

PRELIMINARY MODELS FOR ESTIMATION OF CARRYING CAPACITY FOR HUMAN POPULATIONS
IN A COLONIZATION AREA OF THE TRANSAMAZON HIGHWAY, BRAZIL

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1972

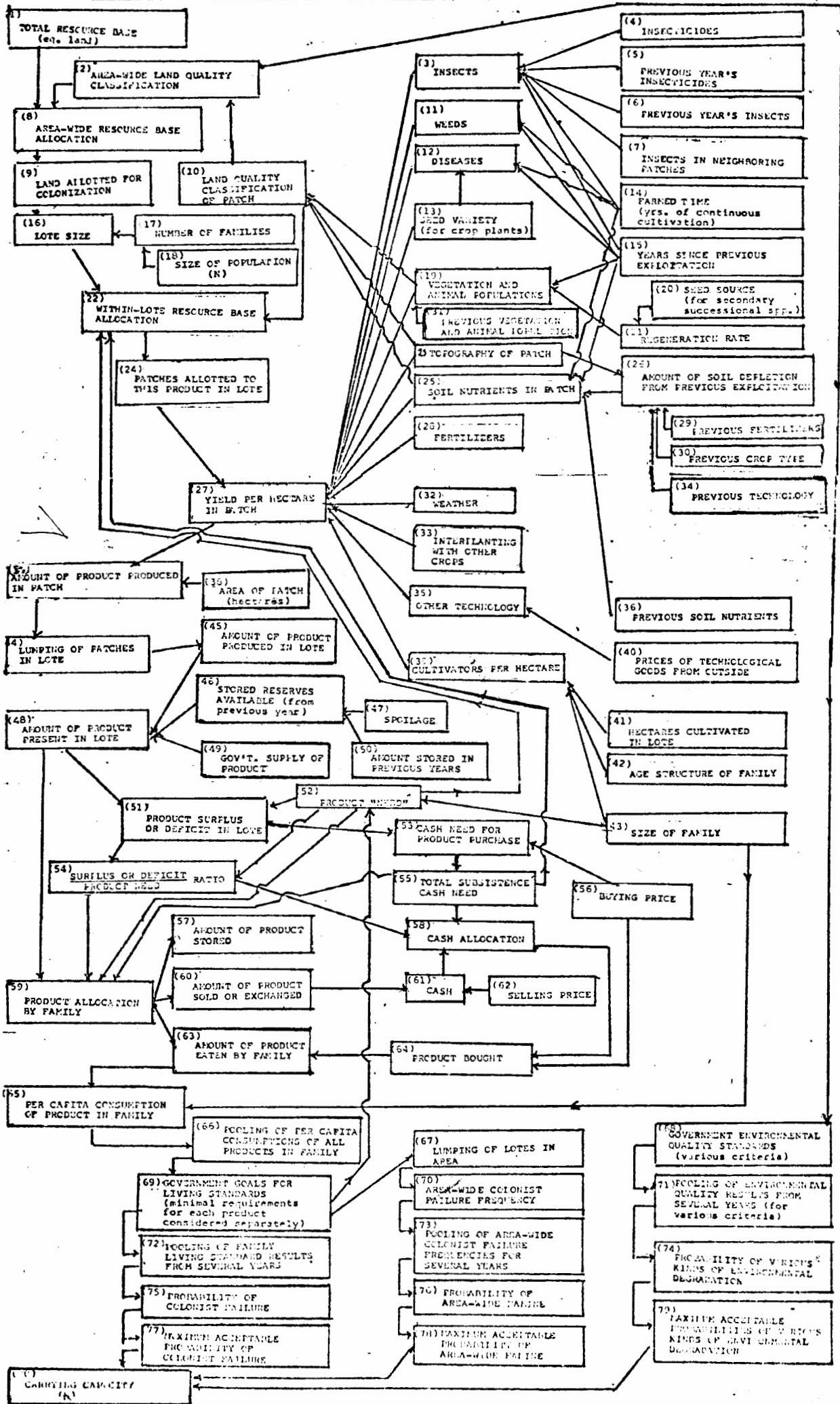
TABLE OF CONTENTS

I.)	INTRODUCTION	p. 1
II.)	FLOW CHART OF CARRYING CAPACITY RELATIONSHIPS	p. 2
III.)	DESCRIPTION OF FLOW CHART OF CARRYING CAPACITY RELATIONSHIPS ..	p. 3
IV.)	FLOW CHART OF SKELETON CARRYING CAPACITY PROGRAM	p. 8
V.)	DESCRIPTION OF SKELETON CARRYING CAPACITY PROGRAM	p. 9
VI.)	DESCRIPTION OF SAMPLE INPUT AND OUTPUT FOR SKELETON PROGRAM ...	p.14
VII.)	APPENDICES:	
	APPENDIX A: Table Describing Flow Chart of Carrying Capacity Relationships	p.16
	APPENDIX B: Skeleton Carrying Capacity Program	p.45
	APPENDIX C: Sample Input and Output for Skeleton Carrying Capacity Program	p.56
	APPENDIX D: Abbreviations used in Skeleton Carrying Capacity Program	p.58
	APPENDIX E: Partial List of Assumptions for Skeleton Carrying Capacity Program	p.66
VIII.)	LITERATURE CITED	p.71

I.) INTRODUCTION:

The following descriptions and accompanying tables and figures describe the beginnings of a series of models for the estimation of carrying capacity to be applied to a portion of the colonization area along the Transamazon Highway in Brazil. It should be emphasized that this is not "The" model for carrying capacity, but only a skeleton which will be altered many times before a series of estimates is complete. What will eventually be produced is not a single model or estimate, but an array of estimates based on different combinations of assumptions. The preliminary models presented here lay the groundwork for a series of stochastic models of carrying capacity. The skeleton computer program presented (Appendix B), although deterministic in the form used to produce the sample output (Appendix C), has been written in such a way that a simple substitution of a frequency distribution generating function for the fixed yield inputs would produce a result which is stochastic with respect to crop yields. The program has been written such that it can be modified and added to with maximum ease.

Data collection methods to be used in obtaining information for use in modifying the model and in making the carrying capacity calculations have been described in my proposal: "Estimation of Carrying Capacity for Human Populations in a Colonization Area of the Transamazon Highway, Brazil." (Fearnside, 1973). Background information on carrying capacity determination methods and agricultural potential in the Transamazon area can also be found in the proposal. The tremendous scale of the colonization programs being realized in the Amazon Basin, together with both the theoretical and great potential human importance of reliable carrying capacity estimates, are emphasized in the original proposal.



III.) DESCRIPTION OF FLOW CHART OF CARRYING CAPACITY RELATIONSHIPS:

The flow chart of carrying capacity relationships presented on page 2 is described box-by-box and arrow-by-arrow in Appendix A beginning on page 66. The table in Appendix A is arranged by box number from the flow chart, and gives a definition of every box plus a description of possible relationships between the boxes implied by the arrows leading out of each box. In addition, Appendix B beginning on page 66, gives a partial list of assumptions (Appendix B, page 45) which models part of the network of relationships shown in the flow chart. This table includes a checklist indicating which of the assumptions of the skeleton program also apply to the full flow chart of carrying capacity relationships. It should be noted that there are additional assumptions not relevant to the computer program which apply only to the flow chart; such assumptions are not included in the list in Appendix B. Likewise those assumptions of the skeleton program which also apply to the other formulations compared in the checklist do not represent complete lists for these formulations. The other formulas compared in the checklist are the one I developed for the Osa Peninsula in Costa Rica (Fearnside, 1972), and one widely-used formulation from the literature (Carneiro, 1960). In fairness to Carneiro, it should be noted that his formulation was not intended for application to an open system such as a colonization program. It should be kept in mind when comparing checklists of assumptions for various carrying capacity models, such as the lists appearing in Appendix B, that the model with the least assumptions is not necessarily the best model. Assumptions vary widely both in their impact on the results and in the degree to which they are met -- one crippling and inaccurate assumption may be far worse than ten more minor and less far-fetched assumptions.

The procedure for calculating carrying capacity outlined in the

flow chart can be summarized as follows. All of the land in the area is first classified by land quality and a portion of it is then allotted to colonization. The land allotted to colonization is then divided up into parcels known as "lots" for colonist families. Each colonist must then decide how to allot the land in his lot to production of the various products. The first step in making these decisions is the dividing of the lot into field-sized "patches" and predicting the potential yield for each product in each patch based on the land quality of the patch. A number of patches must then be allotted to each product sufficient to meet the colonist's needs. The colonist calculates his needs based on per capita requirements for the various products and on the size of his family. Patches are allotted such that the predicted yield will fill the family's needs, with an allowance being made for purchase of products which are predicted to be in short supply after all the patches in the lot have been allocated initially. The cash needed to purchase the products in short supply is calculated based on the buying prices of the products, and the additional amount of the most profitable crop needed to be planted in order to supply that cash is then calculated based on the selling price of the cash crop. The final allocation of patches is then made and the crops are actually planted.

Once the crops have been planted, the yield resulting will be determined based on a number of factors. These are categorized as: insects, weeds, diseases, seed variety, vegetation and animal populations, topography, soil nutrients, fertilizers, weather, interplanting with other crops, other technology, and number of cultivators per hectare. Most of these would be related to yield per hectare through some sort of multilinear regression. Most

year, and will vary according to their own probability distributions. Many of these factors affecting yield are affected, in turn, by other factors which can be used to predict their values. These are also shown in the flow chart.

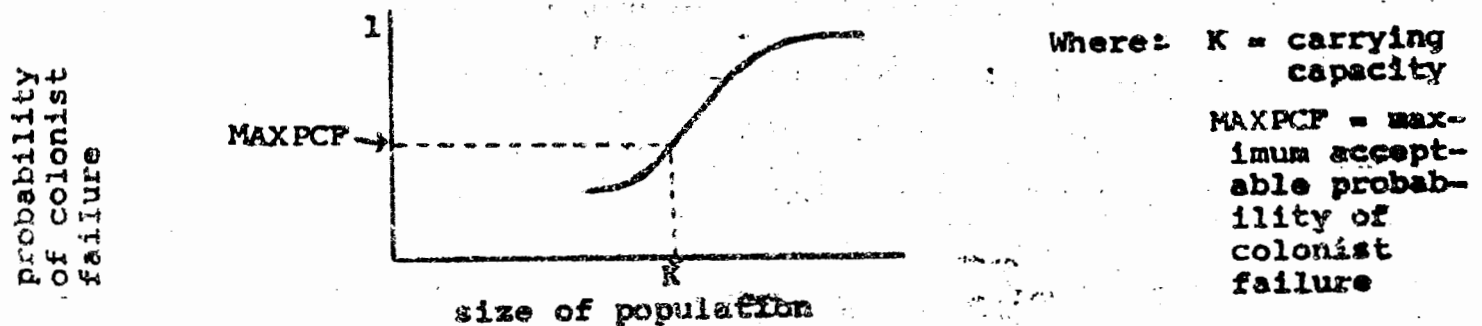
Once the harvest is in and the actual yield is known, the colonist must allocate to the various possible uses the product that has been produced in his lot, plus any stored reserves from previous years or product supplied directly by the government. The product allocation by the family must be made between storage, sale, and eating by the family. Cash resulting from sale of products present in excess of the family's needs for eating and storage is used to purchase those products present in the lot in amounts less than the minimum needed by the colonist.

After the amount of each of the products available for the family to eat after all adjustments through sales and purchases is known, the per capita consumption can be calculated based on the size of the family. This per capita consumption can then be compared against minimal governmental standards for living conditions. If the per capita consumption of any product is less than the minimal standard, then the colonist can be said to have "failed" in that year. Repeated calculations of the yields (and possibly other factors as well) based on values drawn from the probability distributions associated with each variable will allow the computation of a probability of colonist failure.

The model described in this flow chart envisions carrying capacity not as a single point beyond which either inadequate nutrition or environmental degradation or both occur with certainty. Rather, carrying capacity is viewed as a gradient. As the population size increases and thus the size of the lot for any one family decreases, the probability of colonist failure also increases. This relationship

could be expected to hold within the range of population values near the carrying capacity. Once this gradient is established, the planner can pick what he considers to be an acceptable level of risk that any particular colonist will fail in that year, and see what the population size corresponding to that probability of colonist failure. This population size then becomes the carrying capacity. This is diagrammed below in Figure 1.

FIGURE 1: CARRYING CAPACITY GRADIENT

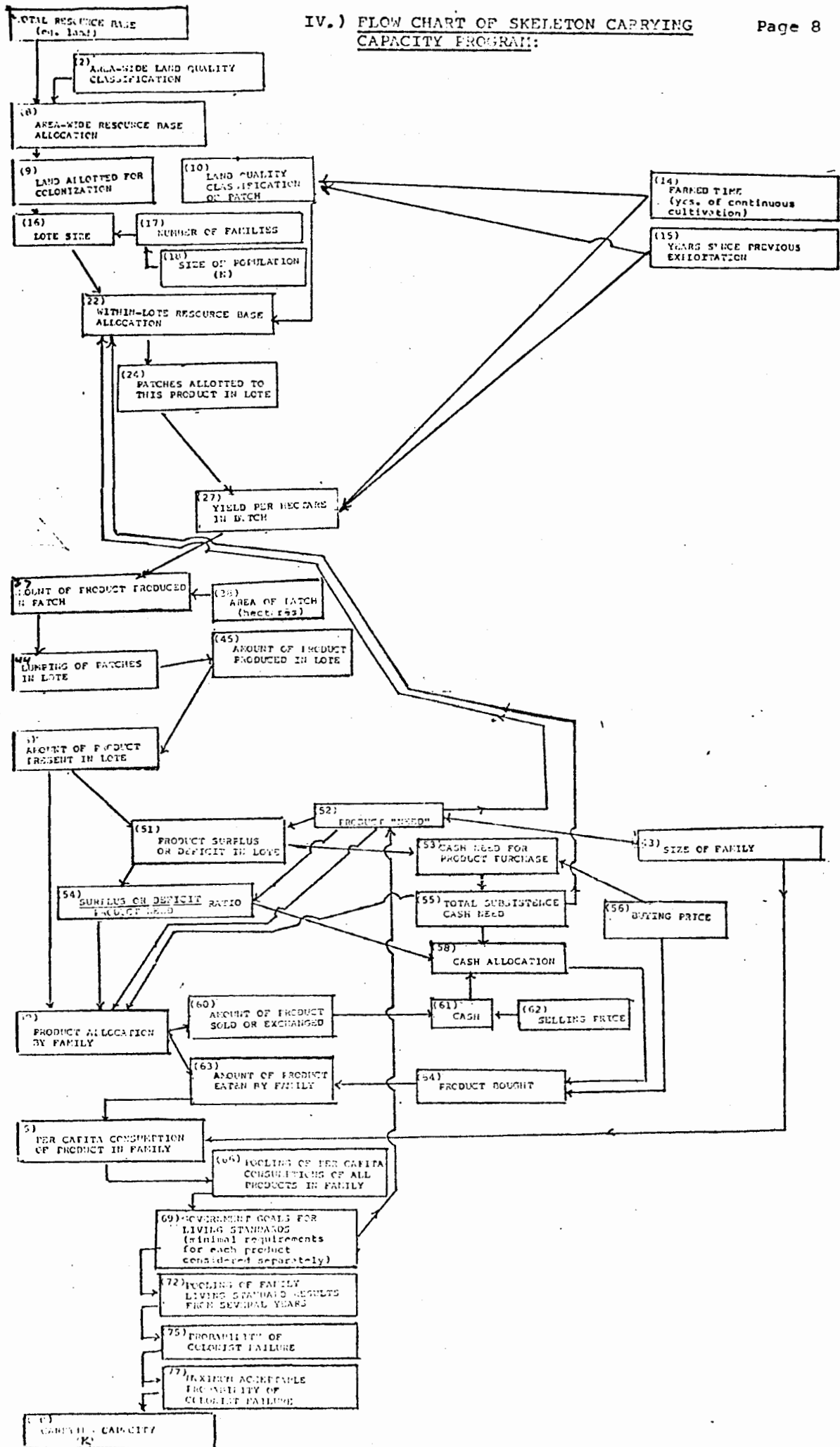


Two additional probabilities related to population size in ways similar to the relation for the probability of colonist failure are also compared with maximum acceptable probabilities in the carrying capacity calculation outlined in the flow chart. These are the probability of area-wide famine and the probability of environmental degradation. The probability of area-wide famine represents the probability of an unacceptably large fraction of colonists "failing" in the same year. The probability of environmental degradation represents the probability that the results of a land quality assessment made after the effects of the exploitation have been examined falls below the governmental environmental quality standards for any one of a number of criteria. Graphs similar to the one presented in Figure 1 could also be prepared for the probabilities of area-wide famine and environmental degradation.

In assessing environmental degradation the study area is viewed, not as a homogeneous expanse whose average land quality decreases under the pressure of exploitation, but rather as a mosaic of individual patches in different stages of degradation or regeneration. At carrying capacity an equilibrium would be maintained with the proportions of patches in each stage of regeneration or degradation remaining constant. What those equilibrium proportions are would greatly affect the resulting value for carrying capacity, and would be determined by the restrictions placed on the system in the form of governmental environmental quality standards.

The carrying capacity would be known to have been reached if a given population size resulted in any one of the three probabilities -- the probability of colonist failure, the probability of area-wide famine, or the probability of various kinds of environmental degradation -- exceeding the maximum acceptable probabilities for each of these.

IV.) FLOW CHART OF SKELETON CARRYING CAPACITY PROGRAM:



V.) DESCRIPTION OF SKELETON CARRYING CAPACITY PROGRAM:

The skeleton carrying capacity program presented in Appendix B beginning on page 45 includes many of the same relationships as the full flow chart of carrying capacity relationships. This can be seen from a comparison of the Flow Chart of Skeleton Carrying Capacity Program in Section IV on page 8 with the full Flow Chart of Carrying Capacity Relationships in Section II on page 2. The numbers of the boxes and arrows for the two flow charts are the same, so that the "Table Describing Flow Charts of Carrying Capacity Relationships" in Appendix A beginning on page 16 will also serve for the skeleton program flow chart. In addition there is a table of "Abbreviations Used in the Skeleton Carrying Capacity Program" presented in Appendix D beginning on page 58 and a "Partial list of Assumptions for the Skeleton Carrying Capacity Program" given in Appendix E beginning on page 66.

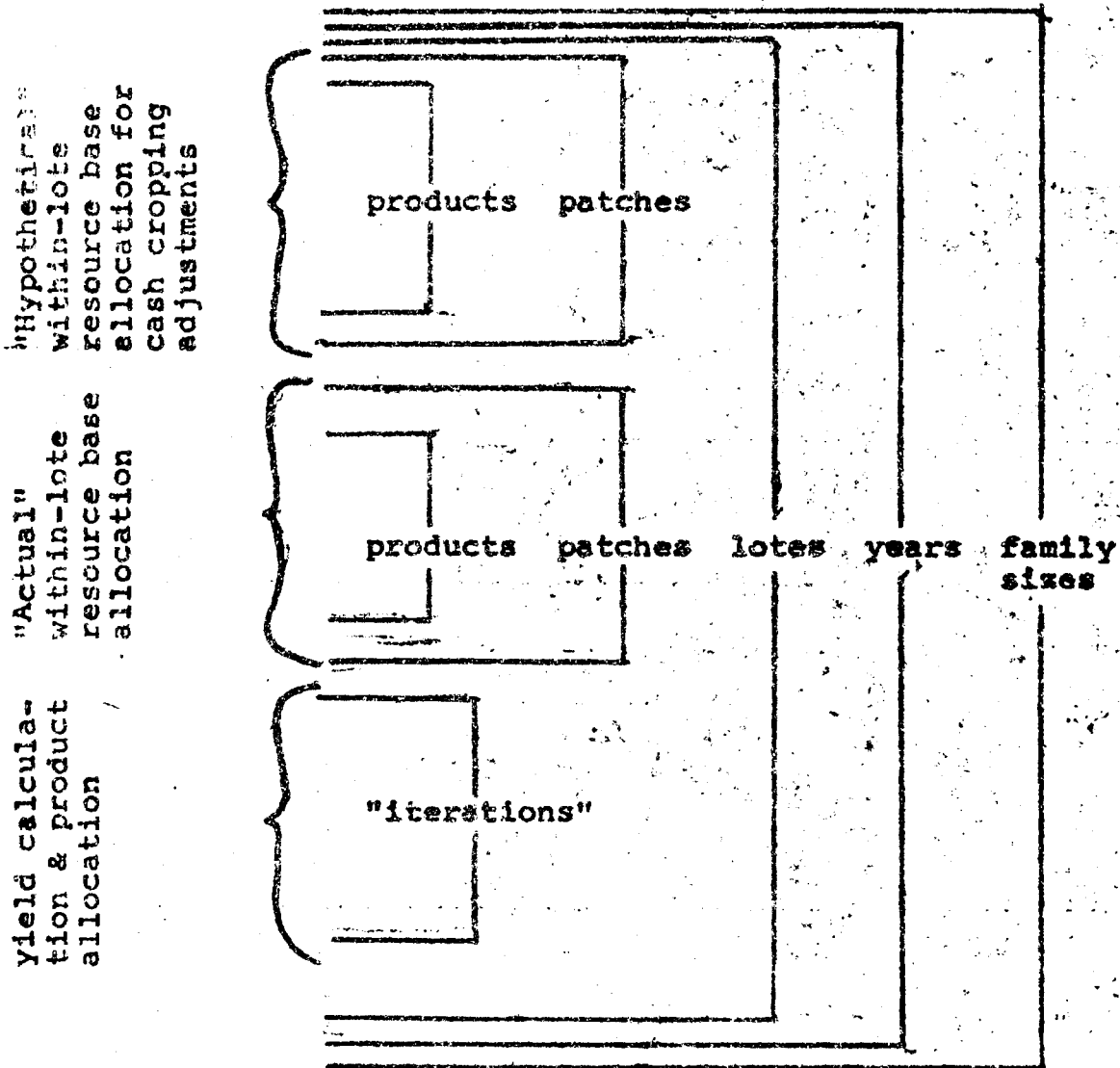
The calculations made in the program follow the description of the flow chart of carrying capacity relationships given in section III, with the exception that the great array of factors used to calculate the yields of the different crops is eliminated, as are the provisions for storage. Also eliminated are the calculations of the second and third probability restrictions placed on carrying capacity in the full flow chart: the probability of area-wide famine and the probability of environmental degradation. The knotty problem of environmental degradation has been, in a sense, defined away with the assumption that colonists are not able to shorten the fallow period below the figure specified as sufficient for full recovery of the land (see assumption nos. 6, 7, and 25 in Appendix E).

As emphasized in the Introduction, the beauty of the skeleton carrying capacity program lies not in what it actually can do in its present condition, but what it potentially can do when appropriate

embellishments have been made to eliminate, or at least partially detoxify, some of the more poisonous assumptions listed in Appendix E. A checklist has been included in Appendix E indicating which of the assumptions listed can potentially be either removed or softened through modifications of the skeleton program.

The calculations are made through a series of iterations which are diagrammed below in Figure 2. The lines in the figure represent the major "DO" loops of the program.

**FIGURE 2: DIAGRAM OF MAJOR ITERATIONS
IN SKELETON CARRYING CAPACITY PROGRAM:**



The calculations proceed as follows. First an initial area-wide land quality classification is made, land is allotted for colonization in an area-wide resource base allocation, and the lot size is calculated by dividing the area of land to be colonized by the number of families. The "within-lote resource base allocation" then begins, which accounts for most of the body of the program. This involves two sets of iterations, one for a "hypothetical" within-lote resource base allocation for the adjustment of production targets based on cash cropping, and the second the "actual" allocation. The hypothetical allocation is designed to simulate a decision process which would result in rational decisions as to how much of each of the various agricultural crops should be planted. As described in the Description of Flow Chart of Carrying Capacity Relationships on page 4 and in the appropriate place in the table of boxes and arrows in Appendix A, this is based on the perceived "needs" of the colonist and on the expected yield from each of the available patches of land. The colonist's needs must therefore first be calculated, and this is done by multiplying the "government goals for living standards" applying to each product times the size of the family. A "hypothetical" allocation is made assigning patches serially first to rice, then to beans, and then to maize until either each need is met or all usable land is exhausted. Game is produced in the "virgin" or fully recovered patches left over after the allocations to agricultural crops have been completed. Whether or not a particular patch can be used for agriculture, and what yield can be expected from it, depends on the condition of the patch. The position of each patch in the cycle of farming and fallowing has been stored in the computer's memory, and is recalled and examined as each patch is considered for allocation. Separate yields for the agricultural crops are calculated depending on whether it is in the first or second year of cultivation; if the patch has

for the deterministic estimate it produces in its present form. The additional complexity will make it possible, however, to easily modify the program for future stochastic simulations.

The product allocation by the family includes a provision for the sale of all product produced in excess of that needed for seed for the following year and for the family to eat. The cash from the sale of the products present in excess of the family's needs is used to purchase those for which there is a deficit.

The final amount of each product eaten by the family is then compared with the "government goals for living standards" for that product. If any product is not present in the requisite quantities, the colonist is classified as having "failed". After a set number of iterations of the yield and product allocation calculations, the proportion of iterations on which the colonist has failed is taken as the "probability of colonist failure" for that lot, year, and family size. If the probability of colonist failure exceeds the maximum acceptable probability of colonist failure, then carrying capacity is judged to have been reached, and the family size used in the preceding run is taken to be the carrying capacity.

All of the calculations above are then made for each of the lots in the study area.

Next the calculations are made for the subsequent year, with the land quality classification of each patch having been adjusted appropriately based on its use in the past year. Calculations are made over a large number of years as if it were "real time". During this extended time the number of patches in each land quality class will either reach an equilibrium, or at some point insufficient useable land will remain and the colonist's probability of failure will be high.

If the colonist's probability of failure has not exceeded the maximum acceptable amount at the end of the specified number of years in the run, then the family size is increased by some increment and the entire set of calculations repeated. The family size is increased in subsequent runs until either a preset upper limit is reached or the probability of colonist failure exceeds the maximum acceptable probability of colonist failure. Once the maximum acceptable probability is exceeded, the carrying capacity is then taken to be the population level corresponding to the family size used in the run preceeding the excessive failures.

For comparison with the results derived from the above described skeleton program, a short series of calculations is also included calculating carrying capacity based on the U_{sa} formula (of Fearnside, 1972) and on the U_{sa} formula with a modification added for the purchase of game and the seed sown to make it more comparable with the skeleton program results.

All carrying capacities are expressed in the output in several forms: as the maximum number of persons supportable on the total resource base, as the maximum number of persons per square kilometer, as the minimum number of hectares per capita, and as the minimum size of lote required to support a family of six persons.

VI.) DESCRIPTION OF SAMPLE INPUT AND OUTPUT FOR SKELETON PROGRAM:

The sample input and output for the skeleton carrying capacity program is presented in Appendix B beginning on page 45. The data used in the input is not intended to represent reality, but is intended only as an illustration of how the model operates. The resulting carrying capacity estimates in the output are, of course, likewise not considered to represent carrying capacities of any

actual locality.

The output of the program (lines 10-45) contains a full description of the meaning of thirty of the thirty-three different values which must be entered in the input. The three values not explained in the output are: the initial family size at the start of the first run, the interval by which the family size is to be incremented between runs, and the format requested for the output. Two formats are possible for the output: one partial and one full. The full output is quite voluminous, so only the partial one has been included in Appendix G.

It should be emphasized that the results displayed in the output not only do not represent reliable figures because of the semi-fictitious nature of the input data, but also have restricted value due to the many crippling assumptions listed in Appendix E. The beauty of the program, however, lies in the fact that it is only a "skeleton" in its present form, and it is designed to be added to and modified to deal with most of these assumptions. The assumptions of fixed values for many of the variables will be important ones to change. The result will be a far more powerful stochastic model for carrying capacity.

VII.) APPENDICES:APPENDIX A: TABLE DESCRIBING FLOW CHART OF CARRYING CAPACITY RELATIONSHIPS:

Note: This table must be used in conjunction with the flow chart appearing in Section II, page 2. Numbers of boxes (designated by **“(no.)”**) refer to definitions of the terms in the boxes, and the arrows of the flow chart (designated by **(no.,no1)**) give possible relationships of the box numbered first to the box numbered second.

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
“(1)”	Total resource base (eg. land)	def: The total amount of land of all qualities available in the study area.
(1-8)	Total resource base — Area-wide resource base allocation	The amount of land allotted to each of the various uses will be limited by total amount of land available (the total resource base). The amount of land allotted to any particular use would be equal to the total resource base times the proportion designated for that use (the area-wide resource base allocation).
“(2)”	Area-wide land quality classification	def: The pooling of the land quality classifications for each patch (box 10) to give the proportions of land in each of the different land quality classes. The land quality classes are defined by vegetation and animal populations (box 19), Topography (box 23), and soil nutrients (box 25).
(2-68)	Area-wide land quality classification — government environmental quality standards (various criteria)	The proportion of land in each quality class (box 8, the area-wide land quality classification) will be compared with the proportion which has been specified for that quality class as a government standard (box 68). In more complicated models adherence to the different criteria could be weighted by different amounts.
(2-8)	Area-wide land quality classification — area-wide resource base allocation	The proportion of land allotted to each of the various uses (area-wide resource base allocation, box 8) will be constrained by the proportions of land which are suitable for each of the different uses (Area-wide land quality classification, box 2). The proportion allotted to uses requiring a particular land quality cannot exceed the proportion of land of that quality available. The area-wide resource base allocation would only be made at the beginning of the colonization process.

APPENDIX A, CONT:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
** (3) **	Insects	def: A measure of the number of insects which are potentially damaging to crop plants. In addition to number, other relevant qualities might include: type of damage done (chewing, leaf mining, sucking), amount of damage per insect, and timing of damage in life cycle of plant. Not included are pollinators and bio-control agents.
(3-27)	Insects -- Yield per hectare in patch	The larger the population of insects, the less the yield per hectare that can be expected in the patch.
** (4) **	Insecticides	def: Quantities of insecticides applied per hectare. Other factors not included: type of insecticide, and timing of application.
(4-3)	Insecticides -- insects	The greater the amount of insecticides applied in a given year, the less the number of insects that can be expected. The effectiveness of the insecticides will be lessened, however, by the previous year's insecticides (box 6).
** (5) **	Previous year's insecticides	def: The value for insecticides (box 4) for the year before. Another possible formulation would weight the value for insecticides in each of the previous several years by some decay factor.
(5-3)	Previous year's insecticides -- insects	The relation between the previous year's insecticides and the current year's insect population levels will be complex. At first one would expect a negative correlation, with higher previous year's insecticides being associated with lower insects values. After a given number of years of insecticide use, however, high values for the previous year's insecticides will reduce the effectiveness of the present year's insecticides due to the acquisition of pesticide resistance by the insect population. Once this threshold point has been reached, at any given value for current pesticide use the number of insects will be positively correlated.
** (6) **	Previous year's insects	def: The value for insects (box 3) from the previous year.
(6-3)	Previous year's insects -- insects	A positive relation is expected, with higher values for insects in the previous year

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(7)	Insects in neighboring patches	def: The values for insects (box 3) in all patches within some radius, weighted by some factor for the area of the patch, the area of the neighboring patch, and the distance to the neighboring patch. Possibly one should also consider the type of crop in the neighboring patches, and the type of insects in the neighboring patches (dispersal ability and damage potential)
(7-3)	Insects in neighboring patches -- insects	A positive relation is expected, with high values for insects in neighboring patches being associated with high insect population values in the patch under consideration.
(8)	Area-wide resource base allocation	def: The proportion of land allotted by planners for use as colonization sites, forest reserves, cattle ranches, etc. This allocation would probably only be made at the outset of a colonization program.
(8-9)	Area-wide resource base allocation -- land allotted for colonisation	The amount of land allotted to colonization is the proportion of land allotted to colonization in the area-wide resource base allocation (box 8) times the total resource base (box 1).
(9)	Land allotted for colonization	Def: The number of hectares of land which is designated for colonization by small farmers as a result of the area-wide resource base allocation.
(9-16)	Land allotted for colonization -- lote size	The lote size will be equal to the amount of land allotted for colonization (box 9) divided by the number of families (box 17), assuming that all of the lotes are of equal size and that all land allotted for colonization is distributed at once. Modifications of these assumptions can be made, if necessary, in more elegant models.
(10)	Land quality classification of patch	def: A classification into one of several discrete classes based on vegetation and animal populations (box 19), topography of patch (box 23), and soil nutrients in patch (box 25).
(10-2)	Land quality classification of patch -- area-wide land quality classification	The proportion of land in each quality class in the Area-wide land quality classification (box 2) is equal to the sum of the areas of patches of each quality divided by the total area of patches of all qualities.

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(10-22)	Land quality classification of patch -- within-lote resource base allocation	The allocation of patches to each of the various products (box 22) will be constrained by the number of patches in the lote with land qualities appropriate for producing that product. One would expect farmers to allocate the patches on their lotes (after considering the amount of yield to be expected for each product given the land quality classification) in such a way as to maximize the fulfillment of the product "needs" (box 52).
aa(11)**	Weeds	def: A measure of the density of weeds which are competing with crop plants in the patch.
(11-27)	Weeds -- yield per hectare in patch	One would expect a negative relation to be found, where more weeds result in lower yields.
** (12)**	Diseases	def: A measure of the damage from crop diseases in the patch. (Perhaps this could be expressed as a percentage of the "expected" yield from non-diseased plants).
(12-27)	Diseases -- yield per hectare in patch	One would expect a negative relation to be shown, where more diseases result in lowered yields per hectare.
** (13)**	Seed variety (for crop plants)	def: The variety of crop plant seed used. Each variety will have differences in: response to fertilizers, succceptability to disease, response to weather conditions (timing and amount of rainfall), nutrient content, and expected yield given the soil type, etc.
(13-12)	Seed variety -- diseases	One would expect each seed variety to have an associated succceptability to disease attack. Unfortunately, it is often the case that the varieties with the highest resistance to diseases are not the same varieties which give the highest yields when disease-free.
(13-27)	Seed variety -- yield per hectare in patch	Each seed variety will have an associated expected yield per hectare. The associated yield for a given seed variety will vary with weather conditions (box 32), fertilizers (box 28), soil nutrients (box 25), diseases (box 12), and "other technology" (box 35). The effect of seed variety on yield will be mediated through these interaction effects.

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
** (14) **	Farmed time (yrs. of continuous cultivation)	def: The number of years that the patch has been cultivated continuously. Modification of this might include: the number of crops (rather than years), and separate measures for each crop grown. (This could be combined with box 30 -- previous crop type -- to give a weighted measure).
(14-3)	Farmed time (yrs. of continuous cultivation) -- insects	It is quite possible that insect problems will increase with increased farmed time; Insects will approach a high value asymptotically
(14-11)	Farmed time (yrs. of continuous cultivation) -- weeds	Weeds can be expected to increase with farmed time. This will approach a high value asymptotically.
(14-12)	Farmed time (yrs. of continuous cultivation) -- diseases	Diseases can be expected to increase with increased farmed time. Diseases will approach a high value asymptotically.
(14-25)	Farmed time (yrs. of continuous cultivation) -- soil nutrients in patch	Soil nutrients can be expected to decrease with increased farmed time. Soil nutrients will approach a minimum value asymptotically.
** (15) **	Years since previous exploitation	Def: The number of years which the patch has been lying fallow since its previous exploitation. In the case where the patch had not been exploited previously (for agriculture, as opposed to hunting), separate starting values would be used for the various boxes affected by this.
(15-3)	Yrs. since previous exploitation -- insects	Insects will probably decrease with increased years since previous exploitation. The relation would be monotonically decreasing, but might well not be linear. The value for insects might approach some low residual value asymptotically after a large number of years since previous exploitation.
(15-11)	Yrs. since previous exploitation -- weeds	Weeds would be expected to decrease monotonically with increased years since previous exploitation. The relation may not be linear, and the weed value may approach some residual value asymptotically at high values of years since previous exploitation.

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(15-12)	Yrs. since previous exploitation --- diseases	The value for disease could be expected to decrease monotonically with increased time since previous exploitation. The decrease might not be linear, and the value for diseases might approach some residual value asymptotically after many years since the previous exploitation.
(15-19)	Yrs. since previous exploitation -- vegetation and animal populations	Secondary succession will proceed as years pass since the previous exploitation. This will include changes in the relative abundances of the various species, increasing or decreasing depending on the species.
(15-25)	Yrs since previous exploitation -- soil nutrients in patch	The soil nutrients in the patch will probably decrease at first due to erosion and subsequently increase with years since previous exploitation. The nutrient level will level off at some equilibrium value after a given number of years. The effect of the "Yrs. since previous exploitation" (box 15) will show itself through its rate of soil nutrient regeneration (not shown in flow chart), which will be a function of the years since previous exploitation. (box 15). The rate of soil nutrient regeneration will probably begin as a negative value due to initial erosion, increase quickly, level off, and then decline approaching zero asymptotically. The soil nutrients in the patch (box 25) will be equal to the previous soil nutrients (box 36) minus any loss from soil depletion or plus any gain from regeneration (ie. the soil nutrient regeneration for the year in question times the interval of one year). Also see explanation for amount of soil depletion from previous exploitation -- soil nutrients in patch (26-25) and previous soil nutrients -- soil nutrients in patch (36-25).
(16)	Lote size	def: The size of each colonist's parcel of land (lote) in hectares. It is assumed that all lotes for colonists are the same size.
(16-22)	Lote size -- within-lote resource base allocation	The number of hectares allotted to each product will be constrained by the number of hectares available in the lote to be allocated.
(17)	Number of families	Def: The number of colonist families in the colonization area. In more elaborate formulations of the model, a subprogram using demographic information to project

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(17-16)	Number of families -- lote size	The lote size will be equal to the land allotted for colonization divided by the number of families (see 9-16).
{18)	Size of population (N)	def; The total number of colonists in the area. This could also be expanded to include non-farming portions of the population (shop keepers, government personnel, etc.) In more elaborate formulations of the model, a subprogram using demographic information to project changes in population size could be added.
(18-17)	Size of population (N) -- number of families	The number of families will be equal to the size of the population (box 18) divided by the average family size (equal to box 43 if all families are of equal size).
{19)	Vegetation and animal populations	def: A classification of the wild plants and animals in the patch. Animals refers to potential game species -- not insects, or animals not eaten, etc. The vegetation and animal populations box is only to be used for the calculation of yield per hectare for patches which have either never been cleared, or have been exploited and left fallow. For the land quality classification process (box 10) however, crop use is to be included.
(19-10)	Vegetation and animal populations-- land quality classification of patch	The vegetation and animal populations will be one set of criteria for making a land quality classification. The populations or the sizes of individuals of particular species could be singled out as defining criteria for various classes.
(19-27)	Vegetation and animal populations-- yield per hectare in patch	The relation here depends on the product whose yield is being measured and the plant or animal population in question. The animal populations are clearly directly related to the yields to be expected from hunting for game. The plant populations often provide a good indicator of the yield to be expected for agricultural crops if the land is cleared and planted. Later successional stages would probably be correlated with higher crop yields after clearing up to a point.

APPENDIX A, CONTINUED

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(20)	Seed source (for secondary successional species)	def: This includes a variety of factors affecting the availability of seeds for regeneration: planting of seeds on "abandonment", distance to an uncleared patch, the size of the uncleared patch, and the types of seeds in the seed source (dispersal abilities, etc.)
(20-21)	Seed source (for secondary successional species)-- regeneration rate	The nearer and the larger the seed source, the faster regeneration can be expected to proceed. The regeneration rate would probably be limited by the arrival of seeds within a certain range of values for arrival rates. This would be directly proportional to the area of the source area and inversely proportional to the square of the distance from the source area. It would also be dependent on the dispersal ability of each species. This would be more-or-less parallel the analysis for dispersal between oceanic islands.
(21)	Regeneration rate	def: The rate at which various components of "vegetation and animal populations" (box 1) are regained after the ceasing of exploitation. This will be different for each type of plant and animal. It will also not be constant over time.
(21-19)	Regeneration rate -- vegetation and animal populations	The population levels for any plant or animal species (box 21) will be equal to the previous year's population of that plant or animal (box 31) plus the product of the increment (one year) and the regeneration rate (box 21). It should be remembered that the regeneration rate (box 21) to be used in the above will differ depending on the number of years elapsed since previous exploitation (box 15). If the patch was exploited for agriculture in the previous year, then the value for "previous vegetation and animal populations" (box 31) will be zero.
(22)	Within-lote resource base allocation	def: The assignment of patches to various crops and other uses by the family. See the explanation for product "need" -- within-lote resource base allocation (52-22) for the allocation procedure. In addition to the influences shown on the flow chart from lot size (box 16), land quality classification of patch (box 10), total subsistence cash need (box 55), and product "need" (box 52), the within-lote resource base allocation will be influenced by...

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(22) (continued)		influenced by government standards (box 68) such as the stipulation that 50% of the land must be forested, by an anticipated yield from each patch (not shown in flow diagram), and by seed availability (also not shown on flow chart). Also involved in some cases might be the amount of land that could reasonably be cleared in a given time as restricted by the family size (box 43).
(22-24)	Within-lote resource base allocation -- patches allotted to this product in lote	Once the assignment of each patch in the lote has been made, the collection of patches which have been assigned to this product is the "patches allotted to this product in lote" (box 24). It will be necessary to keep track of the history of each patch, as this will affect the yield expected from each of the different patches.
(23)	Topography of patch	def: The slope of the terrain in the patch.
(23-10)	Topography of patch -- land quality classification of patch	There are two possible ways to use topography data in classifying land quality: (1) to divide all patches into classes based on land slope groupings, and then subdivide each of these classes based on soil nutrients (box 25) and vegetation and animal populations (box 19). This could be used in predicting expected yields, but the second approach would probably be better for this. Approach no. 1 would be most useful in making the area-wide resource base classification (box 2) for use in comparison with government environmental quality standards (box 68). (2) The other approach would be to obtain multilinear regressions for predicting yield for each of the different crops based on topography (box 23), vegetation and animal populations (box 19), and soil nutrients (box 25). The predicted yield from this approach would be most useful for within-lote resource base allocation (box 22).
(23-26)	Topography of patch -- amount of soil depletion from previous exploitation.	The greater the slope of the land, the more erosion can be expected from each previous exploitation.
(23-27)	Topography of patch -- yield per hectare in patch	The greater the slope of the land, the less yield one would normally expect. There may be additional special cases, such as swamps, etc. where low land gives reduced or no yield.

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(24)	Patches allotted to this product in lots	def: This is the breakdown of the analysis by patch. Separate yields will be calculated for each of the patches assigned to this product, to be later lumped (box 44) to give the total amount of the product produced in the lots. Most patches will be equivalent in size to one of the colonist's fields -- something on the order of one hectare or less.
(24-27)	Patches allotted to this product in lots -- yield per hectare in patch	Each patch allotted to this product must be examined separately and a yield calculated based on the various variables listed as affecting yield.
** (25)**	Soil nutrients in patch	def: Measures of concentrations of various soil nutrients and other indicators of soil quality. Possible measures might include: soil type, depth of soil, porosity, compaction, pH, percent organic matter (or total Carbon), and both total and available quantities of phosphorous, potassium, and nitrogen, (nitrates and nitrites).
(25-10)	Soil nutrients in patch -- land quality classification of patch	See relation for "topography of patch -- land quality of patch" (23-10); the same two approaches could be applied here.
(25-27)	Soil nutrients in patch -- yield per hectare in patch	The greater the soil nutrient content, the greater the yield one can expect. The relation may not be linear; diminishing returns may be expected at high values for soil nutrients.
(26)	Amount of soil depletion from previous exploitation	The reduction in the various measures of soil nutrients (box 25) at the end of the previous exploitation (harvest time).
(26-25)	Amount of soil depletion from previous exploitation -- soil nutrients in patch	The soil nutrients in patch (box 25) will be equal to the value for "soil nutrients in patch" from before the previous exploitation (box 36) reduced by the "amount of soil depletion from previous exploitation" (box 26) after modification for effects of "farmed time" (box 14) and "years since previous exploitation" (box 15). (The subtraction of soil depletion from previous exploitation (box 26) from the soil nutrients in patch at the beginning of the previous exploitation leaves the soil nutrient value at the end of the harvest period. The farmed time effect drops out when making calculations for every year, as would be done in a computer simulation. To the soil nutrient

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(26-25) continued		value for the end of the last harvest one would add some function of the soil nutrient value from the end of the last harvest. This function would be a measure of the amount of erosion or regeneration occurring between the end of the last harvest and the beginning of the current one, and would be derived from the relation of the years since previous exploitation (box 26) to the soil nutrients (box 25).
** (27) **	Yield per hectare in patch	def: The production in kgs/hectare/yr. of the product being considered in the patch. If a patch is interplanted with more than one crop, the yield for each crop will be computed separately.
(27-37)	Yield per hectare in patch -- amount of product produced in patch	The amount of product produced in the patch (box 37) is equal to the yield per hectare in the patch (box 27) times the area of the patch (box 28).
** (28) **	Fertilizers	def: The quantity of fertilizer used (Kgs/Hect). Further refinements could be made to allow for different types of fertilizers.
(28-27)	Fertilizers -- yield per hectare in patch	The yield per hectare can be expected to increase with increased applications of fertilizers. Diminishing returns can be expected, however, at high application levels. The relation will also depend on the amount of soil nutrients already present in the patch (box 25). The increment from fertilizers will probably be greatest at lower starting fertility levels.
** (29) **	Previous fertilizers	def: The quantities of fertilizers (box 28) used in previous years.
(29-26)	Previous fertilizers -- amount of soil depletion from previous exploitation	This relation is not easy to predict. One might expect soil depletion to decrease with increased previous fertilization, but the relation could easily prove to be otherwise.
** (30) **	Previous crop type	def: The type of crop which had been grown in the patch during a previous period of exploitation.

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(30-26)	Previous crop type -- amount of soil depletion from previous exploitation	Each crop type will have a characteristic amount of soil depletion associated with it.
(31)	Previous vegetation and animal populations	def: The previous year's populations of those kinds of wild plants which are relevant to the regeneration of soil nutrients.
(31-19)	Previous vegetation and animal populations	See explanation for regeneration rate -- vegetation and animal populations (21-19).
(32)	weather	def: A measure of the suitability of the weather for the growing of the crop in question. This will include not only the amount of rainfall, but also the timing of the rainfall in the life cycle of the plant. The measure might be expressed in some form such as the percent of the optimum yield (with respect to weather) to be expected under the conditions observed during the year of measurement.
(32-27)	weather -- yield per hectare in patch	The more suitable the weather (from the definition of box 32) the higher the yield.
aa(33)	Interplanting with other crops	def: The mixed planting of more than one crop simultaneously. This might be expressed as the percent of ground area devoted to the crop whose production is being observed.
(33-27)	Interplanting with other plants -- yield per hectare in patch	The greater the percent of the ground area planted with a particular crop, the higher the percent of the optimum yield to be expected.
(34)	Previous technology	def: Any forms of technology employed in the previous year which would have a bearing on either the depletion or regeneration of soil nutrients.
(34-26)	Previous technology -- amount of soil depletion from previous exploitation.	Each type of technology will have a characteristic rate of soil depletion associated with it. Both the mean and the variance of the soil depletion rate can be expected to differ between technologies.
(35)	Other technology	def: Any other forms of technology used in the current year not listed above which would have an effect on the yield per hectare in the patch. These might include: mulching, various methods of clearing and burning (bulldozing, slash-and-burn, slash-and-leave,

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(35) continued		herbicides (having effect on weeds, box 11), composting, irrigation, plowing, and planting and harvesting variations, and other special production techniques such as paddy, fish culture, garden flats, etc.
(35-27)	Other technology-- yield per hectare in patch	Each type of technology will have a characteristic yield associated with it. Both mean and variance of the expected yields can be expected to vary with different technologies.
(36)	Previous soil nutrients	def: The values for the various measures of "soil nutrients in patch" (box 25) from the beginning of the previous year.
(36-25)	Previous soil nutrients -- soil nutrients in patch	If the patch was exploited in the previous year, then the soil nutrients in the patch will be decreased by the amount of soil depletion from previous exploitation (see explanation 26-25). In any case, the soil nutrients in patch (box 25) will be increased by some soil nutrient regeneration rate value (not shown in flow chart) which is characteristic of the years since exploitation (box 15). See also: explanation for yrs. since previous exploitation -- soil nutrients in patch (15-25).
(37)	Amount of product produced in patch	The amount of product in kilograms produced in patch.
(37-44)	Amount of product produced in patch -- lumping of patches in lote.	The amount of product produced in patch (box 4) is summed over all patches in the lote (box 4) to give the amount of product produced in lote (box 45).
(38)	Area of patch (hectares)	The area of the patch in hectares
(38-37)	Area of patch (hectares) -- amount of product produced in patch	The amount of product produced in patch (box 37) is equal to the yield per hectare in the patch (box 27) times the area of the patch (box 38).
(39)	Cultivators per hectare	def: The number of persons in the family will have to be expressed in some form reflecting the cultivating work they can be expected to do. Conversion factors can be devised for standardizing the work of children into "cultivator" units. In the case of patches allotted to agriculture, the number of such hypothetical cultivators per hectare of cultivated land is the number

APPENDIX A, CONTINUED:

BOX NCS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(39) continued		some other measure such as man-hours per hectare of uncleared land would have to be used.
(39-27)	Cultivators per hectare -- yield per hectare in patch	The yield per hectare could be expected to increase with increasing numbers of cultivators per hectare up to a point, and then level off as further inputs of labor resulted in diminishing returns in terms of yield. The relation would differ, of course, for each crop and technology.
(40)	Prices of technological goods from outside	The price (including transportation costs, etc. of goods needed for any of the procedures being used under the heading "other technology" (box 35). Similar costs might be needed for outside-supplied items such as insecticides (box 4), fertilizers (box 28) and seeds (box 13).
(40-35)	Prices of technological goods from outside -- other technology	As prices of a given technological good needed from outside increase, one would expect a decrease in the use of technologies requiring that item. There would be a minimum threshold price below which further decreases in price would not result in increased use of the technology.
(41)	Hectares cultivated in lote	def: the total number of hectares cultivated with some agricultural (annual) crop. Tree crop area and pasture could probably be excluded unless it formed a large part of the lote. In the case of calculations for hunting, the uncleared area in the lote should be used.
(41-39)	Hectares cultivated in lote -- cultivators per hectare	The cultivators per hectare (box 39) would be equal to the number of cultivators in the family (which would be obtained by correcting the size of the family for the sex and age of the individual members (box 42) reflecting their comparative value as cultivators) divided by the number of hectares cultivated in the lote (box 41).
(42)	Age structure of family?	def: The number of persons in the family, in each age class. (Sex information may also be useful for the adjustment for each person's potential value as a cultivator). In more elaborate formulations of the model a subprogram using demographic information to project changes in age structure could be added.

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(42-39)	Age structure of family -- cultivators per hectare	The ages (and also the sexes) of the individual members of the family (box 42) would be used with some correction factor to standardize the individuals in terms of their value as cultivators. The sum of all the corrected cultivator values for the family would be divided by the number of hectares cultivated in the lote (box 41) to give the cultivators per hectare (box 39).
** (43) **	Size of family	def: The number of persons in the family. In more elaborate formulations of the model, a subprogram could be added using demographic information to project changes in the family size.
(43-39)	Size of family -- cultivators per hectare	See explanations for age structure of family cultivators per hectare (42-39) and hectares cultivated in lote -- cultivators per hectare (41-39).
(43-65)	Size of family -- per capita consumption of product by family	The per capita consumption of product by family (box 65) is equal to the amount of product eaten by family (box 63) divided by the size of family (box 43).
(43-52)	Size of family -- product "need"	The product "need" (box 52) for a given product is equal to the "government goals for living standards" (box 69) for that product times the size of family (box 43). In more elaborate formulations, one could make distinctions between family members of different ages and sexes in calculating the product "need".
** (44) **	Lumping of patches in lote	def: The combining of the amount of product produced (box 37) from all patches in the lote which have been allocated to this product in box 22.
(44-45)	Lumping of patches in lote -- amount of product produced in lote	See explanation for: amount of product produced in patch -- lumping of patches in lote (37-44).
** (45) **	Amount of product produced in lote	def: The amount of the product in Kgs. which has been produced in all of the patches in the lote which had been allocated for this product.

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(45-48)	Amount of product produced in lote -- amount of product present in lote	The amount of product present in lote (box 48) is equal to the amount of product produced in lote (box 45) plus the stored reserves available (box 46) plus the government supply of product (box 49).
** (46) **	Stored reserves available from previous year)	def: The amount (Kgs.) of the product which was stored in the preceding year (box 50) multiplied by the fraction which has been lost in the interim due to spoilage (box 47).
(46-48)	Stored reserves available (from previous year) -- amount of product present in lote.	See explanation for: amount of product produced in lote -- amount of product present in lote (45-48).
** (47) **	Spoilage	def: The fraction of the amount stored in the previous year (box 50) which is lost in one year's time (or in the interval between harvests) due to spoilage, rats, insects, etc.
(47-46)	Spoilage -- stored reserves available (from previous year)	The "stored reserves available (from previous year)" (box 46) is equal to the amount stored in previous years (box 50) times the spoilage (box 47).
** (48) **	Amount of product present in lote	def: The amount of the product (Kgs.) which is present in the lote from indigenous production, stored reserves, or government supply. This does not include product which is bought, either from other colonists or from outside of the system. It is this "amount of product present in lote" which will be used by the family in making decision about how to allocate product, if there is a "surplus" of product, or in making decision about how to allocate cash if there is a "deficit" of product present.
(48-51)	Amount of product present in lot -- product surplus or deficit in lote	The "product surplus or deficit in lote" (box 51) is equal to the amount of product present in the lote (box 48) minus the product "need" (box 52). If the value is negative, it is a "deficit", and if it is positive it is a "surplus".

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(48-59)	Amount of product present in lote -- product allocation by family	See definition of product allocation by family (box 59).
** (49) **	Government supply of product	def: The amount (in lbs.) of product given to the colonist in famine relief efforts, in first-year settling-in allocations, etc.
(49-48)	Government supply of product -- amount of product present in lote	See explanation of: amount of product produced in lote -- amount of product present in lote (45-48). Also note: one might include gifts or "loans" from neighboring colonists here in the analysis.
** (50) **	Amount stored in previous years	def: The value from "Amount of product stored (box 57) from the preceding year or harvest.
(50-46)	Amount stored in previous years -- stored reserves available (from previous yrs.)	See explanation of: spoilage -- stored reserves available (47-46).
** (51) **	Product surplus or deficit in lote	def: The "amount of product present in lote" (box 49) less the "product need" (box 52). This is a measure of the amount of "surplus" to be allocated by the family between storage and sale, or the amount of "deficit" in the lote's production to be made up by purchases from outside. It should be noted that "surplus" and "deficit" here do not have their classical economic meanings, as this "surplus" is not beyond subsistence need (as storage is very much a subsistence need, as is sale in order to obtain cash for other subsistence requirements). Likewise "deficit" does not refer to any net imbalance in the family's trade with the outside, but to the amount of product which needs to be purchased to attain minimal subsistence standards.
(51-53)	Product surplus or deficit in lote -- cash need for product purchase	If there is a deficit (the product surplus or deficit value (box 51) is negative), then the cash need for product purchase (box 53) is equal to the absolute value of the product surplus or deficit in lote (box 51) times the buying price (box 56) for the product in question. If there is a "surplus"

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(51-54)	Product surplus or deficit in lote- - surplus or deficit/or deficit in lote product need ratio	The "surplus or deficit/product need ratio" (box 54) is equal to the product surplus (box 51) divided by the product "need" (box 52).
••(52)••	Product "need"	def: The amount (Kgs.) of the product which would be needed by the family to meet minimal subsistence standards as set by the government goals (box 69). It should be noted that there is an important assumption here that the colonists perceive the amount of product they need to be the same as the goal set by the government. It could actually be either more or less than this when the farmer is making decisions about how to allocate his land, his product, and his cash. If information on the colonist's own perception of the "needed" quantities can be obtained, then separate simulations can be done using both of these values.
(52-22)	Product "need"--- within-lote resource base allocation	The product "need" might be used in the within-lote resource base allocation as follows: Anticipated yield figures from each patch (not shown in flow chart) would be calculated by the farmer based on the land quality classification of each patch (box 10) and the yields for that crop obtained in the past (not shown in flow chart). The farmer would allow patches from his lote to each crop until the product "need" (box 52) for that crop had been reached, plus an amount for sale from the total subsistence cash need (box 55) and the selling price (box 52) plus, perhaps, an additional storage target as an allowance for the possibility of a poor crop. (not shown in flow chart). The farmer would stop allocating patches to that product when either the sum of these "needs" had been fulfilled by the anticipated yield, or else the lote size (box 16) had been reached. See also: definition for Within lote resource base allocation (box 22) for additional possible influences on the allocat.
(52-51)	Product "need" -- product surplus or deficit in lote	See explanation for: amount of product in lote -- product surplus or deficit in lote (48-51).

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(52-54)	Product "need" -- surplus or deficit/product need ratio	See explanation for Product surplus or deficit in lots -- surplus or deficit/product need ratio (51-54).
(52-59)	Product "need" -- product allocation by family	See definition of product allocation by family (box 59).
(53)	Cash need for product purchase	def: The amount of cash that would be needed to purchase enough of the product to make up any deficit (box 51) if there is a deficit. This would be the "product surplus or deficit in lots" (box 51) multiplied by the buying price (box 56) if "product surplus or deficit in lots" (box 51) is less than zero.
(53-55)	Cash need for product purchase-- total subsistence cash need	The total subsistence cash need (box 55) is the sum over all products of the cash need for product purchase (box 53). See also: definition for total subsistence cash need (box 55).
(54)	Surplus or deficit/product need ratio	def: The "product surplus or deficit in lots" (box 51) divided by the "product need" (box 52). This value gives an indication of the priority that should be assigned to making up a deficit if there is a deficit or the priority that should be given to selling the product if there is a surplus of the product.
(54-58)	Surplus or deficit/product need ratio-- cash allocation	Cash is first allocated to the purchase of the product with the smallest (most negative) surplus or deficit/product need ratio (box 54). Quantities (eg. kilos) of the product are purchased until either the surplus or deficit/product need ratio (box 54) is no longer the smallest, the product "need" (box 52) has been filled (ie. the ratio in box 54) is greater than or equal to zero), or all of the cash (box 61) has been spent. The allocation will proceed by switching between the various products for which there is a deficit until either all needs are satisfied or the cash is exhausted.
(54-59)	Surplus or deficit/product need ratio-- product allocation by family	See definition of product allocation by family (box 59).

APPENDIX A, CONTINUEE:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(59)	Total subsistence cash need	<p>def: The total amount of cash needed to buy enough of each product for which there is a deficit (box 51) to bring the family's consumption to the minimal subsistence level (box 52). This is obtained by summing all of the "cash need for product purchase" values for all products.</p> <p>Other modifications could be added to include cash needs for non-subsistence activities, such as paying for the land, and other expenses. Cash requirements could also be added for agricultural expenses such as seeds, fertilizers, insecticides, herbicides, other transportation costs, etc. (not shown in flow chart).</p>
(55-22)	Total subsistence cash need -- within-lote resources base allocation	<p>See explanation for: product "need" -- within-lote resource base allocation (52-22) for an explanation of the allocation procedure. Also see definition of within-lote resource base allocation (box 22) for additional possible factors influencing the allocation.</p>
(55-58)	Total subsistence cash need -- cash allocation	<p>See explanation for: surplus or deficit / product need ratio -- cash allocation (54-58) description of the allocation procedure.</p>
(55-59)	Total subsistence cash need -- product allocation by family	<p>See definition of product allocation by family (box 59) for description of the allocation procedure.</p>
(56)	Buying price	<p>def: The price of the product bought, either from other colonists or from outside the system. This should include any costs involved in the purchase, such as transportation, etc. If need be, elaborations could be made to include products which have been exchanged or "given" to the colonists with the expectation of later reciprocation.</p>
(56-63)	Buying price-- cash need for product purchase	<p>The cash need for product purchase (box 53) is equal to the product surplus or deficit in lots (box 51) times the buying price of the product (box 56) if there is a deficit (box 51 is negative). If there is not a deficit (box 51 is greater to or equal to zero), then the cash need for product purchase (box 53) is zero.</p>

APPENDIX A, CONTINUED:

BOX NCS	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(56-64)	Buying price -- product bought	The product bought (box 64) is equal to the buying price of the product (box 56) times the amount of cash allotted to the purchase of that product in the cash allocation (box 58)
(57)	Amount of product stored	def: The amount of product which is stored for use in future years or harvest periods.
(58)	Cash allocation	def: The allocation of the cash (box 61) available to the family between the various possible uses. These include the purchase of products (box 64) to make up "deficits" (box 51), as well as the use of cash for other purposes (not shown in flow chart) such as purchasing seeds (box 13), insecticides (box 4), fertilizers (box 28), and other items of technology (box 35), as well as paying for loans made in purchasing land and other expenses. The procedure for the allocation of cash for product purchases is described under surplus or deficit/product need ratio -- cash allocation (54-58).
(58-64)	Cash allocation-- product bought	See explanation for: buying price -- product bought (56-64).
(59)	Product allocation by family	def: The allocation of the "amount of product present in lot" (box 48) between storage (box 57), sale (box 60), and consumption by the family before the next harvest period (box 63). The allocation procedure is as follows: Take quanta of product (ex: bags or kilos of rice) and feed into "amount of product eaten" (box 63) until "amounts of product eaten" = "product 'need'" (box 52). Then take the product with the highest surplus or deficit/product need ratio (box 51) and begin converting the remaining quanta to cash (feed into "amount of product sold or exchanged" (box 60) until "cash" (box 61) = "Total subsistence cash need" (box 55), or until the "surplus or deficit/product need ratio" (box 54) is no longer the highest. Switch between products until all "surplus or deficit/product need ratios" are equal and then take equally from each until "cash" (box 61) = "total subsistence cash need" (box 55), or until all product is used up ("product allocation by family, meaning the amount of product being allocated (box 52) is equal to zero). Then allocate to storage until storage target is reached. Then sell the remainder.

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(59-57)	Product allocation by family -- amount of product stored	See definition of product allocation by family (box 59).
(59-60)	Product allocation by family -- amount of product sold or exchanged	See definition of product allocation by family (box 59).
(59-63)	Product allocation by family -- amount of product eaten by family	See definition of product allocation by family (box 59).
** (60) **	Amount of product sold or exchanged	def: The amount of product (Kgs.) which is sold, either to other colonists or outside of the system. It may also prove necessary to include here any products which are exchanged for other goods and services without a transfer of cash, as well as any "gifts" made to other colonists with the expectation of reciprocation at some future time.
(60-61)	Amount of product sold or exchanged -- cash	Cash (box 61) is equal to the sum over all products of the amount of product sold (box 60) times the selling price for the product in question (box 62).
** (61) **	Cash	def: The total amount of cash available to the family for allocation. This would include the sum over all products of the "amount of product sold or exchanged" (box 60) times the corresponding "selling price" (box 62). In more elaborate formulations of the model it would be possible to add a provision for other cash sources (not shown in flow chart).
(61-58)	Cash -- cash allocation	See explanation for: surplus or deficit/product need ratio -- cash allocation (54-58).
** (62) **	Selling price	def: The price for which the product can be sold, after deducting costs involved in the sale (such as transportation, taxes, etc.).
(62-61)	Selling price -- cash	See explanation for: amount of product sold or exchanged -- cash (60-61).

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(63)	Amount of product eaten by family	def: The amount of the product which is consumed directly by the family in one year, or alternatively in the period between one harvest period and the next. This is the actual number of kgs. allotted for consumption by the family, as distinct from the amount which would ideally be needed to meet subsistence needs (box 52). The allocation of the amount of product eaten by family" is described under "product allocation by family" (box 59).
(63-65)	Amount of product eaten by family-- per capita consumption of product by family	The per capita consumption of product by family (box 65) is equal to the amount of product eaten by family (box 63) divided by the size of family (box 48).
(64)	Product bought	The amount of product in Kgs. which is purchased, either from other colonists or from stocks imported from outside of the system. Also included here is any of the product which is obtained through exchange rather than as a cash purchase, as well as any of the product which is obtained as a "gift" from other colonists which might be reciprocated in another year.
(64-63)	Product bought-- amount of product eaten by family	The amount of product eaten by family (box 63) is equal to the amount of product allotted to eating in the product allocation by family (box 59) plus the product bought (box 64).
(65)	Per capita consumption of product in family	The actual amount of product which is eaten per capita in the family.
(65-66)	Per capita consumption of product in family --, pooling of per capita consumptions of all products in family	See definition for per capita consumption of product in family (box 66).

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(66)	Pooling of per capita consumptions of all products in family	def: The conversion of all the amounts of the various products consumed ((box 65) for each product) into units for comparison with government living standards (box 69). This would probably involve conversion to grams/day/person of various nutrients -- proteins of various qualities, calories, fats, vitamins, etc. In less complete formulations, direct comparisons can be made of per capita consumptions for various products with standards for minimum acceptable amounts of those products without conversion to nutrient equivalents.
(66-69)	Pooling of per capita consumptions of all products in family -- government goals for living standards (minimal requirements for each product considered separately).	The pooled per capita consumptions are compared against the government standards for each item. If any item is less than the government standard, then the colonist can be classified as having "failed" in that year.
(67)	Lumping of lotes in area	def: The combining of colonist failure results from all the lotes in the area for the same year. This is the summing of failures over all lotes and dividing by the total number of lotes to give the area-wide colonist failure frequency (box 70) for that year. (colonist failure = having the pooled per capita consumption of the various nutrients (box 66) less than the minimal standard set by the government (box 69).)
(67-70)	Lumping of lotes in area -- area-wide colonist failure frequency	The proportion of colonists in the area which "failed" in the year in question will be the area-wide colonist failure frequency (box 70). This will be the number of families "failing" in that year divided by the total number of families.
(68)	Government environmental quality standards (various criteria)	def; The different stipulations which might be placed by the government on area-wide land quality. These might include such things as specifying a certain percentage of land to be left as forest reserves, or stipulating that a given number of reserves of a certain size must be left, or that various proportions of the land should fall into certain use categories. (completely

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(68) continued		annual agricultural crops, land used for tree crops, etc.)
(68-71)	Government environmental quality standards (various criteria) -- pooling of environmental quality results from several years (for various criteria)	The "pooling" involves comparing each criterion in the area-wide land classification (box 2) for each year with the government environmental quality standard (box 68) for that criterion and year, and calculating the proportion of the total years in which each criterion is violated.
(69)	Government goals for living standards (minimal requirements for each product considered separately)	def: Goals which have been adopted by government planners as minimal nutritional requirements. These would be broken down into various categories, such as proteins, of different kinds, calories, lipids, vitamins, etc. Most of these would be expressed as gms/person/day. In simple formulations (as in the present skeleton program) this conversion to nutrient equivalents can be bypassed and the goals expressed directly in quantities of each product.)
(69-52)	Government goals for living standards (minimal requirements for each product considered separately)--product "need"	In the simplest formulation where the government goals for living standards (box 69) are expressed directly in terms of minimum per capita consumption of products rather than in terms of nutrients, the product "need" (box 52) for each product is equal to the government goal for that product (box 69) times the size of the family (box 43). In more complex formulations where government goals for living standards are expressed in terms of nutrients, a conversion must be made based on the nutrient content of each product. This can be done in a variety of ways of varying complexity. The simplest such conversion would make assumptions about all or certain fixed percentages of given nutrients coming from given sources based on observed consumption habits. More complex models of how the colonist makes the decision of which crops to plant would have to include various cultural preferences, ease of cultivation of each crop, reliability of production, etc.
(69-67)	Government goals for living standards (minimal requirements for each product considered	See definition of lapping of lots in area (box 67).

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(69-72)	Government goals for living standards (minimal requirements for each product considered separately) -- pooling of family living standard results from several years	See definition of pooling of family living standard results from several years (box 72)
** (70) **	Area-wide colonist failure frequency	def: The percentage of colonists failing in the year of observation. "Filing" refers to having the pooled per capita consumption (box 66) less than the government goals (box 69) in the year of observation.
(70-73)	Area-wide colonist failure frequency-- pooling of area-wide colonist failure frequencies for several years	The comparing of each year's area-wide colonist failure frequency (box 70) against some governmental standard defining a "famine".
** (71) **	Pooling of environmental quality results from several years (for various criteria) -- probability of various kinds of environmental degradation	The storing of the result of whether or not the "area-wide land quality classifications (box 2) matched the "government environmental quality standards" (box 68) for the various criteria over a number of years.
(71-74)	Pooling of environmental quality results from several years (for various criteria) -- probability of various kinds of environmental degradation	In the simplest formulation this would involve dividing the number of years in which all of the criteria set a government environmental quality standards were not met (box 71) by the total number of years. In more complex formulations different kinds of degradation could be weighted differently to produce an over-all measure of environmental quality, which could be used either apart from or in addition to the individual criteria of box 68.
** (72) **	Pooling of family living standard results from several years	def: As diagrammed in the flow chart, this refers to the storing of the result of whether or not the per capita consumption of the various items (box 66) matched the government goals (box 69) when the program is run over several years. "Colonist failure" here refers to a negative family living standard result for a given year. As used in the present skeleton program, the colonist failure probabilities are calculated for each year by pooling the results of several iterations in the same

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(72-75)	Pooling of family living standard results from several years -- probability of colonist failure	<p>In one formulation, the probability of colonist failure (box 75) can be interpreted as equal to the number of years in which the colonist fails (from pooling of family living standard results from several years (box 72)) divided by the total number of years.</p> <p>Another kind of probability of colonist failure is used in the present skeleton computer program, where the probability of the colonist failing in the particular year under examination, rather than over all of the years in the run. This is obtained by pooling results over several iterations for the same year rather than over several years as shown in box 72.</p>
(73)	Pooling of area-wide colonist failure frequencies for several years	The storing of the "area-wide colonist failure frequency" (box 70) for several years of simulation.
(73-76)	Pooling of area-wide colonist failure frequencies for several years -- probability of area-wide famine	The probability of area-wide famine (box 76) is equal to the proportion of years (or alternatively runs) in which the area-wide colonist failure frequency (box 70) exceeds the government definition of a famine (set in box 73).
(74)	Probability of various kinds of environmental degradation	<p>def: The proportion of results after "pooling of environmental quality results from several years (various criteria)" (box 71) in which the "government environmental quality standards" (box 68) had not been met for the various criteria. Environmental degradation here is taken to mean falling below the various environmental quality standards set in box 68. It should be noted that there are many alternative definitions of "environmental degradation", not used in computing this probability. One important indicator of degradation not used in computing this probability might be the lowering of the carrying capacity (box 80) over time.</p>
(74-79)	Probability of various kinds of environmental degradation -- maximum acceptable probabilities of various kinds of environ-	The probability of each kind of environmental degradation is compared against the maximum allowable probability for that kind of degradation. If the probability for that kind of degradation is greater than the maximum allowed, then the carrying capacity (box 80) has been exceeded. The carrying

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(75)	Probability of colonist failure	<p>def: As diagrammed in the flow chart, this refers to the proportion of results "after pooling of family living standard results from several years" (box 72) in which the "government goals for living standards" (box 69) were not met. This probability refers to the probability that a given colonist will fail in a span of several years.</p> <p>As used in the skeleton program, the colonist failure probabilities are calculated separately for each year, and refer to the proportion of iterations run for that year in which the government standards were not all met.</p>
(75-77)	Probability of colonist failure -- maximum acceptable probability of colonist failure	<p>The probability of colonist failure (box 75) is compared against the maximum acceptable probability of colonist failure (box 77). If the probability is greater than the maximum allowed, then the carrying capacity (box 80) has been exceeded.</p>
(76)	Probability of area-wide famine	<p>def: The proportion of years in which the fraction of colonists failing (box 70) exceeded some officially defined value indicating an area-wide famine. Various values could be arbitrarily used and separate results computed.</p>
(76-78)	Probability of area-wide famine -- maximum acceptable probability of area-wide famine	<p>The probability of area-wide famine (box 76) is compared against the maximum acceptable probability of area-wide famine (box 78). If the probability exceeds the maximum allowable then the carrying capacity (box 80) has been exceeded. The carrying capacity can then be taken to be less than the value for the size of population in box 18.</p>
(77)	Maximum acceptable probability of colonist failure	<p>def: Some value set by government planners as an acceptable probability that any given colonist will fail. Various values could be arbitrarily used and separate results computed.</p>
(77-80)	Maximum acceptable probability of colonist failure -- carrying capacity (K)	<p>See explanation for: probability of colonist failure -- maximum acceptable probability of colonist failure (75-77).</p>

APPENDIX A, CONTINUED:

BOX NOS.	BOX NAMES	DEFINITION OR EXPECTED FUNCTIONAL RELATIONS
(78)	Maximum acceptable probability of area-wide famine	def: Some value set by government planners as an acceptable probability of area-wide famine. Various values could be used arbitrarily and separate results computed.
(78-80)	Maximum acceptable probability of area-wide famine-- carrying capacity (K)	See explanation for: probability of area-wide famine -- maximum acceptable probability of area-wide famine (76-78).
(79)	Maximum acceptable probabilities of various kinds of environmental degradation	def: A series of values for each of the different criteria set by government planners as acceptable levels of risk for these kinds of environmental degradation. Arbitrary values could be substituted here and an array of separate results could be computed.
(79-80)	Maximum acceptable probabilities of various kinds of environmental degradation -- carrying capacity (K)	See explanation for: probability of various kinds of environmental degradation -- maximum acceptable probability of various kinds of environmental degradation (74-79).
(80)	Carrying capacity (K)	def: The highest figure for the "size of population (N) (box 18) which can be used which will not result in either the "probability of colonist failures (box 75) exceeding the "maximum acceptable probability of colonist failure" (box 77) or the "probability of area-wide famine" (box 76) exceeding the "maximum acceptable probability of area-wide famine" (box 78) or the "probability of various kinds of environmental degradation" (box 74) exceeding each of the values for the various criteria for "maximum acceptable probabilities of various kinds of environmental degradation" (box 79). The carrying capacity would be computed for runs of a substantial number of years. This definition is consistent with the often-used definition of carrying capacity as: "The maximum number of persons that can be supported in perpetuity on an area, with a given technology and set of consumptive habits, without causing environmental degradation." (Allan, 1949).

APPENDIX B: SKELETON CARRYING CAPACITY PROGRAM:

INTEGER OUTPUT	1.00
INTEGER G	2.00
INTEGER FALLOW, FALZ, CYH	3.00
INTEGER YEARS	4.00
INTEGER CY, Y, P, FS, FAMNO, BASE, AWRBA	5.00
INTEGER PICENO, BEANNO, VIRGNO, REGNO	6.00
INTEGER RIMNO, BEHNO, MAHNO, VIHNO, REHNO	7.00
REAL MABUY, MASELL, MAIZY1, MAIZY2, MASEED, MAGOAL, MAXPFC,	8.00
MAPRES, MAPERC, MAPROD, MINHPC, MINLOS, KPPKM	9.00
REAL MACASH	10.00
REAL MASOLD, MAEAT, MANEED	11.00
DIMENSION CY(1,100), CYH(1,100), G(20)	12.00
EQUIVALENCE (RIPROD,RIPRES), (BEPROD,BEPRES), (MAPROD,MAPRES),	13.00
1(GAPROD,GAPRES)	14.00
DATA CY/100*0/	15.00
DATA CYH/100*0/	16.00
READ(5,1)G	17.00
1 FORMAT(20A4)	18.00
READ (5,2) INITFS, IVALFS, OUTPUT	19.00
2 FORMAT(3I5)	20.00
WRITE (6,500)	21.00
500 FORMAT(1X, ' FORMAT SPECIFICATION G FOR INPUT DATA'//)	22.00
WRITE (6,1) G	23.00
READ(5,G) BASE, AWRBA, FAMNO, MAXFS, RIBUY, BEBUY, MABUY, GABUY, RISELL,	24.00
1BESELL, MASELL, GASELL, RICEY1, RICEY2, BEANY1, BEANY2, MAIZY1, MAIZY2,	25.00
1GAMEY, FALLOW, RISEED, BESEED, MASEED, RIGOAL, BEGOAL, MAGOAL, GAGOAL, MAXP	26.00
1FC, YEARS, ITERAT	27.00
WRITE (6,501)	28.00
501 FORMAT(1X, ' INPUT DATA AS ENTERED'//)	29.00
WRITE (6,G) BASE, AWRBA, FAMNO, MAXFS, RIBUY, BEBUY, MABUY, GABUY, RISELL,	30.00
1BESELL, MASELL, GASELL, RICEY1, RICEY2, BEANY1, BEANY2, MAIZY1, MAIZY2, GAM	31.00
1EY, FALLOW, RISEED, BESEED, MASEED, RIGOAL, BEGOAL, MAGOAL, GAGOAL, MAXPFC,	32.00
1YEARS, ITERAT	33.00
WRITE (6,502)	34.00
502 FORMAT(1X, ' EXPLANATION OF INPUT DATA'//)	35.00
WRITE (6,3) INITFS, IVALFS, OUTPUT	36.00
3 FORMAT(1X, ' INITIAL FAMILY SIZE (INITFS)= ', I15, '/	37.00
11X, ' INTERVAL FOR FAMILY SIZE INCREMENTS USED IN RUN (IVALFS)= ',	38.00
1I15, .X ,/1X, ' OUTPUT SPECIFICATION (1=FULL; 2= PARTIAL)= ', I5, '1X/'	39.00
1/)	40.00
WRITE (6,503) BASE, AWRBA, FAMNO, MAXFS, RIBUY, BEBUY, MABUY, GABUY,	41.00
1RISELL, BESELL,	42.00
1MASELL, GASELL, RICEY1, RICEY2, BEANY1	43.00
WRITE (6,504) BEANY2, MAIZY1, MAIZY2, GAMEY,	44.00
1FALLOW, RISEED, BESEED,	45.00
1MASEED, RIGOAL, BEGOAL, MAGOAL, GAGOAL, MAXPFC, YEARS, ITERAT	46.00
503 FORMAT(1X, ' TOTAL RESOURCE BASE (BASE)= ', I15, '/1X, ' AREA WIDE RESO	47.00
URCE BASE ALLOCATION TO COLONIZATION (AWRBA)= ', I15, '/1X, ' NUMBER O	48.00
1F FAMILIES (FAMNO)= ', I15, '/1X, ' MAXIMUM FAMILY SIZE (MAXFS)= ', I15	49.00
1, /1X, ' RICE BUYING PRICE (RIBUY)= ', I15.0, '/1X, ' BEAN BUYING PRICE	50.00
1(BEBUY)= ', I15.0, '/1X, ' MAIZE BUYING PRICE (MABUY)= ', I15.0, '/1X, ' G	51.00
1AME BUYING PRICE (GABUY)= ', I15.0, '/1X, ' RICE SELLING PRICE (RISELL	52.00
1)= ', I15.0, '/1X, ' BEAN SELLING PRICE (BESELL)= ', I15.0, '/1X, ' MAIZE	53.00
1 SELLING PRICE (MASELL)= ', I15.0, '/1X, ' GAME SELLING PRICE (GASELL)	54.00
1= ', I15.0, '/1X, ' RICE YIELD PER HECTARE IN FIRST YEAR OF CULTIVATIO	55.00

APPENDIX B, CONTINUED:

IN (RICEY1)= ',1F5.0,/1X,' RICE YIELD PER HECTARE IN SECOND YEAR OF 56.0
 1 CULTIVATION (RICEY2)= ',1F5.0,/1X,' BEAN YIELD PER HECTARE IN FIR 57.0
 1ST YEAR OF CULTIVATION (BEANY1)= ',1F5.0/ 58.0
 504 FORMAT(1X,' BEAN YIELD PER HECTARE IN SECOND YEAR OF C 59.0
 1ULTIVATION (BEANY2)= ',1F5.0,/1X,' MAIZE YIELD PER HECTARE IN FIRS 60.0
 1T YEAR OF CULTIVATION (MAIZY1)= ',1F5.0,/1X,' MAIZE YIELD PER HECT 61.0
 1ARE IN SECOND YEAR OF CULTIVATION (MAIZY2)= ',1F5.0,/1X, 62.0
 1 63.0
 1LD PER HECTARE OF "VIRGIN" FOREST (GAMEY)= ',1F5.2,/1X,' FALLOW PE 64.0
 1RIOD IN YEARS (FALLOW)= ',1I5,/1X,' RICE SEED SOWN PER HECTARE IN 65.0
 1KILOS (RISEED)= ',1F5.0,/1X,' BEAN SEED SOWN PER HECTARE IN KILOS 66.0
 1(BESEED)= ',1F5.0,/1X,' MAIZE SEED SOWN PER HECTARE IN KILOS (MASE 67.0
 1ED)= ',1F5.0,/1X,' GOVERNMENT GOAL FOR PER CAPITA RICE CONSUMPTION 68.0
 1 (RIGOAL)= ',1F5.0,/1X,' GOVERNMENT GOAL FOR PERCAPITA BEAN CONSUM 69.0
 1PTION (BEGOAL)= ',1F5.0,/1X,' GOVERNMENT GOAL FOR PER CAPITA MAIZE 70.0
 1 CONSUMPTION (MAGOAL)= ',1F5.0,/1X,' GOVERNMENT GOAL FOR PER CAPIT 71.0
 1A GAME CONSUMPTION (GAGOAL)= ',1F5.0,/1X,' MAXIMUM ACCEPTABLE PROB 72.0
 1ABILITY OF COLONIST FAILURE (MAXPFC)= ',1F5.2,/1X,' NUMBER OF YEAR 73.0
 1S OVER WHICH RUN IS MADE (YEARS)= ',1I5,/1X,' NUMBER OF ITERATIONS 74.0
 1 USED FOR CALCULATION OF COLONIST FAILURE PROBABILITIES FOR EACH Y 75.0
 1EAR (ITERAT)= ',1I5,1X// 76.0
 C CALCULATION WITH OSA FORMULA 77.0
 FALPER = FALLOW 78.0
 OSAHPC = (((RIGOAL/((RICEY1+RICEY2)/2))+ (BEGOAL/((BEANY1+BEANY2)/2 79.0
 1))+ (MAGOAL/((MAIZY1+MAIZY2)/2)))*((FALPER/2.)+1))+ (GAGOAL/GAMEY) 80.0
 C "OSAHPC" REFERS TO HECTARES PER CAPITA AT K AS COMPUTED WITH THE 81.0
 C OSA FORMU 82.0
 C LA 83.0
 OSAPPK = (1 / OSAHPC) * 100 84.0
 C "OSAPPK" REFERS TO PERSONS PER SQUARE KILOMETER AT K AS COMPUTED 84.0
 C USING 85.0
 C THE OSA FORMULA 86.0
 OSACPC = OSAHPC - (GAGOAL / GAMEY) 87.0
 C "OSACPC" REFERS TO CULTIVATED LAND PER CAPITA AT K USING THE OSA 87.0
 C FORMULA 88.0
 OSAPKC = (1 / OSACPC) * 100 89.0
 C "OSAPKC" REFERS TO PERSONS PER SQUARE KILOMETER OF CULTIVATED 89.0
 C LAND AT K 90.0
 C USING THE OSA FORMULA 91.0
 WRITE (6,600) 92.0
 600 FORMAT(1X,' RESULTS WITH OSA FORMULA'//) 93.0
 WRITE (6,601) OSAHPC,OSAPPK 94.0
 601 FORMAT(1X,' HECTARES PER CAPITA AT K USING OSA FORMULA (OSAHPC)= ' 95.0
 1,F4.1,/1X,' PERSONS PER SQUARE KILOMETER AT K USING OSA FORMULA (O 96.0
 1SAPPK)= ',F4.1//) 97.0
 WRITE (6,602) OSACPC,OSAPKC 98.0
 602 FORMAT(1X,' HECTARES OF CULTIVATED LAND PER CAPITA AT K USING OSA 99.0
 1FORMULA (OSACPC)= ',F4.1,/1X,' PERSONS PER SQUARE KILOMETER OF CUL 100.0
 1TIVATED LAND AT K USING OSA FORMULA (OSAPKC)= ',F4.1//) 101.0
 C OSA FORMULA MODIFIED FOR GAME PURCHASE & SEED SOWN 102.0
 GPOHPC=(((RIGOAL/(((RICEY1+RICEY2)/2)-RISEED))+ (BEGOAL/(((BEANY1+ 103.0
 1BEANY2)/2)-BESEED)))+(MAGOAL/(((MAIZY1+MAIZY2)/2)-MASEED)) + 104.0
 1(GAGOAL*GABUY/(((RICEY1+RICEY2)/2)-RISEED)*RISELL))*(((FALPER/2.) 105.0
 1+1) 106.0
 GPOPPK = (1 / GPOHPC) * 100

	WRITE (6,603)GPOHPC,GPOPPK	107.00
603	FORMAT(IX,' HECTARES PER CAP. W/ OSA FORM. MODIFIED FOR GAME PURCH	109.00
	ASE & SEED SOWN = ',1F5.1,/IX,' PERSONS PER SQ. KM. W/ OSA FORM.	109.00
	1 MODIFIED FOR GAME PURCH. & SEED SOWN = ',1F5.1)	110.00
	LANDCO=AWRBA*BASE	111.00
	LOTESI = LANDCO / FAMNO	112.00
	FAL2 = FALLOW + 2	113.00
C	"FAL2" IS THE LENGTH OF AN ENTIRE CYCLE INCLUDING THE FALLOW TIME	114.00
C	PLUS A 2	114.00
C	YEAR CULTIVATED TIME	115.00
	DO 220 FS=INITFS,MAXFS,IVALFS	116.00
C	FS REFERS TO THE FAMILY SIZE BEING USED FOR THE RUN	117.00
	DO 79 JB=1,LOTESI	118.00
	DO 79 IB = 1,FAMNO	119.00
79	CY(IB,JB) = 0	120.00
	DO 81 JC=1,LOTESI	121.00
	DO 81 IC=1,FAMNO	122.00
81	CYH(IC,JC) = 0	123.00
	FAMSIZ = FS	124.00
	RINEED = RIGOAL * FAMSIZ	125.00
	BFNEED = BEGOAL * FAMSIZ	126.00
	MANEED = MAGOAL * FAMSIZ	127.00
	GANEED = GAGOAL * FAMSIZ	128.00
	DO 90 Y=1,YEARS	129.00
C	"Y" REFERS TO THE YEAR	130.00
C	SPLITTING OF YEARS	131.00
	DO 78 JA = 1,LOTESI	132.00
	DO 78 IA = 1,FAMNO	133.00
78	CYH(IA,JA) = CY(IA,JA)	134.00
	DO 80 L=1,FAMNO	135.00
C	"L" REFERS TO THE LOTE	136.00
C	SPLITTING OF LOTES	137.00
	RICAYI = ((RICEY1 + RICEY2) / 2) - RISEED) * RISELL	138.00
	BFCAYI = ((BEANY1 + BEANY2) / 2) - BESEED) * BESELL	139.00
	MACAYI = ((MAIZY1 + MAIZY2) / 2) - MASEED) * MASELL	140.00
	GACAYI = GAMEY * GASELL	141.00
C	SUBPROGRAM FOR SETTING THE CASH TARGET (CATARG)	142.00
	RIHPRD = 0.	143.00
	BEHPRD = 0.	144.00
	MAHPRD = 0.	145.00
	GAHPRD = 0.	146.00
	RIHND = 0	147.00
	BEHND = 0	148.00
	MAHND = 0	149.00
	VIHND = 0	150.00
	REHND = 0	151.00
	RIHTAR = RINEED	152.00
	BEHTAR = BENEED	153.00
	MAHTAR = MANEED	154.00
	GAHTAR = GANEED	155.00
	P = 0	156.00
C	"P" IS THE PATCH NUMBER	157.00
	DO 160 IH = 1,LOTESI	158.00
C	"IH" IS THE PATCH NUMBER	159.00
	P = P + 1	160.00

APPENDIX B, CONTINUED:

	DO 170 KH = 1,3	161.
C	"KH" IS THE PRODUCT NUMBER (EXCLUSIVE OF GAME): 1=RICE, 2= BEANS,	162.
C	3= MAIZE	162.
	IF (KH.EQ.1) GO TO 123	163.
	IF (KH .EQ. 2) GO TO 124	164.
	IF (KH .EQ. 3) GO TO 125	165.
123	CONTINUE	166.
C	HYPOTHETICAL ALLOCATION OF PATCHES TO RICE PRODUCTION FOR CASH	167.
C	TARGET (CATARG) DETERMINATION	169.
	IF (RIHPRD .GE. RIHTAR) GO TO 170	169.
	IF (CYH(L,P) .EQ. 0 .OR. CYH(L,P) .GE. FAL2) GO TO 150	170.
C	"CYH(L,P)" REFERS TO CYCLE POSITION, OR LAND QUALITY CLASS OF	171.
C	LOTE "L" AND PATCH "P" FOR THE "HYPOTHETICAL" ALLOCATION; 0=VIRGIN	172.
C	OR FULLY RECOVERED, 1= FIRST YEAR OF CULTIVATION, 2= SECOND YEAR	173.
C	OF CULTIVATION, 3= FIRST YEAR OF FALLOW, ... , FAL2= LAST YEAR OF	174.
C	FALLOW.	175.
	IF (CYH(L,P) .EQ. 1) GO TO 110	176.
	IF (CYH(L,P) .GE. 2) GO TO 120	177.
110	CYH(L,P) = 2	178.
	RIPROD = RIPROD + RICEY2	179.
	GO TO 155	180.
120	CYH(L,P) = CYH(L,P) + 1	181.
	REHND = REHND + 1	182.
	GO TO 160	183.
150	CYH(L,P) = 1	184.
	RIHPRD = RIHPRD + RICEY1	185.
155	CONTINUE	186.
	RIHND = RIHND + 1	187.
	RIHTAR = RIHTAR + RISEED	188.
	GO TO 160	189.
124	CONTINUE	190.
C	HYPOTHETICAL ALLOCATION OF PATCHES TO BEAN PRODUCTION FOR CASH	191.
C	TARGET	191.
C	(CATARG) CALCULATION	192.
	IF (BEHPRD .GE. BEHTAR) GO TO 170	193.
	IF (CYH(L,P) .EQ. 0 .OR. CYH(L,P) .GE. FAL2) GO TO 151	194.
	IF (CYH(L,P) .EQ. 1) GO TO 109	195.
	IF (CYH(L,P) .GE. 2) GO TO 121	196.
109	CYH(L,P) = 2	197.
	BEHPRD = BEHPRD + BEANY2	198.
	GO TO 156	199.
121	CYH(L,P) = CYH(L,P) + 1	200.
	REHND = REHND + 1	201.
	GO TO 160	202.
151	CYH(L,P) = 1	203.
	BEHPRD = BEHPRD + BEANY1	204.
156	CONTINUE	205.
	BEHND = BEHND + 1	206.
	BEHTAR = BEHTAR + BESEED	207.
	GO TO 160	208.
125	CONTINUE	209.
C	HYPOTHETICAL ALLOCATION OF PATCHES TO MAIZE PRODUCTION FOR CASH	210.
C	TARGET	210.
C	(CATARG) CALCULATION	211.
	IF (MAHPRD .GE. MAHTAR) GO TO 170	212.

APPENDIX B, CONTINUED:

	IF (CYH(L,P) .EQ. 0 .OR. CYH(L,P) .GE. FAL2) GO TO 152	213.
	IF (CYH(L,P) .EQ. 1) GO TO 115	214.
	IF (CYH(L,P) .GE. 2) GO TO 116	215.
115	CYH(L,P) = 2	216.
	MAHPRD = MAHPRD + MAIZY2	217.
	GO TO 157	218.
116	CYH(L,P) = CYH(L,P) + 1	219.
	REHND = REHND + 1	220.
	GO TO 160	221.
152	CYH(L,P) = 1	222.
	MAHPRD = MAHPRD + MAIZY1	223.
157	CONTINUE	224.
	MAHND = MAHND + 1	225.
	MAHTAR = MAHTAR + MASEED	226.
	GO TO 160	227.
170	CONTINUE	228.
C	COMBINING OF PRODUCTS IN HYPOTHETICAL ALLOCATION FOR CATARG	229.
C	CALCULATION	229.
C	HYPOTHETICAL ALLOCATION OF PATCHES TO REGENERATION (FALLOW) FOR	230.
C	CASH	230.
	IF (CYH(L,P) .EQ. 0 .OR. CYH(L,P) .GE. FAL2) GO TO 127	231.
	CYH(L,P) = CYH(L,P) + 1	232.
	REHND = REHND + 1	233.
	GO TO 160	234.
127	CONTINUE	235.
C	HYPOTHETICAL ALLOCATION OF PATCHES TO GAME (FOREST FOR CASH	236.
C	TARGET (CATARG	236.
C) CALCULATION	237.
	GAHPRD = GAHPRD + GAMEY	238.
	VIHNO = VIHNO + 1	239.
	CYH(L,P) = 0	240.
160	CONTINUE	241.
C	COMBINING OF PATCHES IN HYPOTHETICAL ALLOCATION FOR CATARG	242.
C	CALCULATION	242.
	IF (RIHPRD .GE. RIHTAR .AND. BEHPRD .GE. BEHTAR .AND. MAHPRD .GE.	243.
	MAHTAR .AND. GAHPRD .GE. GAHTAR) GO TO 71	244.
	CATARG = 0.	245.
	IF (RIHPRD .GE. RIHTAR) GO TO 73	246.
	CATARG = CATARG + (RIHTAR - RIHPRD) * RIBUY	247.
73	CONTINUE	248.
	IF (BEHPRD .GE. BEHTAR) GO TO 83	249.
	CATARG = CATARG + (BEHTAR - BEHPRD) * BEBUY	250.
83	CONTINUE	251.
	IF (MAHPRD .GE. MAHTAR) GO TO 84	252.
	CATARG = CATARG + (MAHTAR - MAHPRD) * MABUY	253.
84	CONTINUE	254.
	IF (GAHPRD .GE. GAHTAR) GO TO 85	255.
	CATARG = CATARG + (GAHTAR - GAHPRD) * GABUY	256.
85	CONTINUE	257.
	IF (RICAYI .GE. BECAYI .AND. RICAYI .GE. MACAYI .AND. RICAYI .GE.	258.
	IGACAYI) GO TO 11	259.
	IF (BECAYI .GE. RICAYI .AND. BECAYI .GE. MACAYI .AND. BECAYI .GE.	260.
	IGACAYI) GO TO 12	261.
	IF (MACAYI .GE. RICAYI .AND. MACAYI .GE. BECAYI .AND. MACAYI .GE.	262.
	IGACAYI) GO TO 13	263.

APPENDIX B, CONTINUED:

	IF (GACAYI .GE. RICAYI .AND. GACAYI .GE. BECAYI .AND. GACAYI .GE. MACAYI) GO TO 14	264.000
	11 RICASH = CATARG	265.000
	BECASH = 0.	266.000
	MACASH = 0.	267.000
	GACASH = 0.	268.000
	GO TO 22	269.000
	12 BECASH = CATARG	270.000
	RICASH = 0.	271.000
	MACASH = 0.	272.000
	GACASH = 0.	273.000
	GO TO 22	274.000
	13 MACASH = CATARG	275.000
	RICASH = 0.	276.000
	BECASH = 0.	277.000
	GACASH = 0.	278.000
	GO TO 22	279.000
	14 GACASH = CATARG	280.000
	RICASH = 0.	281.000
	BECASH = 0.	282.000
	MACASH = 0.	283.000
	22 CONTINUE	284.000
	RITARG = RINEED + (RICASH/RISELL)	285.000
	BETARG = BENEED + (BECASH / BESELL)	286.000
	MATARG = MANEED + (MACASH / MASELL)	287.000
	RIPROD = 0.	288.000
	BEPROD = 0.	289.000
	MAPROD = 0.	290.000
	GAPROD = 0.	291.000
	RICEND = 0	292.000
	BEANN0 = 0	293.000
	MAIZNO = 0	294.000
	VIRGNO = 0	295.000
	REGNO = 0	296.000
	P = 0	297.000
	DO 60 I = 1, LOTESI	298.000
	SPLITTING OF PATCHES ; "I" IS THE PATCH NUMBER	299.000
	P = P + 1	300.000
	"P" IS THE PATCH NUMBER	301.000
	DO 70 KP = 1, 3	302.000
	"KP" IS THE PRODUCT NUMBER (EXCLUSIVE OF GAME); 1= RICE, 2= BEANS, 3=MAIZE	303.000
	SPLITTING OF PRODUCTS	304.000
	IF (KP .EQ. 1) GO TO 23	305.000
	IF (KP .EQ. 2) GO TO 24	306.000
	IF (KP .EQ. 3) GO TO 25	307.000
	23 CONTINUE	308.000
	ALLOCATION OF PATCHES TO RICE PRODUCTION	309.000
	"CY(L,P)" REFERS TO THE CYCLE POSITION OR LAND QUALITY CLASS OF LOTE "L" AND PATCH "P" IN THE "ACTUAL" ALLOCATION	310.000
	IF (RIPROD .GE. RITARG) GO TO 70	311.000
	IF (CY(L,P) .EQ. 0 .OR. CY(L,P) .GE. FAL2) GO TO 50	312.000
	IF (CY(L,P) .EQ. 1) GO TO 10	313.000
	IF (CY(L,P) .GE. 2) GO TO 20	314.000
	10 CY(L,P) = 2	315.000
		316.000
		317.000

APPENDIX B, CONTINUED:

	RIPROD = RIPROD + RICEY2	318.00
	GO TO 55	319.00
20	CY(L,P) = CY(L,P) + 1	320.00
	REGNC = REGNO + 1	321.00
	GO TO 60	322.00
50	CY(L,P) = 1	323.00
	RIPROD = RIPROD + RICEY1	324.00
55	CONTINUE	325.00
	RICENO = RICENO + 1	326.00
	RITARG = RITARG + RISEED	327.00
	GO TO 60	328.00
24	CONTINUE	329.00
C	ALLOCATION OF PATCHES TO BEAN PRODUCTION	330.00
	IF (BEPROD .GE. BETARG) GO TO 70	331.00
	IF (CY(L,P) .EQ. 0 .OR. CY(L,P) .GE. FAL2) GO TO 51	332.00
	IF (CY(L,P) .EQ. 1) GO TO 9	333.00
	IF (CY(L,P) .GE. 2) GO TO 21	334.00
9	CY(L,P) = 2	335.00
	BEPROD = BEPROD + BEANY2	336.00
	GO TO 56	337.00
21	CY(L,P) = CY(L,P) + 1	338.00
	REGNO = REGNO + 1	339.00
	GO TO 60	340.00
51	CY(L,P) = 1	341.00
	BEPROD = BEPROD + BEANY1	342.00
56	CONTINUE	343.00
	BEANNO = BEANNO + 1	344.00
	BETARG = BETARG + BESEED	345.00
	GO TO 60	346.00
25	CONTINUE	347.00
C	ALLOCATION OF PATCHES TO MAIZE PRODUCTION	348.00
	IF (MAPROD .GE. MATARG) GO TO 70	349.00
	IF (CY(L,P) .EQ. 0 .OR. CY(L,P) .GE. FAL2) GO TO 52	350.00
	IF (CY(L,P) .EQ. 1) GO TO 15	351.00
	IF (CY(L,P) .GE. 2) GO TO 16	352.00
15	CY(L,P) = 2	353.00
	MAPROD = MAPROD + MAIZY2	354.00
	GO TO 57	355.00
16	CY(L,P) = CY(L,P) + 1	356.00
	REGNO = REGNO + 1	357.00
	GO TO 60	358.00
52	CY(L,P) = 1	359.00
	MAPROD = MAPROD + MAIZY1	360.00
57	CONTINUE	361.00
	MAIZNO = MAIZNO + 1	362.00
	MATARG = MATARG + MASEED	363.00
	GO TO 60	364.00
70	CONTINUE	365.00
C	COMBINING OF PRODUCTS	366.00
C	ALLOCATION OF PATCHES TO REGENERATION	367.00
	IF (CY(L,P) .EQ. 0 .OR. CY(L,P) .GE. FAL2) GO TO 27	368.00
	CY(L,P) = CY(L,P) + 1	369.00
	REGNO = REGNO + 1	370.00
	GO TO 60	371.00
27	CONTINUE	372.00

APPENDIX B, CONTINUED:

C	ALLOCATION OF PATCHES TO GAME (FOREST)	373.0
	GAPROD = GAPROD + GAMEY	374.0
	VIRGNO = VIRGNO + 1	375.0
	CY(L,P) = 0	376.0
60	CONTINUE	377.0
C	COMBINING OF PATCHES	378.0
	GO TO 72	379.0
71	CONTINUE	380.0
C	FOR CASE WHERE THERE IS NO CASH NEED	381.0
	DO 77 JJ=1, LOTESI	382.0
	DO 77 II=1, FAMNO	383.0
77	CY(II, JJ) = CYH(II, JJ)	384.0
	CATARG = 0.	385.0
	RIPROD = RIHPRO	386.0
	BEPROD = BEHPRO	387.0
	MAPROD = MAHPRO	388.0
	GAPROD = GAHPRO	389.0
	RICENO = RIHNO	390.0
	BEANNO = BEHNO	391.0
	MAIZNO = MAHNO	392.0
	VIRGNO = VIHNO	393.0
	REGNO = REHNO	394.0
72	CONTINUE	395.0
	CFAIL = 0.	396.0
C	"CFAIL" IS THE NUMBER OF ITERATIONS IN WHICH THE COLONIST "FAILS"	397.0
	DO 75 IT = 1, ITERAT	398.0
C	"IT" IS THE ITERATION NUMBER	399.0
C	CALCULATION OF TOTAL SUBSISTENCE CASH NEED (CANEED)	400.0
	CANEED = 0.	401.0
	IF (RIPRES .GE. RINEED) GO TO 200	402.0
	CANEED = CANEED + (RINEED - RIPRES) * RIBUY	403.0
200	CONTINUE	404.0
	IF (BEPRES .GE. BENEED) GO TO 201	405.0
	CANEED = CANEED + (BENEED - BEPRES) * BEBUY	406.0
201	CONTINUE	407.0
	IF (MAPRES .GE. MANEED) GO TO 202	408.0
	CANEED = CANEED + (MANEED - MAPRES) * MABUY	409.0
202	CONTINUE	410.0
	IF (GAPRES .GE. GANEED) GO TO 203	411.0
	CANEED = CANEED + (GANEED - GAPRES) * GABUY	412.0
203	CONTINUE	413.0
C	PRODUCT ALLOCATION BY FAMILY	414.0
	RIEAT = 0.	415.0
	BFEAT = 0.	416.0
	MAEAT = 0.	417.0
	GAEAT = 0.	418.0
	RISOLD = 0.	419.0
	BESOLD = 0.	420.0
	MASOLD = 0.	421.0
	GASOLD = 0.	422.0
	CASH = 0.	423.0
65	CONTINUE	424.0
	IF (RIPRES .LE. 0.) GO TO 204	425.0
	RIEAT = RIEAT + 1	426.0
	RIPRES = RIPRES - 1	427.0

APPENDIX B, CONTINUED:

	IF (RIEAT .GE. RINEED) GO TO 66	428.
	GO TO 65	429.
66	CONTINUE	430.
	RISOLD = RIPRES	431.
	CASH = CASH + (RISOLD * RISELL)	432.
204	CONTINUE	433.
	IF (BEPRES .LE. 0.) GO TO 206	434.
	BEEAT = BEEAT + 1	435.
	BEPRES = BEPRES - 1	436.
	IF (BEEAT .GE. BENEED) GO TO 205	437.
	GO TO 204	438.
205	CONTINUE	439.
	BESOLD = BEPRES	440.
	CASH = CASH + (BESOLD * BESELL)	441.
206	CONTINUE	442.
	IF (MAPRES .LE. 0.) GO TO 208	443.
	MAEAT = MAEAT + 1	444.
	MAPRES = MAPRES - 1	445.
	IF (MAEAT .GE. MANEED) GO TO 207	446.
	GO TO 206	447.
207	CONTINUE	448.
	MASOLD = MAPRES	449.
	CASH = CASH + (MASOLD * MASELL)	450.
208	CONTINUE	451.
	IF (GAPRES .LE. 0.) GO TO 210	452.
	GAEAT = GAEAT + 1	453.
	GAPRES = GAPRES - 1	454.
	IF (GAEAT .GE. GANEED) GO TO 209	455.
	GO TO 208	456.
209	CONTINUE	457.
	GASOLD = GAPRES	458.
	CASH = CASH + (GASOLD * GASELL)	459.
210	CONTINUE	460.
212	CONTINUE	461.
C	ALLOCATION OF CASH TO PURCHASE OF RICE	462.
	RIRAT = (RIEAT - RINEED) / RINEED	463.
	BERAT = (BEEAT - BENEED) / BENEED	464.
	MARAT = (MAEAT - MANEED) / MANEED	465.
	GARAT = (GAEAT - GANEED) / GANEED	466.
	IF (RIEAT .GE. RINEED) GO TO 213	467.
	IF (RIRAT .GT. BERAT) GO TO 213	468.
	IF (RIRAT .GT. MARAT) GO TO 214	469.
	IF (RIRAT .GT. GARAT) GO TO 215	470.
	CASH = CASH - RIBUY	471.
	IF (CASH .LE. 0.) GO TO 216	472.
	RIEAT = RIEAT + 1	473.
	GO TO 212	474.
213	CONTINUE	475.
C	ALLOCATION OF CASH TO PURCHASE OF BEANS	476.
	IF (BEEAT .GE. BENEED) GO TO 214	477.
	BERAT = (BEEAT - BENEED) / BENEED	478.
	IF (BERAT .GT. RIRAT) GO TO 213	479.
	IF (BERAT .GT. MARAT) GO TO 214	480.
	IF (BERAT .GT. GARAT) GO TO 215	481.
	CASH = CASH - BEBUY	482.

APPENDIX B, CONTINUED:

	IF (RIEAT .GE. RINEED) GO TO 66	428.
	GO TO 65	429.
66	CONTINUE	430.
	RISOLD = RIPRES	431.
	CASH = CASH + (RISOLD * RISELL)	432.
204	CONTINUE	433.
	IF (BEPRES .LE. 0.) GO TO 206	434.
	BEEAT = BEEAT + 1	435.
	BEPRES = BEPRES - 1	436.
	IF (BEEAT .GE. BENEED) GO TO 205	437.
	GO TO 204	438.
205	CONTINUE	439.
	BESOLD = BERRES	440.
	CASH = CASH + (BESOLD * BESELL)	441.
206	CONTINUE	442.
	IF (MAPRES .LE. 0.) GO TO 208	443.
	MAEAT = MAEAT + 1	444.
	MAPRES = MAPRES - 1	445.
	IF (MAEAT .GE. MANEED) GO TO 207	446.
	GO TO 206	447.
207	CONTINUE	448.
	MASOLD = MAPRES	449.
	CASH = CASH + (MASOLD * MASELL)	450.
208	CONTINUE	451.
	IF (GAPRES .LE. 0.) GO TO 210	452.
	GAEAT = GAEAT + 1	453.
	GAPRES = GAPRES - 1	454.
	IF (GAEAT .GE. GANEED) GO TO 209	455.
	GO TO 208	456.
209	CONTINUE	457.
	GASOLD = GAPRES	458.
	CASH = CASH + (GASOLD * GASELL)	459.
210	CONTINUE	460.
212	CONTINUE	461.
C	ALLOCATION OF CASH TO PURCHASE OF RICE	462.
	RIRAT = (RIEAT - RINEED) / RINEED	463.
	BERAT = (BEEAT - BENEED) / BENEED	464.
	MARAT = (MAEAT - MANEED) / MANEED	465.
	GARAT = (GAEAT - GANEED) / GANEED	466.
	IF (RIEAT .GE. RINEED) GO TO 213	467.
	IF (RIRAT .GT. BERAT) GO TO 213	468.
	IF (RIRAT .GT. MARAT) GO TO 214	469.
	IF (RIRAT .GT. GARAT) GO TO 215	470.
	CASH = CASH - RIBUY	471.
	IF (CASH .LE. 0.) GO TO 216	472.
	RIEAT = RIEAT + 1	473.
	GO TO 212	474.
213	CONTINUE	475.
C	ALLOCATION OF CASH TO PURCHASE OF BEANS	476.
	IF (BEEAT .GE. BENEED) GO TO 214	477.
	BERAT = (BEEAT - BENEED) / BENEED	478.
	IF (BERAT .GT. RIRAT) GO TO 213	479.
	IF (BERAT .GT. MARAT) GO TO 214	480.
	IF (BERAT .GT. GARAT) GO TO 215	481.
	CASH = CASH - BEBUY	482.

APPENDIX B, CONTINUED:

	IF (CASH .LE. 0.) GO TO 216	483.0
	BEEAT = BEEAT + 1	484.0
	GO TO 213	485.0
214	CONTINUE	486.0
	ALLOCATION OF CASH TO PURCHASE OF MATIZE	487.0
	IF (MAEAT .GE. MANEED) GO TO 215	488.0
	MARAT = (MAEAT - MANEED) / MANEED	489.0
	IF (MARAT .GT. RIRAT) GO TO 212	490.0
	IF (MARAT .GT. BERAT) GO TO 213	491.0
	IF (MARAT .GT. GARAT) GO TO 215	492.0
	CASH = CASH - MABUY	493.0
	IF (CASH .LE. 0.) GO TO 216	494.0
	MAEAT = MAEAT + 1	495.0
	GO TO 214	496.0
215	CONTINUE	497.0
	ALLOCATION OF CASH TO PURCHASE OF GAME	498.0
	IF (GAEAT .GE. GANEED) GO TO 216	499.0
	GARAT = (GAEAT - GANEED) / GANEED	500.0
	IF (GARAT .GT. RIRAT) GO TO 212	501.0
	IF (GARAT .GT. BERAT) GO TO 213	502.0
	IF (GARAT .GT. MARAT) GO TO 214	503.0
	CASH = CASH - GABUY	504.0
	IF (CASH .LE. 0.) GO TO 216	505.0
	GAEAT = GAEAT + 1	506.0
	GO TO 215	507.0
216	CONTINUE	508.0
	LIVING STANDARD CALCULATION	509.0
	RIPERC = RIEAT / FAMSIZ	510.0
	BEPERC = BEEAT / FAMSIZ	511.0
	MAPERC = MAEAT / FAMSIZ	512.0
	GAPERC = GAEAT / FAMSIZ	513.0
	IF (OUTPUT .EQ. 2) GO TO 623	514.0
	IF (IT .GT. 1) GO TO 622	515.0
	WRITE (6,621)	516.0
621	FORMAT(64X, ' LOTE YEAR', 2X, ' ITER', 2X, ' RIPERC', 2X, ' BEPERC', 2X,	517.0
	1 ' MAPERC', 2X, ' GAPERC')	518.0
622	CONTINUE	519.0
	WRITE (6,620) L, Y, IT, RIPERC, BEPERC, MAPERC, GAPERC	520.0
620	FORMAT(65X, I3, 2X, I3, 4X, I3, 4X, F5.1, 4X, F5.1, 4X, F5.1, 4X, F5.1)	521.0
623	CONTINUE	522.0
	IF (RIPERC .GE. RIGOAL .AND. BEPERC .GE. BEGOAL .AND. MAPERC .GE.	523.0
	IMAGOAL .AND. GAPERC .GE. GAGOAL) GO TO 217	524.0
	CFAIL = CFAIL + 1	525.0
217	CONTINUE	526.0
75	CONTINUE	527.0
	POOLING RESULTS FOR ALL ITERATIONS	528.0
	XITER = ITERAT	529.0
	PCFAIL = CFAIL / XITER	530.0
	IF (FAMND .EQ. 1) GO TO 505	531.0
80	CONTINUE	532.0
	POOLING RESULTS FOR DIFFERENT LOTES	533.0
505	CONTINUE	534.0
	IF (Y .GT. 1) GO TO 616	535.0
	WRITE (6,246)	536.0
246	FORMAT(1X, ' PERCENTAGE OF LAND ALLOTTED TO VARIOUS USES & PROBABL	537.0

APPENDIX B, CONTINUED:

	TITLES OF COLONIST FAILURE (//)	538.000
	WRITE (6,241) FS	539.000
241	FORMAT(1X, ' FAMILY SIZE = ',113//)	540.000
	WRITE (6,243) L	541.000
243	FORMAT(10X, ' LUTE NUMBER = ',113//)	542.000
	WRITE (6,244)	543.000
244	FORMAT(2X, ' YEAR',3X, ' RICENO',2X, ' BEANNO',2X, ' MAIZNO',2X, ' REGN	544.000
	IO',3X, ' VIRGNO',3X, ' PCFAIL')	545.000
616	CONTINUE	546.000
	WRITE (6,245) Y,RICENO, BEANNO, MAIZNO, REGNO, VIRGNO, PCFAIL	547.000
245	FURMAT(2X,113,7X,113,6X,113,6X,113,6X,113,6X,113,5X,F4.2)	548.000
90	CONTINUE	549.000
	POOLING OF RESULTS FOR DIFFERENT YEARS	550.000
	IF (Y .GE. YEARS) GO TO 221	551.000
	GO TO 222	552.000
221	CONTINUE	553.000
	IF (PCFAIL .LE. MAXPFC) GO TO 223	554.000
	GO TO 222	555.000
223	K = FAMSIZ * FAMNO	556.000
	ACCLIM = (IVALFS / FAMSIZ) * 100	557.000
	MINHPC = LOTESI / FAMSIZ	558.000
	MINLO6 = 6 * MINHPC	559.000
	KPPKM = 100 / MINHPC	560.000
	IF (FS .EQ. MAXFS) GO TO 605	561.000
	GO TO 606	562.000
605	CONTINUE	563.000
	WRITE (6,607)	564.000
607	FORMAT(/1X, ' WARNING: MAXFS HAS BEEN REACHED PRIOR TO COLONIST FAI	565.000
	ILURE, K RESULT MAY BE SPURIOUS//)	566.000
606	CONTINUE	567.000
220	CONTINUE	568.000
	COMBINING OF RESULTS FROM EACH FAMILY SIZE RUN	569.000
222	CONTINUE	570.000
	WRITE (6,224) K,KPPKM,ACCLIM,FS,MINHPC,MINLO6	571.000
224	FORMAT(1X, ' CARRYING CAPACITY (K) OF THE TOTAL RESOURCE BASE = ',	572.000
	114, /1X, ' CARRYING CAPACITY IN PERSONS PER SQUARE KILOMETER (KPPKM)	573.000
	1= ',F3.0, /1X, ' ACCURACY LIMIT DUE TO FAMILY DESIGN = ',F3.0, 1X,	574.000
	1' PERCENT WITH FAMILY SIZE = ',12, /1X, ' MINIMUM HECTARES PER CAPIT	575.000
	1A (MINHPC)= ',F4.1, /1X, ' MINIMUM LOTESIZE FOR A FAMILY OF 6 PERSON	576.000
	1S (MINLO6)= ',F5.1//)	577.000
	END	578.000

APPENDIX C: SAMPLE INPUT AND OUTPUT FOR SKELETON CARRYING CAPACITY PROGRAM:

SAMPLE INPUT:

```

$LIST DATAFILE
1 (415,12F5.0/(2F5.0,1F5.2,115,7F5.0,1F5.2,215))
2 11 1 2
3 100 1 1 15 5. 12. 3. 30. 5. 12. 3. 30.1200. 800. 244. 200.
4 600. 600. .52 20 7. 27. 11. 100. 50. 25. 36. .05 100 1
END OF FILE

```

SAMPLE OUTPUT:

```

$LIST LIVINGSTO
1 FORMAT SPECIFICATION G FOR INPUT DATA
3 (415,12F5.0/(2F5.0,1F5.2,115,7F5.0,1F5.2,215))
4 INPUT DATA AS ENTERED
6 100 1 1 15 5. 12. 3. 30. 5. 12. 3. 30.1200. 800. 244. 200.
7 600. 600. 0.52 20 7. 27. 11. 100. 50. 25. 36. 0.05 100 1
8 EXPLANATION OF INPUT DATA
10 INITIAL FAMILY SIZE (INITFS)= 11
11 INTERVAL FOR FAMILY SIZE INCREMENTS USED IN RUN (IVALFS)= 1
12 OUTPUT SPECIFICATION (1=FULL; 2= PARTIAL)= 2
15 TOTAL RESOURCE BASE (BASE)= 100
16 AREA WISE RESOURCE BASE ALLOCATION TO COLONIZATION (ANRBA)= 1
17 NUMBER OF FAMILIES (FAMNO)= 1
18 MAXIMUM FAMILY SIZE (MAXFS)= 15
19 RICE BUYING PRICE (RIBUY)= 5.
20 BEAN BUYING PRICE (BEBUY)= 12.
21 MAIZE BUYING PRICE (MABUY)= 3.
22 GAME BUYING PRICE (GABUY)= 30.
23 RICE SELLING PRICE (RISELL)= 5.
24 BEAN SELLING PRICE (BESSELL)= 12.
25 MAIZE SELLING PRICE (MASELL)= 3.
26 GAME SELLING PRICE (GASELL)= 30.
27 RICE YIELD PER HECTARE IN FIRST YEAR OF CULTIVATION (RICEY1)= 1200.
28 RICE YIELD PER HECTARE IN SECOND YEAR OF CULTIVATION (RICEY2)= 800.
29 BEAN YIELD PER HECTARE IN FIRST YEAR OF CULTIVATION (BEANY1)= 244.
31 BEAN YIELD PER HECTARE IN SECOND YEAR OF CULTIVATION (BEANY2)= 200.
32 MAIZE YIELD PER HECTARE IN FIRST YEAR OF CULTIVATION (MAIZY1)= 600.
33 MAIZE YIELD PER HECTARE IN SECOND YEAR OF CULTIVATION (MAIZY2)= 600.
34 GAME SUSTAINABLE YIELD PER HECTARE OF "VIRGIN" FOREST (GAMEY)= 0.52
35 FALLOW PERIOD IN YEARS (FALLOW)= 20
36 RICE SEED SOWN PER HECTARE IN KILOS (RISEED)= 7.
37 BEAN SEED SOWN PER HECTARE IN KILOS (BESSEED)= 27.
38 MAIZE SEED SOWN PER HECTARE IN KILOS (MASEED)= 11.
39 GOVERNMENT GOAL FOR PER CAPITA RICE CONSUMPTION (RIGOAL)= 100.
40 GOVERNMENT GOAL FOR PERCAPITA BEAN CONSUMPTION (BEGOAL)= 50.
41 GOVERNMENT GOAL FOR PER CAPITA MAIZE CONSUMPTION (MAGOAL)= 25.
42 GOVERNMENT GOAL FOR PER CAPITA GAME CONSUMPTION (GAGOAL)= 36.
43 MAXIMUM ACCEPTABLE PROBABILITY OF COLONIST FAILURE (MAXPFC)= 0.05
44 NUMBER OF YEARS OVER WHICH RUN IS MADE (YEARS)= 100
45 NUMBER OF ITERATIONS USED FOR CALCULATION OF COLONIST FAILURE PROBABILITIES FOR EACH YEAR (ITERAT)= 1

48 RESULTS WITH USA FORMULA
51 HECTARES PER CAPITA AT K USING USA FORMULA (OSAHPC)= 73.3
52 PERSONS PER SQUARE KILOMETER AT K USING USA FORMULA (OSAPPK)= 1.4
54 HECTARES OF CULTIVATED LAND PER CAPITA AT K USING USA FORMULA (OSACPC)= 4.0
55 PERSONS PER SQUARE KILOMETER OF CULTIVATED LAND AT K USING USA FORMULA (OSAPKC)= 24.8
58 HECTARES PER CAP. W/ USA FORM. MODIFIED FOR GAME PURCHASE & SEED SOWN = 6.8
59 PERSONS PER SQ. KM. W/ USA FORM. MODIFIED FOR GAME PURCH. & SEED SOWN= 14.7

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APPENDIX D: ABBREVIATIONS USED IN SKELETON CARRYING CAPACITY PROGRAM

ABBREVIATION	TRANSLATION	MEANING	APPROXIMATE BOX NO. IN FLOW CHART
ACCLIM	accuracy limitation	accuracy limitation due to family size design	none
AWRBA	area-wide resource base allocation	area-wide resource allocation to colonization	(8), & (9) implied
BASE	base	total resource base (eg. land)	(1)
BEANNO	bean number	number of patches allotted to bean production	(22)
BEANY1	bean yield one	bean yield per hectare in first year of cultivation	(27)
BEANY2	bean yield two	bean yield per hectare in second year of cultivation	(27)
BEBUY	bean buying price	buying price for beans (per kilo)	(56)
BECASH	bean cash	cash from sale of beans	(60-61)
BECAVI	bean cash yield	net cash yield per hectare expected from growing beans	none (included in 22)
BEZAT	beans eaten	amount (kilos) of beans eaten by family	(63)
BEGOAL	bean goal	government goal for per capita bean consumption	(69)
BEHNO	bean hypothetical number	Number of patches planted in beans used in making hypothetical within-lote resource base allocation for adjusting production targets for cash cropping.	none (included in 22)
BEHPRO	bean hypothetical production	Bean production estimate used in making hypothetical within-lote resource base allocation adjusting targets for cash cropping	none (included in 22)
BEHTAR	bean hypothetical target	Target for bean production in hypothetical within-lote resource base allocation for adjusting for cash cropping	none (included in 22)
BENEED	bean need	product "need" for beans	(52)

APPENDIX D, CONTINUED:

ABBREVIATION	TRANSLATION	MEANING	APPROXIMATE BOX NO. IN FLOW CHART
BEPERC	beans per capita	per capita consumption of beans (Kgs/yr)	(65)
BEPRES	beans present	kilos of beans present in lot	(48)
BERAT	bean ratio	bean surplus or deficit/product need ratio	(54)
BESEED	bean seed	Bean seed sown per hectare (kilos/yr.)	none
BESELL	bean selling price	Selling price for beans (cruzeiros/kilo)	(62)
BESOD	bean surplus or deficit	Bean surplus or deficit in lot	(51)
BESOLD	Beans sold	Amt. of beans sold or exchanged (Kgs.)	(60)
CANEED	Cash need	Total subsistence cash need	(55)
CASH	cash	cash	(61)
CATARG	cash target	Cash target used for making within-lot resource base allocation	implied in (55-22)
CFAIL	colonist failure	Number of iterations in which colonist fails	(72) (see def. of box 72, App.A)
CY	cycle position	The position of the patch in the cycle of cultivation and fallowing (yrs. since last clearing)	implied in (15) and (10)
CYH	hypothetical cycle position	Position in the cycle of farming and fallowing used in the "hypothetical" allocation of patches in adjusting targets for cash cropping	implied in (10)
FALLOW	fallow	Fallow period (yrs. required for full recovery)	implied in (21)
FAL2	Fallow plus two years	The length of a full cycle including both fallow and farmed time (here farmed time = 2 years)	none
FAMNO	family number	number of families	7

APPENDIX D, CONTINUED:

ABBREVIATION	TRANSLATION	MEANING	APPROXIMATE BOX NO. IN FLOW CHART
FAMSIZ	family size	size of family (also see FS)	(43)
FS	family size	the family size for which calculations are being made	(43)
GABUY	game buying price	buying price for game (cruzeiros/kilo)	(56)
GACASH	game cash	cash from sale of game	(60-61)
GACAYI	game cash yield	Net cash yield per hectare expected from producing game	none (included in 22)
GAEAT	game eaten	amount of game eaten by family (kgs.)	(63)
GAGOAL	game goal	Government goal for per capita game consumption	(69)
GAHPRO	game hypothetical production	Game production estimate used in making "hypothetical" within-lote resource base allocation for adjusting targets for cash cropping	none (included in 22)
GAHTAR	game hypothetical target	Target for game production in hypothetical within-lote resource base allocation for fixing cash targets.	none (included in 22)
GAMEY	game yield	Game sustainable yield per hectare of "virgin" forest	(27)
GANEED	game need	Product "need" for game	(52)
GAPERC	game per capita	per capita game consumption	(65)
GAPRES	game present	Kilos of game present in lot	(48)
GAPROD	game production	Amount of game produced in lote	(45)
GARAT	game ratio	Game surplus or deficit/ product need ratio	(54)
GASELL	game selling price	Game selling price	(62)

APPENDIX D, CONTINUED:

ABBREVIATION	TRANSLATION	MEANING	APPROXIMATE BOX NO. IN FLOW CHART
GASOD	game surplus or deficit	Game surplus or deficit in lote	(51)
GASOLD	game sold	Amount of game sold or exchanged	(60)
GPOHPC	game purchase Osa hectares per capita	Hectares per capita at carrying capacity from Osa formula modified for game purchase	none
GPOPPK	game purchase Osa persons per square kilometer	Persons per square kilometer at carrying capacity from Osa formula modified for game purchase	none
INITFS	initial family size	Family size at beginning of run	none
IT	iteration	Number of the iteration being made of calculation of yields and product allocation by family (for PCFAIL)	none
ITERAT	iterations	Number of iterations used for calculation of colonist failure probabilities for each year	none
IVALFS	interval for family size	interval for family size increments used in run	none
KPPKM	carrying capacity in persons per square kilometer	Carrying capacity in persons per sq. kilometer as calculated with skeleton program	none
L	lote	lote number	none
LANDCO	land colonized	land allotted for colonization	(9)
LOTSI	lote size	lote size (hectares)	(16)
MBUY	maize buying price	buying price for maize (cruzeiros/kg.)	(56)
MACASH	maize cash	cash from sale of maize	(60-61)
MACAYII	maize cash yield	net cash yield per hectare expected from growing maize	none (included in 22)

APPENDIX D, CONTINUED:

ABBREVIATION	TRANSLATION	MEANING	APPROXIMATE BOX NO. IN FLOW CHART
MAEAT	maize eaten	Amount of maize eaten by family	(63)
MAGOAL	maize goal	Government goal for per capita consumption of maize	(69)
MAHNO	maize hypothetical number	Number of patches planted in maize use in making hypothetical within-lote resource base allocation for adjusting targets for cash cropping.	none (included in 22)
MAHPRO	maize hypothetical production	Maize production estimate used in making hypothetical within-lote resource base allocation for adjusting targets for cash cropping	none (included in 22)
MAHTAR	maize hypothetical target	Target for maize production in hypothetical within-lote resource base allocation for adjusting targets for cash cropping.	none (included in 22)
MAIZNO	maize number	Number of patches allotted to maize production	(22)
MAIZY1	maize yield one	Maize yield per hectare in first year of cultivation	(27)
MAIZY2	maize yield two	Maize yield per hectare in second year of cultivation	(27)
MA NEED	maize need	product "need" for maize	(52)
MAPERC	maize per capita	Per capita consumption of maize	(65)
MAPRES	maize present	Kilos of maize present in lote	(48)
MAPROD	maize production	Amount of maize produced in lote (Kgs/yr)	(45)
MARAT	maize ratio	Maize surplus or deficit/product need ratio	(54)
MASEED	maize seed	Maize seed sown per hectare in kilos	none
MASELL	maize selling	Selling price for maize	(62)

APPENDIX D, CONTINUED:

ABBREVIATION	TRANSLATION	MEANING	APPROXIMATE BOX NO. IN FLOW CHART
MASOD	maize surplus or deficit	Maize surplus or deficit in lote	(51)
MASOLD	maize sold	Amount of maize sold or exchanged ([^] qs/yr)	(60)
MAXFS	maximum family size	Upper limit on family sizes for which run is made	none
MAXFPC	maximum acceptable probability of colonist failure	Maximum acceptable probability of colonist failure	(77)
MINHPC	minimum hectares per capita	Hectares per capita at carrying capacity as calculated using skeleton program	none
MINLOG	Minimum lote six	Minimum lote size for a family of six persons at carrying capacity calculated using skeleton program	none
OSACPC	Osa cultivated hectares per capita	Hectares per capita of cultivated land at carrying capacity using [^] sa formula	none
OSAHPC	[^] sa hectares per capita	Hectares per capita at carrying capacity as calculated using [^] sa formula.	none
OSAPKC	[^] sa persons per square kilometer of cultivated land	Persons per square kilometer of cultivated land at carrying capacity as calculated using [^] sa formula	none
OSAPPK	[^] sa persons per square kilometer	Persons per square kilometer of total land area at carrying capacity as calculated using Osa formula	none
OUTPUT	output	Output format requested. Two choices: full or partial.	none
P	patch	the patch number	(24)
PCFAIL	probability of colonist failure	Probability of colonist failing in a given year	(75) (see def. of box 75 in App. A)

APPENDIX D, CONTINUED:

ABBREVIATION	TRANSLATION	MEANING	APPROXIMATE BOX NO. IN FLOW CHART
REGNO	regenerating number	Number of patches regenerating	(22)
REHNO	regenerating hypothetical number	Number of patches regenerating in hypothetical within-lote resource base allocation for adjusting targets in view of cash cropping	none (included in 22)
RIBUY	rice buying price	Buying price for rice (cruzeiros/kilo)	(56)
RICASH	rice cash	Cash from sale of rice	(60-61)
RICAYI	rice cash yield	Net cash yield/hectare expected from growing rice	none (included in 22)
RICENQ	rice number	Number of patches allotted to rice production	(22)
RICEY1	rice yield one	Rice yield per hectare in first year of cultivation	(27)
RICEY2	rice yield two	Rice yield per hectare in second year of cultivation	(27)
RIEAT	rice eaten	Amount of rice eaten by family	(63)
RIGOAL	rice goal	Government goal for per capita rice consumption	(69)
RIHNO	rice hypothetical number	Number of patches planted in rice used in making hypothetical within-lote resource base allocation for adjusting targets in view of cash cropping	none (included in 22)
RIHPRO	rice hypothetical production	Rice production estimate used in making hypothetical within-lote resource base allocation for adjusting targets in view of cash cropping.	none (included in 22)
RIHTAR	rice hypothetical target	Target for rice production in hypothetical within-lote resource base allocation for adjusting targets in view of cash cropping	none (included in 22)

APPENDIX D, CONTINUED:

ABBREVIATION	TRANSLATION	MEANING	APPROXIMATE BOX NO. IN FLOW CHART
RINEED	rice need	product "need" for rice	(52)
RIPERC	rice per capita	Per capita consumption of rice	(65)
RIPRES	rice present	Kilos of rice present in lote	(48)
RIPROD	rice production	Amount of rice produced in lote	(45)
RIRAT	rice ratio	Rice surplus or deficit/ product need ratio	(54)
RISEED	rice seed	Rice seed sown per hectare per year in kilos	none
RISELL	rice selling price	Selling price for rice (Cruzeiros/kg.)	(62)
RISOD	rice surplus or deficit	Rice surplus or deficit in lote	(51)
RISOLD	rice sold	Amount of rice sold or exchanged (Kgs.)	(60)
VIHNO	virgin hypothetical number	Number of patches either virgin or fully recovered in hypothetical within-lote resource base allocation for adjusting targets in view of cash cropping	none (included in 22)
VIRGNO	virgin number	Number of patches either virgin or fully regenerated	(22)
Y	year	The year for which calculations are being made	none
YEARS	years	The number of years for which the run is to be made	none
XITER	iterations	Maximum number of iterations to be made in run (also see ITERAT)	none

APPENDIX E: PARTIAL LIST OF ASSUMPTIONS FOR SKELETON CARRYING CAPACITY PROGRAM:

Note: This partial listing has been compiled for the skeleton program -- other formulas included in the checklist have many other assumptions in addition to the ones listed here. "Osa formula" refers to the formula of Fearnside (1972), and "Carneiro" refers to the formula of Carneiro (1960). A plus sign (+) indicates that an assumption has been made, and a minus sign (-) that it has not been made.

ASSUMPTION NUMBER	ASSUMPTION NAME	ASSUMED CONDITION	SKELETON PROG. (pre-sent)	SKELETON PROG. POTENTIAL	FLOW CHART	OSA	CARNEIRO
(1)	Homogeneous initial land quality	At beginning of colonization all land included in the total resource base is equal in its ability to produce each of the crops, and in its susceptibility to degradation (no variance in space)	(+)	(-)	(-)	(+)	(+)
(2)	All land colonized	All of the land area classed as suitable for agriculture should be used for agriculture, as opposed to other uses such as forest reserves.	(+)	(-)	(-)	(+)	(+)
(3)	Equivalence of colonists	All colonists are identical in the way the various allocations are made and in consumption requirements	(+)	(-)	(-)	(+)	(+)
(4)	Fixed consumption	Consumption requirements do not change through time	(+)	(-)	(+)	(+)	(+)
(5)	Fixed yields	Fixed yields for first year and for second year for each agricultural crop. This implies variance in time is unimportant	(+)	(-)	(-)	one yield only (fixed)	one yield only (fixed)

APPENDIX E, CONTINUED:

ASSUM- PTION NUMBER	ASSUMPTION NAME	ASSUMED CONDITION	SKEL- ETON PROG. (pre- sent)	SKEL- ETCH PROG. POTEN- TIAL	FLOW CHART	OSA	CARN- EIRO
(5) continued		assumptions of fixed fallow time (6) and fixed consumption (4), this implies that carrying capacity is a constant.					
(6)	Fixed fallow time	The fallow time used is fixed: it does not vary for different crops, different locations, different colonists, or over time, or under influence from increasing population pressure.	(+)	(-)	(-)	(+)	(+)
(7)	Full recovery after fallowing	Land which has been fallow for the specified fallow time is completely equivalent to virgin land in terms of production and susceptibility to degradation.	(+)	(-)	(-)	(+)	(+)
(8)	Products produced	Only four products are required or produced: rice, beans, maize, & game.	(+)	(-)	(-)	(+) (in form used here)	only one prod- uct used
(9)	No storage	All product produced is either eaten, sold, or used as seed. Cash is also not saved.	(+)	(-)	(-)	(+)	(+)
(10)	No production cash costs	There are no cash costs involved in production, as for purchase of fertilizers, insecticides, and other technology.	(+)	(-)	(-)	(+)	(+)
(11)	No non-subsistence cash needs	No cash is needed for any purpose other than purchase of subsistence quantities of rice, beans, maize and game. This includes cash needs for paying loans for purchase of land, taxes, costs of clothing, medicines, etc. (see also no production cash costs (10)).	(+)	(-)	(-)	(+) (in form used here)	(+)

APPENDIX E, CONTINUED:

ASSUMPTION NUMBER	ASSUMPTION NAME	ASSUMED CONDITION	SKEL-ETON PROG. (pre-sent)	SKEL-ETON PROG. POTENTIAL	FLOW CHART	OSA	CARN-ETRO
(12)	Only one cash crop	Only one cash crop, the most "profitable" one, is grown for cash purposes.	(+)	(-)	(-)	No cash crops (in form used here)	No cash crops
(13)	Fixed prices	The buying and selling prices of all products are fixed.	(+)	(-)	(-)	No cash crops (in form used here)	No cash crops
(14)	No government aid	No government aid is given in the form of either direct supply of product or aid to production.	(+)	(-)	(-)	(+)	(+)
(15)	Equivalence of minimal requirements determining colonist failure and perceived goals of colonists	The "government goals for living standards" (box 69) is used both by the colonist in deciding how to allocate his land and his product, and in defining colonist failure for purposes of identifying when the carrying capacity has been passed. Colonists also do not plant crops in excess of these minimal needs within the restriction of the one hectare patch size assumption (20)	(+)	(-)	(+)	not applicable	not applicable
(16)	One product per patch per year	Each patch is assigned to the production of one crop for an entire year. This implies both that there is no interplanting with more than one crop simultaneously and that, if there is more than one harvest per year, that they are all of the same crop.	(+)	(-)	(-)	not applicable	not applicable

APPENDIX E, CONTINUED:

ASSUMPTION NUMBER	ASSUMPTION NAME	ASSUMED CONDITION	SKEL-ETON PROG. (pre-sent)	SKEL-ETON PROG. POTENTIAL	FLOW CHART	OSA	CARN-EIRO
(17)	No manpower restrictions	The amount of land within the lote that the family can cultivate at any one time is not restricted by insufficient manpower (ie. by the size of the family).	(+)	(-)	(+)	(+)	(+)
(18)	Game taken only at sustainable rate	Game is assumed to be taken at the maximum rate sustainable over the long term without any depletion of game yield per hectare of forest.	(+)	(-)	(-)	(+)	game not considered
(19)	Size of family is an integer	This restricts the accuracy limit to the "ACCLIM" figure in the skeleton program and sample output.	(+)	(+)	(+)	not applicable	not applicable
(20)	Patch area fixed at one hectare	This restricts the fineness of the farmer's response to units of one hectare in planting crops.	(+)	(+)	(+)	not applicable	not applicable
(21)	Cash allocation	Cash allocation proceeds as described (see Appendix A, box 58), and does not change through time.	(+)	(+)	(+)	no cash (in form used here)	no cash
(22)	Product allocation	Product allocation proceeds as described (see Appendix A, box 59), and does not change through time.	(+)	(+)	(+)	not applicable	not applicable
(23)	Within-lote resource base allocation	Within-lote resource base allocation proceeds as described (see Appendix A, box 22), and does not change through time.	(+)	(+)	(+)	not applicable	not applicable

APPENDIX E, CONTINUED:

ASSUMPTION NUMBER	ASSUMPTION NAME	ASSUMED CONDITION	SKEL-ETON PROG. (pre-sent)	SKEL-ETON PROG. POTENTIAL	FLOW CHART	OSA	CARN-EIRO
(24)	Accuracy of input data	Input data is accurate and not affected by statistical assumptions, sampling biases or errors in observations. Adequate statistical confidence has been achieved for the use to which the result will be put.	(+)	(+)	(+)	(+)	(+)
(25)	Probability of colonist failure only factor deter- mining carry- ing capacity.	No additional restriction is placed on the probability of area-wide famine. Also note: full recovery after fallowing and fixed fallow period make "environmental degradation" impossible -- the colonist "fails" before degrading his land.	(+)	(-)	(-)	not applicable	not applicable

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