR	I		SCALES
IGA	MONTHLY VARIABLE COSTS, CONVERTED TO CG	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 IHE	I	20	NXPANO
IOP	SWITCH USED IN GRE	I		SCALES
IPRDEL	CONTROLS LARGE OUTPUT 0,1	I		SCALES
IPREG	CONCEPTION FLAG	I		ANLOOP
IREP	ID NUMBERS OF INTERACTIVE REPLACEMENTS	I	200	F
IREPP	REPLACEMENT HEIFER COUNTER	I		INLOOP
IRUM	RUN TYPE (0=> KAHN ORIGINAL, 1=>OTHER)	R		SCALES
IRUN	0,1,2 CFW OR TAMU CFW - STERILE PROB FACTOR	I		ANLOOP
ISEL	ID NUMBERS OF INTERACTIVE BREEDER SELLINGS	I	200	F
ISELL	SELECTION FUNCTION TYPE (1-5)	I		PASMIP
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
IWSWCH	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	HERD 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-]

JY	CURRENT YEAR OF RUN	I		SCALES
KCUL	MAX. NO. DAYS SINCE LAST CALVING FOR AUTOCUL	I		F
KFA	REQUIRED HERD SIZE, INTERACTIVE	I		F
KF	VICOEF*WMX	R		MIXER
KL	ENERGY REQ FOR MILK, MJ ME/KG FCM	R		ANLOOP
KNA	DESIRED HERD SIZE	I		SCALES
LACT	ME INVESTED IN MILK PRODUCTION MJ/DAY	R		SCALES
LBAL	ENERGY BALANCE FOR LACTATION	R		ANLOOP
LDEP	LACTATION REDUCTION FACTOR, FROM LDEPF	R		ANLOOP
LDEPF	PREVIOUS MILK YIELD X LACTATION STAGE	R	2,3	B
LDM	VOL. INTAKE OF DM LIMITED BY CP, DIG, AVAIL.	R		SCALES
LDM1	ACTUAL LIMIT TO INTAKE OF SOLIDS, CALVES	R		ANLOOP
LFAC	LACTATION STAGE FACTOR, TISSUE MOBILIZATION	R		ANLOOP
LIA	WEANED ANIMAL NUMBER	I	300	NX
LOL	PASSED PARAMETER (1 GROWTH, 2 POSTCONSUMPTION)	I		PASMIP
LOMOS	LENGTH OF OLD (STORED) CASH FLOW IN MONTHS	I		INCREM
LT	LACTATION STAGE CLOCK INCREMENTOR	R		SCALES
LTIME	NO OF DAYS LACTATING	R		SCALES
LY	CURRENT MONTH OF RUN (CUMULATIVE)	I		EC
LYR	NO OF DAYS IN YEAR	I		SCALES
MAINT	ENERGY REQ FOR MAINTENANCE	R		ANLOOP
MAINTC	MAINT REQ. OF CALVES	R		ANLOOP
MANDAT	MANAGEMENT DATES (JULIAN) PER YEAR	I	2	F
MCOD	PHYS. STATE NUMBER ASSIGNED FOR ICOD (1 - 14)	I		MOBRAT
MCUL	NO. OF SUCC.NEG.PREG.TESTS FOR AUTOCUL	I		F
MDA	DAY NUMBER, PANEL VARIABLE	I		NXLOOP
MECONV	ME EQUIVALENT OF WCONV	R		ANLOOP
MEP	ME BALANCE FOR WEIGHT GAIN	R		ANLOOP
MEPC	ME FOR GAIN IN CALVES	R		ANLOOP
MEPWT	WT GAIN IN ADULTS AND WEANED CALVES	R		ANLOOP
MER	ME OF DAILY FEED CONSUMED, ADULTS + W.CS.	R		ANLOOP
MERC	ME OF DAILY FEED CONSUMED, CALVES	R		ANLOOP
MFA	MALE INCREASED BTH WT FACTOR A, ADULTS (10%)	R		SCALES
MFAC	MATURITY FACTOR	R		ANLOOP
MFACC	MALE INCREASED BTH WT FACTOR A, CALVES (10%)	R		SCALES
MFB	MALE INCREASED BTH WT FACTOR B, ADULTS	R		SCALES
MFBCC	MALE INCREASED BTH WT FACTOR B, CALVES	R		SCALES
MINT	INTEGER EAT CODE (= VV(IA,23))	I		MIXER
MINWT	MIN WT OF HEIFER CALVES AS REPLACERS	R		SCALES
MLOP	NO. OF COWS + FOLLOWERS, NA+NFOLS	I		INLOOP
MMOS	NUMBER OF MONTHS IN RUN	I		EC
MODE	RUN MODE 0-9 NO BUY 10-19 BUY IN	I		SCALES
MOP	OUTPUT PRINTED EACH MOP DAYS	I		PASMIP
MORE	FLAG FOR EOF LU15 - CAN'T BUY ANY MORE COWS	I		INLOOP
MY	= IY, OR = IY-1 IF NO REPLACERS	I		INLOOP
MYR	YEAR NUMBER, PANEL VARIABLE	I		NXLOOP
MYRS	NUMBER OF YEARS OF RUN	I		EC
NA	CUMULATIVE NO OF ANIMALS	I		NX----
NB	NO OF FEMALE CALVES IN HERD	I		SCALES
NCD	LENGTH OF ARRAY CDF	I		SCALES
NCF	LENGTH OF ARRAY CFDWF	I		SCALES
NCFW	LENGTH OF ARRAY CFWF	I		SCALES
NCP	LENGTH OF ARRAY CPF	I		SCALES

[Variable Name List -continued-]

NDIF	INTRODUCED PRINTOUT 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 360	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 YEAR	I		INLOOP
NFMC	LENGTH OF ARRAY FMCF	I		SCALES
NFOLS	NUMBER OF WEANED-UNSOLD-UNREPLACED ANIMALS	I		NX
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	NULL	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		NX
NPAD	NUMBER OF IMPROVED PASTURE PADDOCKS	I		E
NREP	NO OF REPLACERS WANTED	I		SCALES
NRES	RESOURCE I EATEN OR NO (0,1)	I	5	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		NX
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-]

OFRAT	MILK OFFTAKE RATE 0.0 - 1.0	R	EC
OLBAL	OLD BALANCE BY MONTH FROM LU12	R 24	INCREM
OUT ,32	NO COWS BOUGHT IN YEAR JY	R	D
OUT I,1	PAST CON, OLD PAST	R	D
OUT I,10	WEAN WT, OLD AVCW	R	D
OUT I,11	WEAN AGE, OLD AVCAGE	R	D
OUT I,12	COW AGE, OLD AVAGE	R	D
OUT I,13	NO REPLACED, OLD NNREP	R	D
OUT I,14	DEAD ADULTS, OLD NADEAD	R	D
OUT I,15	DEAD CALVES, OLD NCDEAD	R	D
OUT I,16	REP AGE, OLD REPAGE	R	D
OUT I,17	REP WT, OLD REPWT	R	D
OUT I,18	12 MO WT, OLD YEARWT	R	D
OUT I,19	SURV TO 12 MONTHS, OLD SURV12	R	D
OUT I,2	CONA CON, OLD CONA	R	D
OUT I,20	SURV TO 24 MONTHS, OLD SURV24	R	D
OUT I,21	24 MO WT, OLD YEARSW	R	D
OUT I,22	NO OF ABORTIONS, OLD NUMABS	R	D
OUT I,23	NO BIRTHS, OLD NUMBTS	R	D
OUT I,24	AGE AT FIRST PARTUM, OLD FUSPAR	R	D
OUT I,25	CONCEPTION INTERVAL, OLD CONINT	R	D
OUT I,26	HERD BIOMASS /100, OLD BIO	R	D
OUT I,27	NO OF ORPHANS, OLD NPREW	R	D
OUT I,28	NO OF ANIMAL UNITS IN HERD, OLD AUS	R	D
OUT I,29	NUMBER OF COWS >= 2 YRS	R	D
OUT I,3	CONB CON, OLD CONB	R	D
OUT I,30	COW WT, DRY EMPTY, END OF DRY SEASON	R	D
OUT I,31	COW WT, DRY EMPTY, END OF WET SEASON	R	D
OUT I,32	NUMBER COWS BOUGHT	R	D
OUT I,33	MILK OFFTAKE PRODUCTION	R	D
OUT I,4	CONC MEJ, OLD MEJ	R	D
OUT I,5	CALF SALES, OLD SALEC	R	D
OUT I,6	CULL SALES, OLD SALE	R	D
OUT I,7	CONCEPS, OLD YPREG	R	D
OUT I,8	B H FEMALES, OLD NFEM	R	D
OUT I,9	NO WEANED, OLD NOWEAN	R	D
OUT 20,I	ARRAY OF OUTPUT DATA, 20 YEARS	R	D
OUT 21,I	SUM OF 20 YEARS' DATA	R	D
OUT 22,I	NUMBER OF NON-ZERO YEARS	R	D
OUT 23,I	TRUE AVERAGE (EXCLUDES 0 IF NECESSARY)	R	D
OUT 24,I	SUM OF SQUARES	R	D
OUTNAM	PRODUCTION PARAMETERS ARRAY	C*8 33	INLOOP
P	PROP 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 - CDELT, PREVIOUS TIME INTERVAL, CALF	R	ANLOOP
PD	PROPORTION OF 1 L 2 G IN DIET	R 2	PASMIP
PDELT	CONCEPTION INTEGRATION PERIOD (IN EFFECT)	I	SCALES
PDM	PASTURE DM INTAKE	R	ANLOOP
PEST	PROB OF OESTRUS	R	ANLOOP
PESTCO	PROB AJUSTER FOR INTEGRATION STEP	R	ANLOOP

[Variable Name List -continued-]

PGR	POTENTIAL GROWTH RATE 1 L 2 G	R 2	PASMIP
PHD	AVERAGE PRICES PAID/RECEIVED PER HEAD PER YEAR	R 22,6	ECONOM
PLACT	PREVIOUS MILK ENERGY YIELD	R	ANLOOP
PLUS	DELT/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
PP	FRACTION OF COW ADULT WT REPRESENTING BIRTH WT	R	SCALES
PPDIF	SELECTS COWS WITH DIFFICULT PARTURITIONS (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'S 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 G 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 G	R 2	PASMIP
PT	PREGNANCY CLOCK INCREMENTOR	R	ANLOOP
PTIME	NO OF DAYS PREGNANT	R	SCALES
PWMC	PREVIOUS OPTIMAL CALF WEIGHT	R	ANLOOP
PX	PROPORTION OF 1 L 2 G IN SWARD	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
QC	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 VALUE OF LACT - NOT USED	R	ANLOOP
QM	EFFICIENCY OF ME UTE FOR MAINTENANCE	R	ANLOOP
QMILK	KG MILK PER MONTH	R 241	ECONOM
QQ	BIOMASS PER ANIMAL	R 5	E
RATE	GROWTH RATE PARAM (AMATZ=0.065, HERE=0.054?)	R	SCALES
RATEMK	RATE OF DECLINE OF MILK YIELD POST-PEAK	R	ANLOOP
RLAI	RESIDUAL LEAF AREA INDEX 1 L 2 G	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, CYCLING	R	ANLOOP
R6	RANDOM NUMBER, ABORTION	R	ANLOOP
R7	RANDOM NUMBER, OESTRUS	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	STORE 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	NX
START	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
SUPDIG	SUP FEED DIGESTIBILITY X TIME	R 2,40	C
SUPDMF	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	R	SCALES
TIMT	DATE, DAYS POST 1 NOV	R	SCALES
TIMX	DATE, DAYS POST 1 JAN	R	SCALES
TITLE	TITLE OF RUN	C*25	MAIN
TLACT	TOTAL MILK ENERGY PRODUCTION, LIFETIME	R	ANLOOP
TM	DM CONTENT OF CONSUMED MILK	R	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	MILK OFFTAKE SUMMER PER MONTH	R	EC
TRACT	ME REQS FOR TRACTIVE WORK	R	ANLOOP
TREN	TRACTIVE WORK 0,1,2	R	SCALES
TREND	LINEAR % INCREASE PER YEAR IN PRICE CYCLES	R 2	EC
TRIG	ADULT DEATH TRIGGER	R	ANLOOP
TRIGAB	ABORTION TRIGGER	R	ANLOOP
TRIGC	CALF DEATH TRIGGER	R	ANLOOP
TRIGP	CONCEPTION TRIGGER	R	ANLOOP
TSUPA	TOTAL CONC CONSUMPT, LIFETIME	R	ANLOOP
TSUPB	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 G	R 2	PASMIP

[Variable Name List -continued-]

VA	V(1) AS T/HA (LEGUME)	R		PASMIP
VB	V(2) AS T/HA (GRASS)	R		PASMIP
VICOEF	= VIP	R		SCALES
VIF	PROP INCREASE IN VIP IN LACTATING COWS	R		ANLOOP
VIP	DM INTAKE COEF, FAECAL DM OUTPUT/KG/LWT/DAY	R		SCALES
VM	TOTAL BIOMASS LEG+GRASS	R		PASMIP
VPAD I,1	ROTATIONAL IP PADDOCKS - LEGUME BIOMASS	R	5,4	E
VPAD I,2	GRASS BIOMASS	R	5,4	E
VPAD I,3	AREA	R	5,4	E
VPAD I,4	DAYS OF OCCUPANCY	R	5,4	E
VR	BIOMASS - RESIDUAL UNGRAZEABLE 1 L 2 G	R	2	PASMIP
VRES		R	5	F
VV I,1	SEX OF ITH ANIMAL 1=F 2=M	R		NX
VV I,10	PREG STAGE DAYS (PTIME)	R		NX
VV I,11	POST-PARTUM STAGE DAYS (APTIME)	R		NX
VV I,12	CALF AGE DAYS (CTIME)	R		NX
VV I,13	LACTATION STAGE, DAYS (LTIME)	R		NX
VV I,14	WMC, CW	R		NX
VV I,15	CALF SEX (CSEX)	R		NX
VV I,16	TLACT	R		NX
VV I,17	TDLACT	R		NX
VV I,18	NO OF LIVE CALVES	R		NX
VV I,19	THERBL	R		NX
VV I,2	AGE IN YEARS	R		NX
VV I,20	DATE (ITIME) OF LAST CONCEPTION	R		NX
VV I,21	TSUPA	R		NX
VV I,22	AGE AT LAST CALVING	R		NX
VV I,23	EAT CODE FOR MOB GRAZING	R		NX
VV I,24	NO OF ANIMAL UNITS	R		NX
VV I,25	WMC	R		NX
VV I,26	WM	R		NX
VV I,27	CALF MOB CODE	R		NX
VV I,3	COW MATURE WEIGHT	R		NX
VV I,4	COW IDENTITY NUMBER	R		NX
VV I,5	WEIGHT	R		NX
VV I,6	TDM	R		NX
VV I,7	TSUPB	R		NX
VV I,8	DEST	R		NX
VV I,9	PHYSIOLOGICAL STATUS	R		NX
W	WEIGHT, KG	R		SCALES
WAV	AVERAGE-WEIGHT-OF-COWS CUMULATOR	R		INLOOP
WCONV	MAX TISSUE MOBILISTAION FOR LACTATION	R		ANLOOP
WFAC	WT INDEX FACTOR FOR TISSUE MOBILISATION	R		ANLOOP
WM	POTENTIAL WEIGHT, KG	R		SCALES
WMA	MATURE WEIGHT	R		SCALES
WMAX	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
WMF	ADULT FEMALE WT OF BREED	R		SCALES
WMM	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	SCALES
WF	COW LW INCLUDING PREG OR CALF LW INC GUT FILL	R	ANLOOP
WFREG	WT INCREMENT DUE TO PREGNANCY	R	ANLOOP
WTDIF	DIFFERENCE BETWEEN OPTIMAL AND ACTUAL CALF WT	R	ANLOOP
WW	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	INCREM
ZINC	DELT/270	R	ANLOOP
ZJM	REAL JM	R	ANLOOP
ZJY	REAL JY	R	ANLOOP
ZM	PRODUCTION, KG/AN/YR	R	INLOOP
ZMILK	MILK OFFTAKE PROD PER YEAR	R 241	ECONOM
ZN	PRODUCTION, KG/AN/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 M is shown as *i* M, where *i* is the variable type.

Location - if A, B, C, D, E, EC, F, 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 00 :

JAN 1987 RUSMOB V4.2 CIAT : PKT

INTERACTIVE

RUN COMPLETE

OUTPUT IS STORED IN THE FOLLOWING FILES:

OUTPUT FT6 (ANIMAL PERFORMANCE)
PASTO FT9 (FORAGE RESOURCES)
CASHFLO FT11 (ECONOMIC ANALYSES)

_@@

PF1 - QUIT

Rusmob 01 :

JAN 1987 RUSMOB V4.2 CIAT : PKT

INTERACTIVE

JULIAN DATE (YR DAYS) _@@ _@@@

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                          RUSMOB   V4.2                        CIAT : PKT
                                    INTERACTIVE

                   JULIAN DATE (YR DAYS)        _@@ _@@@


                              SELECT NEXT HALT DATE

                              YEAR                 _@@
                              JULIAN DAY NUMBER _@@@


              PF1 - MAIN MENU     PF2 - ENTER     PF9 - ABANDON

--------------------------------------------------------------------------------
Rusmob 03 :
--------------------------------------------------------------------------------
 JAN 1987                          RUSMOB   V4.2                        CIAT : PKT
                                    INTERACTIVE

                                 MANAGEMENT MENU
                              DATE (YR DAYS)   _@@  _@@@

                               BUY 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 04 :

```
JAN 1987                          RUSMOB   V4.2                            CIAT : PKT
                                   INTERACTIVE

               BREEDING HERD ANIMAL DISPLAYER  :  PANEL_@@ OF_@@

   ID    AGE       WT    NORM WT    DAYS PREG     DAYS LACT   AGE LAST CALF
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000

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

Rusmob 05 :

```
JAN 1987                          RUSMOB   V4.2                            CIAT : PKT
                                   INTERACTIVE

               FOLLOWERS HERD ANIMAL DISPLAYER  :  PANEL_@@ OF_@@

                ID      SE          WT         NORM WT       AGE
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000
              _000000000000000000000000000000000000000000000000000

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

Rusmob 06 :

JAN 1987 RUSMOB V4.2 CIAT : PKT
INTERACTIVE

CALVES DISPLAYER : PANEL_@@ OF_@@

```
DAM ID      SE         WT         NORM WT     AGE (DAYS)
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
_0000000000000000000000000000000000000000000000000
```

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

Rusmob 07 :

JAN 1987 RUSMOB V4.2 CIAT : PKT
INTERACTIVE

PASTURE STATUS

	-----SAVANNA-----			---IMPROVED---	
	1	2	3	LEGUME	GRASS
AREA HA	_@@@@@	_@@@@@	_@@@@@	_@@@@@	_@@@@@
BIOMASS KG DM / HA	_@@@@@	_@@@@@	_@@@@@	_@@@@@	_@@@@@
RESIDUE KG / HA	_@@@@@	_@@@@@	_@@@@@	_@@@@@	_@@@@@
PERCENT DIGESTIBILITY	_@@	_@@	_@@	_@@	_@@
PERCENT CRUDE PROTEIN	_@@	_@@	_@@	_@@	_@@
AVALABILITY KG / AU	_@@@@	_@@@@	_@@@@	_@@@@	_@@@@

PF1 - MAIN MENU PF9 - ABANDON

Rusmob 08 :

```
----------------------------------------------------------------------------------------
 JAN 1987                            RUSMOB   V4.2                                 CIAT : PKT
                                      INTERACTIVE

                          CASHFLOW  DISPLAYER  :  PANEL_@@ OF_@@

                      YEAR   MONTH          SALES          COSTS        BALANCE
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000
                      _0000000000000000000000000000000000000000000000000

      CUMULATIVE TO DATE        _0000000000000000000000000000000000

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

Rusmob 09 :

```
----------------------------------------------------------------------------------------
 JAN 1987                            RUSMOB   V4.2                                 CIAT : PKT
                                      INTERACTIVE



                    RRRRRR    U    U    SSSSSS    M    M     OOOO     BBBBB
                    R    R    U    U    S         MM  MM    O    O    B    B
                    RRRRRR    U    U     SSSS     M MM M    O    O    BBBBB
                    R  R      U    U         S    M    M    O    O    B    B
                    R    R     UUUU     SSSSSS    M    M     OOOO     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
                                            _@


                              PF1 - START RUN    PF9 - ABANDON

----------------------------------------------------------------------------------------
```

Rusmob 10 :

```
--------------------------------------------------------------------------------
 JAN 1987                          RUSMOB   V4.2                       CIAT : PKT
                                    SEMI  BATCH

                          RUN NAME  _@@@@@@@@@@@@@@@@@@@@@@@@@@

  RUN CONTROLS            RANDOM NUMBER SEED   (NSEED)    _@@@@
                          RUN TYPE             (IRUM)        _@
                          RUN MODE             (MODE)       _@@
                          RUN LENGTH, DAYS     (FINTIM)   _@@@@
                          CASH FLOW FLAG       (NIND)        _@
                          TIME STEP, DAYS      (DELT)       _@@
                          ANNUAL STOP DAY NOS  (ISTOD)     _@@@    _@@@
                                                           _@@@    _@@@
  HERD CONTROLS           POTENTIAL MILK YIELD (PMA)      _@@@@
                          INITIAL HERD SIZE    (NA)         _@@

  FORAGE (IRUM=1)         ----SAVANNA----      IMPROVED PASTURE
                          1       2       3     GRASS   LEGUME
    AREAS             _@@@@@@ _@@@@@@ _@@@@@@      _@@@@@@
    BIOMASS            _@@@@@  _@@@@@  _@@@@@  _@@@@@   _@@@@@

                             PF1 - START RUN    PF9 - ABANDON

--------------------------------------------------------------------------------
```

Rusmob 11 :

```
--------------------------------------------------------------------------------
 JAN 1987                          RUSMOB   V4.2                       CIAT : PKT
                                   INTERACTIVE

                          EVENT DISPLAYER  :  PANEL_@@ OF_@@

    DAY  YR  MO   EVENT  ANIMAL  SEX  AGE   W     WM   DAM-ID    AGE   W     WM
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000
  _000000000000000000000000000000000000000000000000000000000000000000000000000000

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

--------------------------------------------------------------------------------
```

Rusmob 21 :

```
JAN 1987                         RUSMOB   V4.2                         CIAT : PKT
                                 INTERACTIVE

                  ADDITIONAL ECONOMIC ANALYSIS NUMBER _@@


      VARIABLE COSTS PER HEAD ($)                     _@@@@
      PRICE CYCLE AMPLITUDES (PERCENT)                _@@@@      _@@@@
      ANNUAL PRICE TRENDS (PERCENT)                   _@@@@      _@@@@
      PRICE CYCLE LENGTHS (YEARS)                     _@@@@      _@@@@
      PRICE CYCLE STARTING POINTS                     _@@@@      _@@@@
      INITIAL PRICES  COWS BOUGHT ($/HD)           _@@@@@@@
                      CULL COWS ($/KG)                _@@@@@
                      CALVES SOLD ($/KG)            F_@@@@@    M_@@@@@
                      FOLLOWERS SOLD ($/KG)         F_@@@@@    M_@@@@@
      MILK PRICE ($/LITRE)                            _@@@@


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

Rusmob 22 :

```
JAN 1987                         RUSMOB   V4.2                         CIAT : PKT
                                 INTERACTIVE

                  ADDITIONAL ECONOMIC ANALYSIS NUMBER _@@

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

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

Rusmob 30 :

```
JAN 1987                    RUSMOB   V4.2                    CIAT : PKT
                            INTERACTIVE

                 CHANGE BREEDING SEASON BY MONTH
                     DATE (YR DAYS) _@@ _@@@


                 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
     CURRENT  :  _@  _@  _@  _@  _@  _@  _@  _@  _@  _@  _@  _@
     CHANGE TO:  _@  _@  _@  _@  _@  _@  _@  _@  _@  _@  _@  _@

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


       PF1 - MANAGEMENT MENU     PF2 - ENTER     PF9 - ABANDON
```

Rusmob 31 :

```
JAN 1987                    RUSMOB   V4.2                    CIAT : PKT
                            INTERACTIVE

                BURN SAVANNA (TYPES 1, 2 AND/OR 3)
                     DATE (YR DAYS)  _@@ _@@@

                         SAVANNA 1      SAVANNA 2      SAVANNA 3

      AREA HA              _@@@@@         _@@@@@         _@@@@@
      UNBURNT BIOMASS KG/HA _@@@@@        _@@@@@         _@@@@@
      BURNT BIOMASS KG/HA  _@@@@@         _@@@@@         _@@@@@

              BURN           _1             _2             _3

       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                          CIAT : PKT
                                  INTERACTIVE

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


             MINIMUM AGE AT WEANING, DAYS                           _@@@
             DEFAULT ANNUAL MANAGEMENT DATES                  _@@@   _@@@
             MA IMUM 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               _@
             MILK OFFTAKE RATE (0.0 TO 1.0)                        _@@@@@
             FIXED MILK PRICE, $/LITRE                             _@@@@@

          PF1 - MANAGEMENT MENU     PF2 - ENTER     PF9 - ABANDON

--------------------------------------------------------------------------------
```

Rusmob 33 :

```
--------------------------------------------------------------------------------
 JAN 1987                        RUSMOB   V4.2                          CIAT : PKT
                                  INTERACTIVE

                    BREEDING HERD  :  CULL  :  PANEL_@@ OF_@@

     ID    AGE       WT     NORM WT    DAYS PREG    DAYS LACT    AGE LAST CALF
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000
   _000000000000000000000000000000000000000000000000000000000000000000000000000

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

--------------------------------------------------------------------------------
```

Rusmob 34 :

```
------------------------------------------------------------------------------
 JAN 1987                        RUSMOB   V4.2                      CIAT : PKT
                                  INTERACTIVE

                FOLLOWERS HERD  :  SELL  :  PANEL_@@ OF_@@

                     ID      SEX          WT         NORM WT        AGE
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000

          TO SELL ANIMALS, PLACE CURSOR ON RELEVANT LINE AND HIT ENTER
    PF1 - MANAGEMENT MENU    PF2 - BACK     PF4 - FORWARD     PF9 - ABANDON

------------------------------------------------------------------------------
```

Rusmob 35 :

```
------------------------------------------------------------------------------
 JAN 1987                        RUSMOB   V4.2                      CIAT : PKT
                                  INTERACTIVE

                      CALVES  :  WEAN  :  PANEL_@@ OF_@@

                   DAM ID      SEX        WT         NORM WT     AGE (DAYS)
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000
                   _00000000000000000000000000000000000000000000000000000

              TO WEAN, PLACE CURSOR ON RELEVANT LINE AND HIT ENTER
    PF1 - MANAGEMENT MENU    PF2 - BACK     PF4 - FORWARD     PF9 - ABANDON

------------------------------------------------------------------------------
```

Rusmob 36 :

```
JAN 1987                             RUSMOB   V4.2                           CIAT : PKT
                                     INTERACTIVE

                NEW BREEDING ANIMALS :  BUY  : _@@ ANIMALS IN HERD

                 AGE    WEIGHT    MAX WT     DAYS PREG    HERD ID
                _0000000000000000000000000000000000000000000
                _0000000000000000000000000000000000000000000
                _0000000000000000000000000000000000000000000
                _0000000000000000000000000000000000000000000
                _0000000000000000000000000000000000000000000
                _0000000000000000000000000000000000000000000
                _0000000000000000000000000000000000000000000
                _0000000000000000000000000000000000000000000
                _0000000000000000000000000000000000000000000
                _0000000000000000000000000000000000000000000

 ===>   COW AGE (MOS)_@@   WEIGHT_@@@   MATURE WEIGHT_@@@   DAYS PREGNANT_@@@

     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 : PKT
                                     INTERACTIVE

                PASTURE MANAGEMENT   :  DATE (YRS DAY) _@@ _@@@

CHANGE PASTURES :
   AREA    SAVANNAS _@@@@@   _@@@@@   _@@@@@      IMPROVED   _@@@@@
   BIOMASS          _@@@@@   _@@@@@   _@@@@@      LEGUME _@@@@@  GRASS _@@@@@

CHANGE MOB CODES :
                        (MOS)                                      (YRS)
   BREEDERS   PREGNANT  1-3    _@@@@@       FOLLOWERS    FEMS  TO 2    _@@@@@
                        4-6    _@@@@@                             2-3    _@@@@@
                        7-9    _@@@@@                              4+    _@@@@@
              LACTATING 1-3    _@@@@@                    MALES TO 2    _@@@@@
                        4-6    _@@@@@                             2-3    _@@@@@
                        7-9    _@@@@@                              4+    _@@@@@
              HEIFERS          _@@@@@
              DRY EMPTY        _@@@@@
              CALVES           _@@@@@

 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 38 :

```
-----------------------------------------------------------------------------------
 JAN 1987                          RUSMOB    V4.2                          CIAT : PKT
                                    INTERACTIVE

    FOLLOWERS FOR REPLACERS : PANEL_@@ OF_@@ : HERD SIZE_@@ ( SIZE WANTED_@@ )

                  ID      SEX          WT         NORM WT       AGE
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000
               _0000000000000000000000000000000000000000000000000000

         TO PICK REPLACERS, PLACE CURSOR ON RELEVANT LINE AND HIT ENTER
    PF1 - MANAGEMENT MENU    PF2 - BACK     PF4 - FORWARD     PF9 - ABANDON

-----------------------------------------------------------------------------------
```

Rusmob 39 :

```
-----------------------------------------------------------------------------------
 JAN 1987                          RUSMOB    V4.2                          CIAT : PKT
                                    INTERACTIVE

               NEW FOLLOWERS  :  BUY  : _@@ ANIMALS IN FOLLOWERS HERD

                     AGE    WEIGHT   MAX WT     SEX     HERD ID
                     _0000000000000000000000000000000000000000
                     _0000000000000000000000000000000000000000
                     _0000000000000000000000000000000000000000
                     _0000000000000000000000000000000000000000
                     _0000000000000000000000000000000000000000
                     _0000000000000000000000000000000000000000
                     _0000000000000000000000000000000000000000
                     _0000000000000000000000000000000000000000
                     _0000000000000000000000000000000000000000
                     _0000000000000000000000000000000000000000

      ===> ANIMAL AGE (MOS)_@@   WEIGHT_@@@   MATURE WEIGHT_@@@   SEX_@

     TO BUY, ENTER RELEVANT INFORMATION ON DATA ENTRY LINE, THEN HIT ENTER

                     PF1 - MANAGEMENT MENU       PF9 - ABANDON

-----------------------------------------------------------------------------------
```

Rusmob 40 :

```
----------------------------------------------------------------------------------
 JAN 1987                        RUSMOB   V4.2                          CIAT : PKT
                                 INTERACTIVE

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


       NUMBER OF PADDOCKS (1-5)      _@

                           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


           PF1 - 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    LEPF      CDF      FMCF
SUPDMF   SUPDIG   HSF      SUPCPF   SEASON
     2       2       2       2       2       2       2       2       2       2       2       2
     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   0000.0     0.0     0.0   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    28
     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      30    300      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    .83       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
```

[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.     0.
   2  1  1.0  160.   448.     0.     0.     0.     0.     0.     0.     0.
   3  1  1.0  150.   447.     0.     0.     0.     0.     0.     0.     0.
   4  1  1.0  155.   448.     0.     0.     0.     0.     0.     0.     0.
   5  1  2.0  200.   450.     0.     0.     0.     0.     0.     0.     0.
   6  1  2.0  215.   449.     0.     0.     0.     0.     0.     0.     0.
   7  1  2.0  195.   448.     0.     0.     0.     0.     0.     0.     0.
   8  1  2.0  210.   449.     0.     0.     0.     0.     0.     0.     0.
   9  1  2.0  205.   448.     0.     0.     0.     0.     0.     0.     0.
  10  1  2.0  185.   449.     0.     0.     0.     0.     0.     0.     0.
  11  1  3.0  270.   450.     0.     0.     0.     0.     0.     0.     0.
  12  1  3.0  250.   445.     0.     0.     0.     0.     0.     0.     0.
  13  1  3.0  260.   443.     0.     0.     0.     0.     0.     0.     0.
  14  1  3.0  280.   442.   180.     0.     0.     0.     0.     0.   -90.
  15  1  3.0  290.   452.   210.     0.     0.     0.     0.     0.   -60.
  16  1  3.0  285.   441.   210.     0.     0.     0.     0.     0.   -60.
  17  1  4.0  300.   440.     0.     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 8.5 SAMPLE EDITED DATA OUTPUT FILES - UNITS 6, 7, 8, 9, 10, 11 & 13

Logical Unit 6

```
RUSMOB 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     BIDL = 40000.
AREA = 400.0      JEV = 1        JHERD = 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      WMR      EXTRA APDELT SUPROP ICCC
0.0094    1.40  100.00   15.00     1.00     0.00 10.0      0.0    0

WWEAN MANDAT(1) MANDAT(2) CCUL MCUL KCUL SWTF SWTM  SAGEF SAGEM IDEFLA
 270     210     330       12.0  6      0   0.0   0.0  0.0  0.0     0
   DFRAT  PREIS
   0.000   32.0
 NDIG  NCP  NDM   NCFW NCF NDMLIM NLD NCD NFMC NSUP  NDIGS
  14   14   12    5    5    6    3    6    5   28     0

ACF
 2.00  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  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
LEPF
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
FMCF
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-]

FORAGE MOB CODES. TIME= 0 0.
10001 10001 10001 10001 10001 10001 10001 10001 10001 10001
10001 10001 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	373	MALE	0.81	138.72					
32	374	MALE	0.78	137.16					
33	375	FEM	0.78	131.48					
34	376	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.	2889.	1925.	2207.	1999.	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.	8198.	8472.	8312.	8407.	8515.	7633.	7472.	6646.
CPS	1731.	1233.	1539.	1842.	1810.	1452.	2023.	2090.	2364.	2321.
YR:	113939.9	AV:	113719.2							
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-]

7 PAS	6890.	7283.	7873.	8319.	8260.	8422.	8562.	7358.	7218.	6953.
CPS	2076.	1468.	1392.	1717.	1929.	2289.	2743.	1938.	1363.	1859.
YR:	112250.2	AV:	113719.2							
8 PAS	7280.	7844.	8504.	8782.	8934.	8884.	9016.	7440.	7300.	7132.
CPS	1413.	1467.	1137.	1723.	1557.	1422.	1740.	1998.	2244.	2531.
YR:	116119.3	AV:	113719.2							
9 PAS	6895.	7429.	8282.	8630.	8642.	8572.	8595.	7363.	7147.	6906.
CPS	2014.	949.	1481.	1860.	2293.	2663.	3128.	2515.	2751.	3017.
YR:	119199.9	AV:	113719.2							
10 PAS	6853.	7281.	7834.	8161.	8341.	8583.	8621.	7884.	7592.	7474.
CPS	966.	559.	1243.	1551.	1893.	2184.	2471.	2480.	2360.	2190.
YR:	115149.6	AV:	113719.2							

YEARLY PRODUCTION TABLE

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YR	1	2	3	4	5	6	7	8	9	10		
CALF SLS	100.44	3306.05	3643.84	2226.32	2248.69	1718.30	2286.58	2523.81	2778.07	2096.19	2292.83	60892960.00
CULL SLS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	443.66	426.07	420.11	128.98	554857.94
CONCEPS	34.00	25.00	23.00	24.00	26.00	23.00	23.00	23.00	25.00	27.00	25.30	6503.00
P H FEMS	30.00	30.00	30.00	30.00	30.00	30.00	29.00	30.00	30.00	30.00	29.90	9841.00
NO WEAND	3.00	25.00	22.00	20.00	20.00	17.00	15.00	19.00	18.00	17.00	17.60	3406.00
WEAN WT	126.96	148.47	158.88	150.82	146.95	147.22	143.53	150.29	152.00	151.28	147.64	218598.44
WEAN AGE	0.63	0.73	0.75	0.72	0.72	0.73	0.74	0.73	0.75	0.75	0.72	5.26
COW AGE	7.97	8.81	9.96	9.82	8.85	7.58	9.20	8.75	8.54	10.24	8.98	812.14
NO REPLD	2.00	3.00	1.00	5.00	7.00	6.00	1.00	6.00	3.00	1.00	3.50	171.00
DEAD ADS	2.00	3.00	1.00	5.00	7.00	6.00	2.00	5.00	2.00	0.00	3.30	157.00
DEAD CLS	1.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00	2.00	1.00	0.70	9.00
REP AGE	0.75	1.00	0.92	1.01	0.94	0.96	1.37	1.16	1.12	0.92	1.01	10.55
REP WT	137.53	161.49	168.46	168.11	159.76	160.89	196.63	174.79	175.85	156.55	166.01	277684.94

[Unit 6 -continued-]

12 MO WT										161.41	260713.06
	154.92	157.95	161.03	171.97	161.82	162.83	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										230.02	530131.12
	201.67	230.97	226.66	233.65	241.13	233.83	235.30	228.82	233.34	234.85	
NO 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	
NO BTHS										20.40	4238.00
	17.00	24.00	21.00	24.00	20.00	20.00	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	
NO 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	20.00	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	0.00	

TRUE AVERAGES :	BH FEMS	>=2	FOLS	<1,>=2	CALVES	FOLS>2	AU.5
	29.07	25.35	4.69	1.64	13.59	0.00	39.62

PRODUCTION SUMMARY
****

CONCEP %	84.62	WEAN %	58.86	COWMORT%	11.04
AGE1CALF	3.03	WEAN WT	147.64	COW INT	379.89
12 MO WT	161.41	24 MO WT	230.02	1YR SUR%	96.57
KG/AN/YR	81.00	KG/AU/YR	68.37	ETESPROD	76.33
CALFMORT	3.43	ETES 2	70.07		

[Unit 6 -continued-]

WEIGHT AGAINST CONCEPTION
****

WT *	ALL NO	CP	* HEF 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
	8.739		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.	33.	15	3.17	276.	398.
60	1	3	BTH	*	16	FEM	0.00	25.	29.	16	3.17	270.	389.
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.	392.
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	*	22	FEM	5.32	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.

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Logical Unit 7

1	0	1	1	129.00	193.59	-0.177	20.846	20.901	-3.151
1	30	1	2	126.45	207.07	0.027	24.183	20.438	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	4.519
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	C	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	3.193	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	0.600	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	230.909	0.009	0.000	0.800	0.000
=	0.000	0.000	0.000	0.000			

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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)	QQ(1)	QQ(2)
QQ(3)	QQ(4)	QQ(5)	D(1)	D(2)	D(3)	D(4)
D(5)	E(1)	E(2)	E(3)	E(4)	E(5)	BIO(1)
BIO(2)	BIO(3)	BIO(4)	BIO(5)	***	FORNO(1)	FORNO(2)
FORNO(3)	FORNO(4)	FORNO(5)	ESUM(1)	ESUM(2)	ESUM(3)	ESUM(4)
ESUM(5)	DIGX	CPA	LDM	ALDM	HERBDM	CPLC
LDM1	WMC	WMX	VICOEF	VV(IA,23)	VV(IA,24)	QA(1)
QA(2)	QA(3)	QA(4)	QA(5)			

Logical Unit 9

RUSMDB V4.2 : IP ALL 10 YRS
****

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* LU9: PASTURE OUTPUT *
****

AREAS : 0.00 0.00 0.00 60.00 60.00

DAY	NO.	BIO	FORNO	P	D	ESUM	QQ	QC	ECDW	ECAR	QA
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	2132.13	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	2383.71	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	787.49	1448.35	3500.18	787.49	0.00	1448.35
55	4	1236.44	29.00	0.252	0.570	274.11	513.52	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	1393.98	4135.46	881.55	0.00	1393.98
75	4	1065.38	35.60	0.201	0.615	227.11	361.40	1072.16	227.11	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

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Logical Unit 10

RUSMOD V4.2 : IP ALL 10 YRS
##

####################
LU10: PASMOD 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	0.00	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	0.30	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	BIO4	BIO5	BTOT	+---AGR---+		+---PGR---+		+---PD---+		+--RLAI--+		+--COMP--+		+---PSM---+		+-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	1267.1	2382.8	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	27.28	69.62	27.28	69.62	0.44	0.56	1.96	3.25	0.28	0.72	6.83	10.02	1.00	1.00
15	1302.0	1843.5	3145.5	24.20	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	1314.8	3291.6	4606.4	13.55	87.23	13.55	87.23	0.29	0.71	1.20	3.90	0.13	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	48.55	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

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Logical Unit 11

RUSMOB V4.2 : IP ALL 10 YRS
****

****
* LU11: ECONOMIC SUMMARY *
****

ANALYSIS PARAMETERS (AMP TRE CYC START PRINITS*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

NO	TOT +	TOT -	BAL	CULSLS	CRFSLS	FDLSLS	HERDCAP	CAPCOST	COWBUY	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.	8345.	-8345.	0.	0.	0.	0.	0.	0.	8345.	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 0.0955909 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	($/HD)	------------	------------	($/KG)	------------	------------
	COW-BUY	CULLCOWS	CALVES-F	CALVES-M	FOLLOWERS-F	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	118.11	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

Logical Unit 13

```
BEG :
    5177       1       2    3600       0       5
      30     330       0       0    5.00      30  400.00    40000
 30.00   0.00   0.00   5.00   5.00   3000      0       0     400     400     1
LEBDOS SAVANNA
MENU :
     0    14
MAN :
    50    14
FOR :
  30   1  50    30.00      0.00      0.00      5.00      5.00
   2822.0       0.0       0.0     716.0    1621.0       11001 11000 11001 11000
 11001 11000 11000 11000 11000 11000 11000 11000 11000 11000
MAN :
     1     0
MENU :
    50     0
MENU :
     0    12
MENU :
     0    14
MAN :
    50    14
FOR :
 330   1  50    30.00      0.00      0.00      0.00      0.00
   9952.0       0.0       0.0       0.0    5668.0       11000 11000 11000 11000
 11000 11000 11000 11000 11000 11000 11000 11000 11000 11000
MAN :
     1     0
MENU :
    50     0
MENU :
    50     0
MENU :
     0     9
MENU :
    50     0
MENU :
    50     0
MENU :
     0    14
MAN :
    50     9
CUL :
  330    3    1
 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 0-2 0-2 0 0 0 0 0
MAN :
     1     0
```

Unit 13 -continued-]

```
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.6 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 PASDUMP FT10 A
FILEDEF FT11F001 DISK CASHFLO FT11 A
FILEDEF FT12F001 DISK INCFLO FT12 A1 (XTENT 242
FILEDEF FT13F001 DISK NXOUT  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	MOBGRA			6
26	MOBRAT			
27	MOVE			
28	NUMPRT			
29	NXBEG0	30 31		
30	NXBEG1	5 71 84 85		
31	NXBEG2	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	NXCAL0	37		
37	NXCAL1	5 14 71 84 85		
38	NXCAS0	39		
39	NXCAS1	5 14 71 84 85		
40	NXCUL0	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	NXFOL0	47 89		
47	NXFOL1	5 14 71 84 85		
48	NXFOR1	5 13 14 20 27 66 71 76 84 85		

#	Routine	Contains Calls To	Reads From #	Writes To #
49	NXHERO	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	NXPANO	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
67	NXSYS1	5 13 14 20 27 71 76 84 85		
68	NXWEAO	69 89		
69	NXWEA1	5 13 14 20 27 71 84 85		
70	PAN	19		
71	PANEL2			
72	PASMIP	11 21 83		10
73	PRICE			
74	PTBINT	1		4 5
75	RANDOM			
76	RAN2			
77	REALIN	5 13 27 84		
78	RELEAS			
79	ROTGRA	72		10
80	SAV1	21		
81	SAV2	21		
82	SAV3	21		
83	SEGLIN			
84	STRING			
85	TABLE			
86	WAIT	18		
87	-null-			
88	ZEROI1			
89	ZEROI2			
90	-null-			
91	ZERORO			
92	ZEROR1			
93	ZEROR2			
94	ZEROR3			
95	ZIR	92		11