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Technical Report

POPULATION-RESOURCE DYNAMICS
IN AN INDIAN VILLAGE

By
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ABSTRACT (within 250 words)

This paper presents a simulation model of population dynamics in an Indian village and discusses its usefulness to a policy maker, concerned with the economic and social development of such a village. The model contains some of the elements and interrelations which seem to have significant impact on the determinants of population dynamics, namely, births, deaths and migrations. The model is then used as a tool, instead of a real village, to test different development policies for their impact on the village's population growth and economic condition over time. The policies such as health services, education, and family planning are introduced in the model to ascertain their effect on the balance of births, deaths and migration. No attempt is made to optimize the outcome of any policy. Preference for one outcome over another is left to the values and objectives of the user of the model.

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Date June 8, 74

Signature of the Author
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Introduction

This paper presents a simulation model of population dynamics in an Indian village and discusses its possible usefulness to a policy maker, concerned with the economic and social development of such a village.

The term 'village' is defined and understood differently for different purposes. For administrative purposes in India, a village is a geographical area which has been or would have been separately assessed for land revenue*. The population of a village is usually less than 5,000 and more than 75 percent of the labor force is engaged in agricultural activities. The concept of village, however, as usually understood by sociologists, is much broader than that stated by this definition. A village is, according to them, a 'complex social system' in which people have developed a distinctive and well-defined way of life.

In addition to people there are other elements, such as physical resources like land and water, traditions and norms, occupations, and institutions which together determine a villager's way of life. Therefore to understand a village is to understand how these elements are interrelated and what role each one plays in the functioning of the village as a whole.

The model presented in this paper takes only a partial view of the village system dealing with its population dynamics. It therefore contains only those elements and interrelations which seem to have a significant impact on the determinants of population dynamics, namely, births, deaths, and migrations. The model is a tool which can be used, instead of a real village, to test different development policies for their impact on the village's population growth and economic condition over time. The policies, such as health services, education, and family planning will be introduced in the model, either simultaneously or

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*The definition is abstracted from the Punjab Land Revenue Act. Generally speaking, all areas not specifically taken as urban, belong to one village or the other.

sequentially, to ascertain their effect on the balance of births, deaths, and migration. No attempt is made to optimize the outcomes of any policy. Preference for one outcome over another is left to the values and objectives of the user of this model.

The usefulness of this approach is derived from the fact that unlike its real world counterpart, a model contains a simplified and therefore understandable abstraction of the village system. At attempt is made to separate out some of the important system elements from the thousands of environmental elements that may have major or minor influence on the population dynamics of the village. The functional relationships between these elements are stated explicitly. This clearly defined model, however crude and incomplete compared to the complexities of the real world, can be useful, especially to a policy maker, in two ways. First, during the course of his work, it can help him to specify and examine his own assumptions about the system. Second, observing the dynamic behavior of a model under a variety of conditions can help him to improve his own mental model of the system, which will always be, as it has been in the past, the ultimate basis of rational decision making.

Historical Perspective on the Village System

Historically, especially before the period of British India, villages seem to have formed and survived as self-sustaining units. Srinivas(1) characterizes them as having generally existed in a state of isolation from the rest of the world, each as a stable, self-sufficient whole, controlling its own affairs and yielding to the outside world only a land tax. There is ample evidence to suggest that until foreign or urban influences, the villages possessed a high degree of economic stability. They managed to produce the food and the services that were necessary for village life with the resources available in the village. In addition, village life seemed to have a certain romantic appeal. Conceptually, for many Indians and Westerners alike, a village was a living entity. Gandhi saw so much virtue in rural life that his dream was to make Indian one big village.(2)

Stability and self-sufficiency were perhaps the main attractive features of historic village life. Social and anthropological studies of that period suggest several possible mechanisms through which the stability was achieved and maintained. First, the population of the villages remained more or less constant, as a result of high fertility and mortality rates. The net migration was also not significant, though migration between villages due to marriage was a common phenomenon in some parts of India. Second, social stability was achieved through functional interdependence of various castes (i.e. occupational groups) in the village. Each village had as many as 30 diffierent castes, each of which was functionally dependent on the members of other castes for its survival. The opportunity for upward mobility was limited, and the fear of extinction or excommunication for the deviants from the caste system was severe. As a result, a stable social system based on occupational hierarchy emerged and existed for generations. Third, the traditional values of family life and prestige associated with them provided a bulwark against rapid change, or sudden transformation of rural life. The ways of behavior continued with little change from generation to generation. Institutions and practices were established during that period to serve and maintain village unity. Strong ties were developed to bind different groups of people in one body called the village.

The Changing Village Scene

The stable, self-sufficient villages that once existed in India are, to a large extent, a part of history. These once isolated units are now increasingly exposed to outside influences through mass transportation and communication. In the new political system they are less in a position to control their own affairs and still less to control their population. Village populations are growing, for a variety of reasons, beyond their capacity to support them. As a result more and more people are forced out of the villages into the cities. Unfortunately, even the cities cannot absorb an unlimited labor force in their economy, and the consequences are obvious. In 1970, not more than 13 million jobs were available for a minimum of 16 million net new workers who entered the urban labor market.[3] The result is a reverse flow of workers from city to village, which is already occurring, as many immigrants encounter continuing unemployment and hardship in the towns. The growing unemployment in the cities and the problems associated with it point out an urgent need to control migration from rural to urban areas. The solutions include both reducing the population growth in the villages and developing the villages to the point where they can support their population.

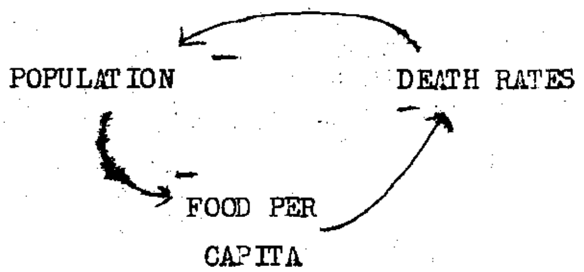
The Government of India is trying to incorporate various development programs in its policies towards the villages so that the villagers of the future may have better health and education, more food and income, and better life in general. Several programs and policies are either already implemented or will be implemented to achieve this goal. With the help of this model, we are seeking answers to the question: how effective will these policies be in achieving population control at the village level, so that the village can support its population at a better standard of living?

Research Methodology

The strength of the following research methodology, in our opinion, lies in that it takes the view of the village as a 'system'. The term system implies an interconnected complex of functionally related components. The components of the village systems include such things as people, material, occupations, traditions and values. These and many other components together formulate a causal structure that determines the behavior of the system. This structure is not directly observable. It can only be deduced from the known behavior of the many elements that make up the village.

As a first step to understanding the village system we will try to identify this underlying causal structure. We will begin with a sample structure, involving just a few elements, such as people, land, income, norms, and values. We will assume that they are related to each other in such a way that they not only influence each other but are also influenced by their own past behavior. In other words, they form feedback loops. An example of feedback loop is shown below.

Fig. 1



This little feedback loop shows that the present population size influences the future size, through its effect on food per capita and death rates. This loop of course is only a part of population dynamics. There are several such loops, each dealing with births, deaths, and migration. Together they describe the behavior of the aggregate population of the village. Similarly there are other feedback loops which relate population to resources of the village and vice versa. By putting all these feedback loops together, we will construct a model describing the dynamics of the population-resource balance in the village. We will then quantify the postulated relationships between the variables that are included in the model. Some of the data used to derive these functional forms are taken from the Khanna Study in the Punjab.[4] The remaining data, not available from that study, are abstracted from other sources, including educated guesses of the experts in the field. The model will then be used to simulate the behavior of the village over time. It will simulate the process by which the population size, food, income, life expectancy, and other characteristics of the village change over time.

In order to keep the model simple, the variables in its are highly aggregated. This simplicity is obtained at the cost of realism. For the model to be closer to reality, the level of aggregation must be reduced considerably. This will mean that instead of treating population as a homogeneous group, the model must account for the differences between ages, sexes, occupations, and castes. Similarly, distinction should be made between lands by their productivity, and if possible the castes by their traditions and values. This list could go on. As we reduce the level of aggregation, we end up with an extremely complex model with heavy data needs. Therefore, in the present version of the model, in which we are only interested in aggregate behavior modes, we assume that disaggregation by age and sex will be adequate for our purposes. However, the level of aggregation can be reduced further, if deemed necessary, in order to understand more detailed behavior modes with a greater degree of accuracy.

Because of the nature of this model (causal, nonlinear) and of the data incorporated in it, none of the standard statistical techniques seem appropriate to validate it. Hence, we have selected the following two criteria to judge the validity of the model. First, each of the causal relationships that is built into the model must be meaningful and supported by either some data or educated opinion. Second, the combined behavior of all these relationships acting together must be consistent with the current as well as historical behavior of actual villages. Admittedly, both these criteria are more qualitative in nature than quantitative, but certainly not less rigorous.

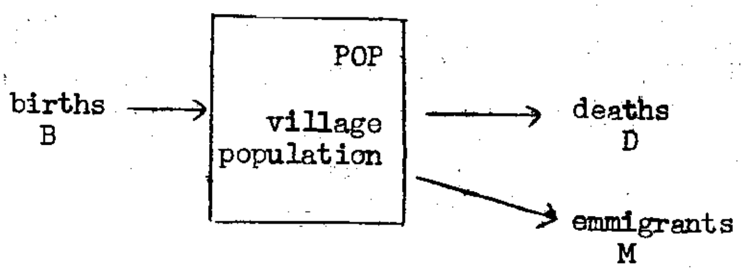
The model will then be used to test several policies proposed for the development of villages. Different development programs, alone or in combination, will be introduced in the model to test their effectiveness in inducing the desired change in births, deaths, migration and other characteristics of the village. Also, by simulating the model over a long period of time, the long- and short-term implications of those programs can be tested and compared.

The Model of Population Dynamics

Population dynamics is defined as the change in population size resulting from births, deaths, and migrations. The model presented in this section describes the population dynamics and its components in an Indian village.

Population dynamics

Figure 2



$$POP_t = POP_{t-1} + B_t - D_t - M_t$$

The factors which influence this dynamics include both the biological factors and the subcultural influences—such as traditions and norms, education and other socio-economic conditions. A model describing this dynamics can be divided into three parts. The first part calculates the number of births, given the biological and socio-cultural influences. The second part determines the number of deaths to be expected, under the same influences, with a given amount of medical care available to people. The third part of the model determines the socio-economic conditions of the village such as available food, income per capita, education, health, and family planning services, given the size and composition of population and the resource base. These three parts are then put together in one model to simulate the village behavior.

A Model for determining Births in the Population

Fig. 3

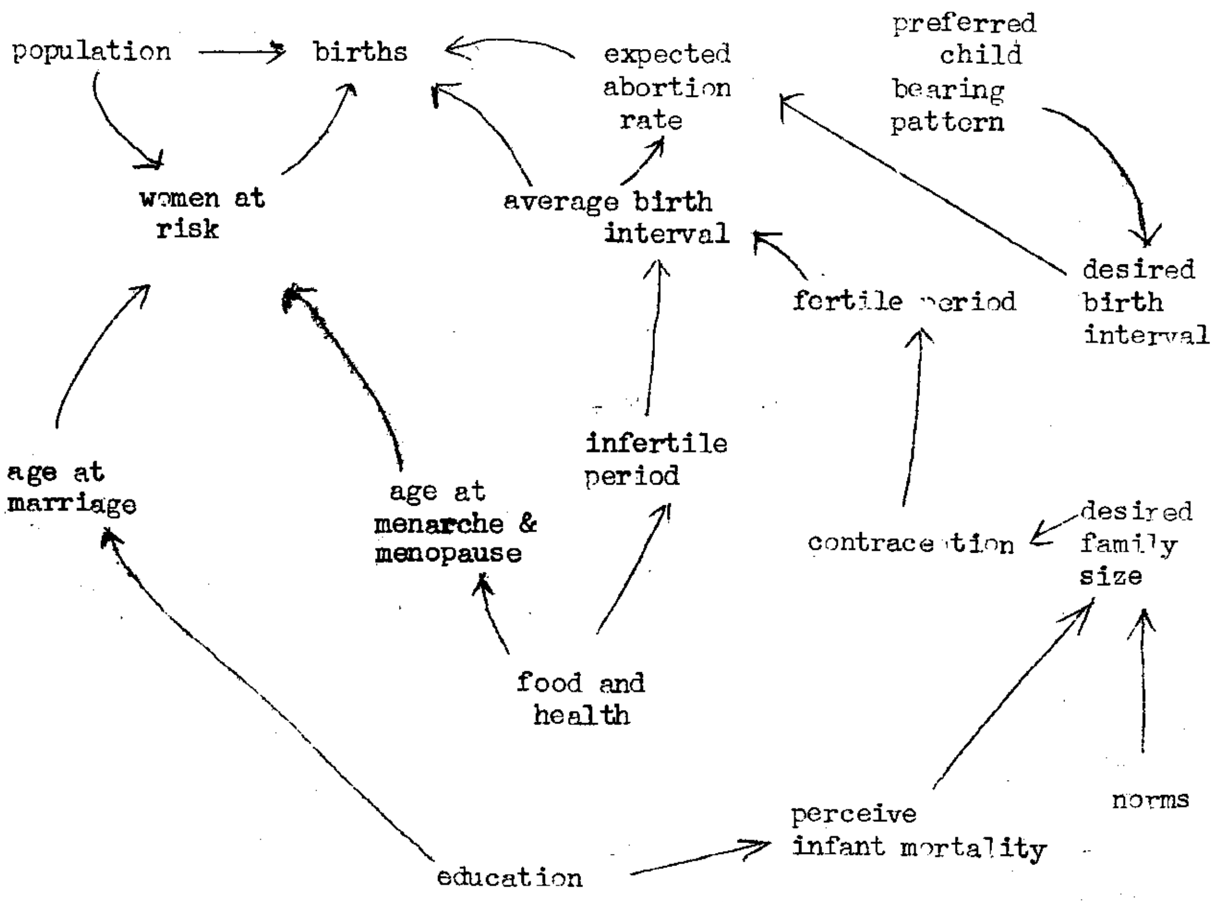


Figure 3 shows a model which calculates the number of births per year after estimating the number of women at risk of pregnancy and the probability of a birth per woman per year.

Thus

$$B_i = WR_i * \frac{1}{BI_i} * (1 - AB_i)$$

where $/B_i$ = number of births to mothers of age i

WR = women in i^{th} reproductive age group

BI_i = Av. birth interval for women giving birth in i^{th} age group

$\frac{1}{BI_i}$ = prob. of a conception per woman per year

ABi = proportion of aborted pregancies

Estimation of Number of Women in Reproductive Period

Ordinarily, the number of women of childbearing ages includes all women of ages 15 to 49. However, the actual reproduction span is determined by the age at marriage, in a society where most of the childbearing is within marriage and by the age of menopause.* Hence, the number of women at risk of childbirth (WR) forms a fraction of the total women of 15 to 49 years of age. The magnitude of that fraction is determined in this model by the age at marriage, the age at menopause and the incidence of sterility in the population.

Wyon and Gorden[(5)] give a very low estimate of primary sterility (2 to 4 percent) among women in Khanna villages in India. In this study a married couple not achieving a pregnancy within seven years was considered sterile. How representative this proportion is for rural India we do not know. But as a first approximation, 3 per cent of women of all ages are assumed to be sterile and are subtracted from the total female population. Further, the average age at marriage and at menopause are changed internally, in response to various socio-economic and physiological influences that exist in the model. The level of education among women influences the age at marriage while improved health condition is assumed to increase the age at menopause.

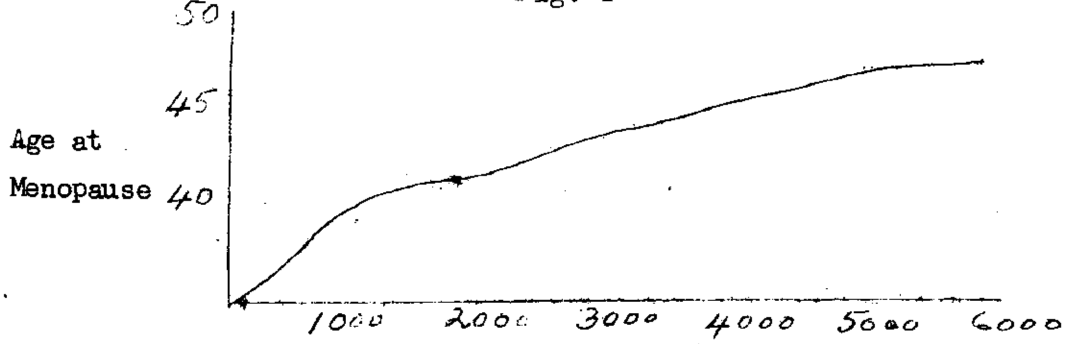
There is some evidence to suggest that higher standard of living and health may increase the total reproductive life time. Chennatamby[(6)] found

* For simplicity, the incidence of widowhood among women age 15-44 is not taken into account.

in a study of Ceylonese women that women in higher socio-economic groups have lower average age at menarche and a higher age at menopause than women in lower socio-economic class. Also, recent results from reprospective studies[7] on western women suggest about 48 years as the average age at menopause, while Wyon and Gordon[8] report an average age of 42.6 years in 11 Punjab villages in India from the sample of 235 women aged 30-55 years. A fraction (probably substantial) of this difference, as Wyon suggests, could be attributed, among other variables, to health conditions of the women.

In the model, the average age at menopause is determined by relating it to available per capita food for consumption since food intake is used as an index of health condition of the population.

Fig. 4



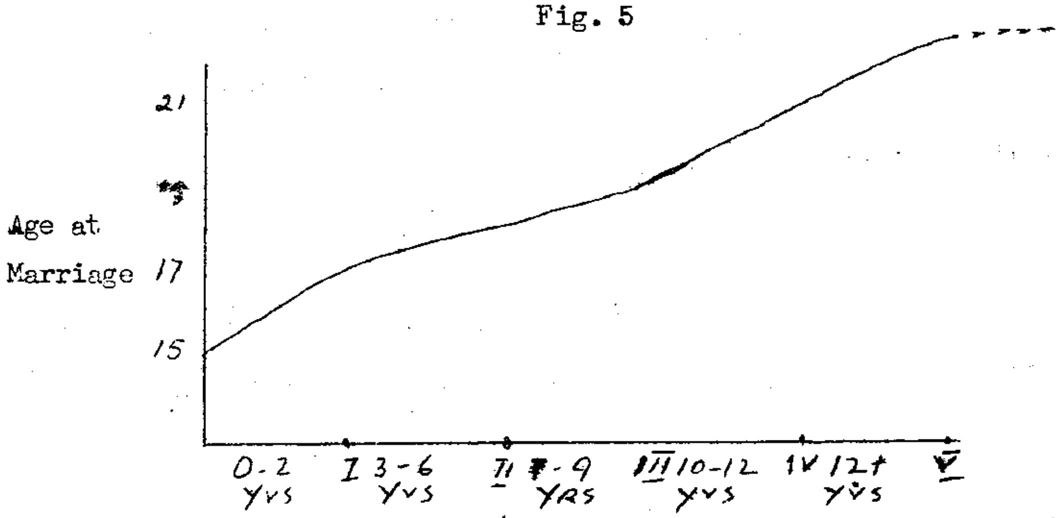
Food Per Capita (in calories)

In traditional rural societies, the average age at marriage is typically very low. This observation had led to many hypotheses, among which the one most widely held is that lack of alternative roles for women in underdeveloped societies contribute to early marriage, universality of marriage and hence to high natality. Hence, it seems that age at marriage may have some role to play in reducing fertility.

Another hypothesis associates the extended family system and parental control to age at marriage. However, the hypothesis that seems most plausible is that education and rising aspirations of parents and couples, have the effect of raising the marriage age. Ross[9] shows that among urban Hindus the customary early marriage is becoming undesirable to elders since it interferes with education of both sexes. Wyon found two preferred ages at marriage for daughters, one between 15 and 16 years, and, one between 18 and 20. The latter may be due to a higher level of education.

We will assume that the above hypthesis is true and postulate the following relationship between age at marriage and level of education.

Fig. 5



Education Level(average number of years of schooling)

Thus, the model calculates the average age at menopause and marriage from their respective determinants. Based on these figures, it estimates the number of women at risk of pregnancy from among all women of ages 15 to 49.

Estimating the Probability of Births: Probability of a birth has two components - the probability of a conception and the probability of that conception being aborted.

$$\text{Probability of a conception for women in age group } i = \frac{1}{BI_i}$$

where BI_i = Av. birth interval for women giving birth

AB_i = prop. of aborted pregnancies

hence

$$\text{Prob. of a birth} = \frac{1}{BI_i} * (1-AB_i)$$

Further, the proportion of aborted conceptions is assumed to depend on the ratio of the actual to the desired interval between births. The method of estimating those intervals and the abortion ratio is described next.

a. Average Birth Interval for a woman giving birth, includes the periods of gestation, infertility (due to post-partum amenorhea) and exposure. Among contracepting population, the exposure period can be increased from an average of six months to any length depending on the effectiveness of contraception.

It is often observed that birth intervals increase with age and parity of the mother. Henry(10) estimated an increase of 6.5 months from ages 20-24 to ages 35-39, but those were deduced rather than observed differences. On the other hand, the estimates for Hutterite women cited by Tietze(11) do not show as much increase in birth interval by age as that shown by Henry.

Table 1: Number of Intervals between Confinements, Including and Excluding Last Intervals, and Mean Duration of Interval, by Age of Mother at Onset of Interval (132 Couples)

	Number of Intervals		Mean duration (mo.)	
Age at onset(yr)	Including last intervals	Excluding last intervals	Including last intervals	Excluding last intervals
Under 25	297	293	23.1	22.8
25-29	308	302	25.0	24.9
30-34	285	270	25.8	25.1
35 and over	282	175	27.6	25.7

(Source: C. Tietze, "Reproductive Span Among Hutterite Women", Fertility and Sterility, 8 P. 95, 1957)

Also, a pattern seems to exist between birth interval and parity, namely, the higher the parity the larger the birth interval, as is reported by

Talawar[12], Dandekar[13], Wolfer[14], and Wyon[15]. However, one cannot be safe in assuming that this is a biological phenomenon and not a conscious attempt to delay births.

We, therefore, have assumed that age and parity have no effect on the natural birth interval and that the minimum interval, in the absence of contraception, varies between 18 and 32 months, depending generally on health conditions. On the other hand, contraception and induced abortion practices are assumed to vary with age of the mother and her desired family size, which together account for varying age specific birth intervals and fertility rates.

a. Actual birth interval (BI), thus, has two components, namely the infertile interval and the period added to it through use of contraception.

$$BI_i = INF + F / (1-CE_i)$$

INF = Average infertile period, includes period of gestation, post-partum amenorhea and anavolutary cycles

F = fertile period of exposure

CE_i = contraceptive effectiveness

b. <u>Desired Birth Interval</u> by age of the mother takes into account the total desired family size and a preferred child bearing pattern in that society. The model assumes the following pattern of desired births by age and in an early or a late marriage pattern.

TABLE 2

Total Desired Births	Early Marriage 21 yrs Age 15-24	25-34	35-44	Late Marriage 21 yrs. Age 15-24	25-34	35-44
2	2	0	0	1	1	0
4	2	2	0	1	3	0
6	2	3	1	1.5	3	1.5
8	3	3	2	2	4	2
10	3	4	3	2	4	4

Thus, desired birth interval (DBI):

$$DBI = \begin{cases} \dfrac{RLT(i)}{DB(i)} & \text{if} > MPI \\ MPI & \text{OTHERWISE} \end{cases}$$

where MPI = average minimum birth interval in the absence of contraception

RLT(i) = reproductive life time in i^{th} age group. Hence

RLT(15-24) = 24 - (Age at marriage)
RLT(25-34) = 10 years
RLT(35-44) = (average age at menopause) - 35

DB(i) = desired number of births during i^{th} age period. This number is selected from Table 2.

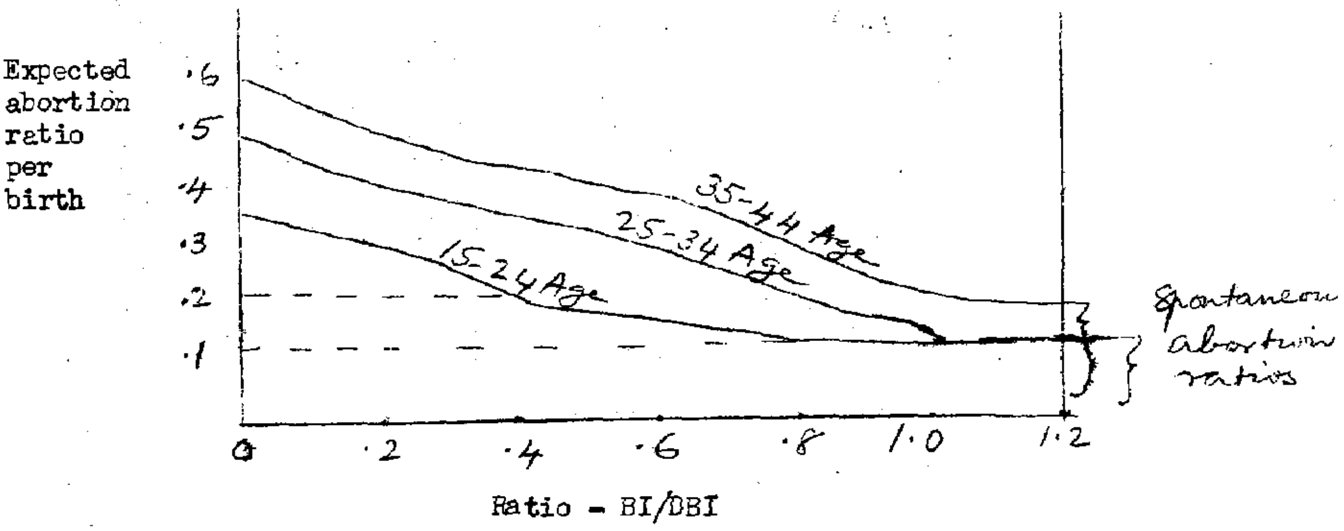
c. <u>Induced abortion</u> is possibly the oldest and the most widely practiced method for terminating unwanted pregnancy, as is suggested by evidence from many societies.(16) Abortion may be used with varying frequency by mothers when their desired family size approaches and also with intention of spacing. In the Khanna study, Potter et al.(17) found that women under 20 and over 35 years had particularly high abortion ratios. L.P. Chow(18) reports on the basis of his Taiwan data that most induced abortions were performed on those women who were approaching their ideal family size and who resorted to abortion when unwanted pregnancy occurred. He also suggests that abortion rates are inversely related to the contraceptive effectiveness available in the society. Women may resort to abortion also when they feel that the 'next baby is coming too soon'. Moni Nag(19) found that in many of the pre-industrial societies contraception, and abortion, were practiced to avoid pregnancy considered undesirable during the period of lactation. From more recent data from Taiwan, L.P. Chow concludes that there may be a desired length of birth interval and women may resort to abortion in order to achieve that length.

In the model, the age specific abortion probability is determined by the following procedure: first, the desired and actual pregnancy interval by age of the mother are calculated. Then the ratio of these two intervals indicates the expected proportion of abortion in that age grou It is assumed that for women under age 35, 15% of the pregnancies result in spontaneous abortion, while for women above 35, this proportion is 20%. To these constant proportions we have added induced abortions as shown in figure 6.

Since abortion is used to prevent unwanted pregnancies, the proportion declines as the ratio $\frac{BI}{DBI}$ rises to 1. Beyond this point, only spontaneous abortions are assumed to occur. The following graph shows the relation between birth interval ratio and expected abortion to pregnancy ratio.

Fig. 6

Age specific abortion ratio as indicated by the ratio of desired and actual pregnancy interval



Use and Effectiveness of Contraception

Use and effectiveness of contraception is an important policy variable in the model, capable of influencing population dynamics. Contraceptive effectiveness (CE) has two dimensions, namely, the clinical effectiveness of available methods and the extent of their use. The clinical effectiveness measures the proportionate reduction in a woman's natural fecundity due to contraception. 'Use' measures the prevalence of a given contraceptive method in the population. Both use and effectiveness are influenced by age and also by desired family size. Westoff et. al.[20] show that in the United States use-effectiveness of contraception increases as the desired family size is reached. In other words, use and effectiveness are functions of motivation to stop at a particular parity. The extent to which this generalization applies across cultures is not known. However, it is easy to see that as the desired family size gets smaller, it can be attained within less than half of the reproductive period, which means that during the next risk period the couple must somehow avoid any further conception. It will require very efficient contraception to prevent conception during an exposure of more than 10 years. This effectiveness can be achieved only if effective methods are available and the will to use them is strong.

We determine the contraceptive effectiveness that will be required to extend the actual birth interval to the desired level, by using the following formula

$$EC(i) = \left(1 - \frac{F}{DBI(i) - INF}\right)^{*}$$

where EC(i) = contraceptive-effectiveness that is necessary to extend the birth interval up to the desired level in i^{th} age group

DBI(i) = desired birth interval

INF = infertile period

F = period of exposure, assumed to be .5 years for all women

* see footnote (1), Appendix B

'Use' of contraception, i.e. the proportion of women who can achieve 'perfect control' over their fertility will be determined externally and will be treated as a policy decision related to the family planning program.

In the preceding description of the model one may notice a rather heavy reliance on so-called desired family size. The concept of desired family size is, no doubt, a useful index for determining the actual family size, contraception practice and extent of induced abortion. However, there is no satisfactory method to measure it. In more than 20 countries the KAP surveys provide some measure of desired family size. Even there, the data on ideal and desired family size are of doubtful nature. It is not quite known whether people express their desire as something they believe in or something they think the interviewer believes in. Furthermore, the desired family size may vary with the actual family size. Even so, desired births is the only index available so far to express quantitatively the family building motivations of people.

Determinants of Desired Family Size

Desired family size may be influenced by many factors. In the model only three of those factors, infant mortality, income, and education will be considered explicitly. Others will be lumped together and expressed as "normal desired family size". The normal size stands for the completed and surviving family size that is considered proper in a given culture. This number is expected to change only gradually. The desired number of births is calculated from the norm size after taking into account the infant mortality risk.

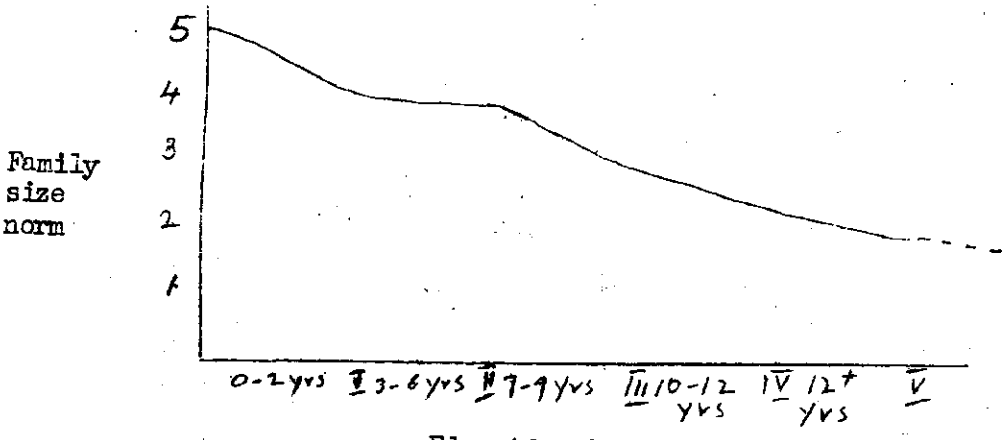
It is probably no accident that people who experience high infant mortality also express larger desired family size. Heer[21] discusses various reasons why the level of mortality has a direct effect on desires and fertility. In Khanna villages, Wyon [22] points out that people weigh the desirability of children in their concept of what is good for their family, and the chances of survival of the children they already have. He observes that among wives of the farmer caste, particularly, survival of most children born early during the process of family building was associated with relatively few subsequent births. Although some couples practiced birth control once they had the number of children they wanted, deaths of children had much greater effect on completed family size. Hassan[23] also supports the idea that experience of infant or childhood mortality tends to raise fertility. Let us assume that a change in infant mortality will cause a proportionate change in desired number of births. Then desired number of births can be determined as follows:

$$DNB = \frac{\text{DFSN (des. family size norm)}}{1 - \text{PIMR}}$$

where PIMR = perceived infant mortality rate which is a delayed function of actual infant mortality rate

DFSN = desired family size norm which is assumed to be a function of education as postulated in fig. 7

Fig. 7



It is further assumed, as shown in figure 7, that desired family size norm is changed only through education. Average number of years of schooling is used as an index of one's ability to take rational decisions and also as an index of one's capacity to deviate from the traditional norms, if they seem inconsistent with current conditions. Also, education helps reduce infant mortality and enhance dissemination of information about family planning. The role of education in influencing desired family size is perhaps even more basic. A plausible hypothesis is that with increased education, the population becomes involved with ideas and institutions of a larger modern culture. If the individual is, or he believes he is, part of a larger non-familial system, he begins to find rewards in social relationships for which larger numbers of children may be irrelevant(24).

Income is also related to desired family size in several direct and indirect ways. For example, it is negatively associated with infant mortality and positively with education, and both have an impact on the family size desired. In addition, the economic utilities and costs of bearing children can be important considerations in the process of family building. The central notion of the economic theory of population dynamics is that people try to balance the satisfactions to be derived from an additional birth against the cost, both monetary and psychological, of having an additional child. As income per capita increases so does the degree of specialization and the degree of economic mobility. If the new occupational environment limits opportunity for child labor and requires more costly training for children, the parents may feel a need for smaller families so that they can take advantage of the new and different economic opportunities (25) (social capillarity thesis).

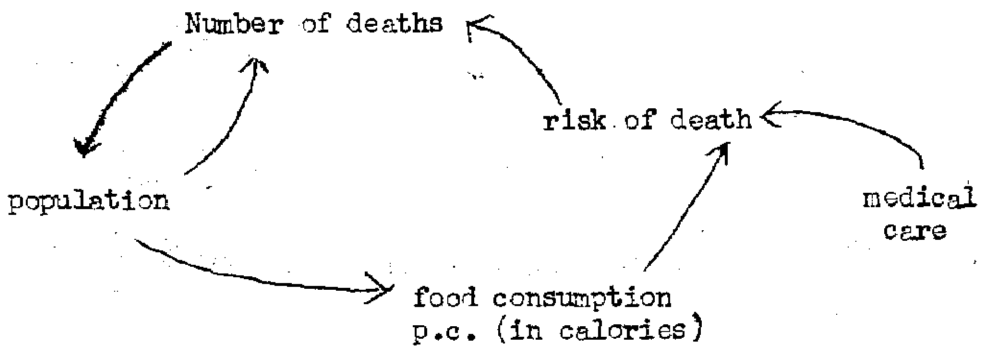
At certain stages of economic development the "social capillarity" effect described above may be an important determinant of family size. However, in an Indian agricultural village, where opportunity for occupational mobility is limited, the opportunity cost of an additional child may be insignificant. On the other hand, the utilities to be derived from the child as a productive agent when he enters the labor force and contributes to the family income and the utilities as a potential source of security could be very important. These utilities are generally expressed in the family size norms, and as they change the norms change too. However, the nature of these utilities may not be totally economical. For example, sons may always be preferred over a social security system independent of sons, for totally non-economic reasons.

Thus, the direct effects of income on family size norms are difficult to measure and isolate from other effects, especially in an agricultural village society. Therefore, for simplicity, we will incorporate only the indirect influences of income on desired family size through education and health conditions.

A Model for Determining Deaths in the Population

The process which determines the death rate in this model is rather simplistic and aggregate.

Fig. 8



It is assumed that the risk of death decreases with increasing food consumption. The functional relation between food consumption per capita and death rate is shown in Figure 9.

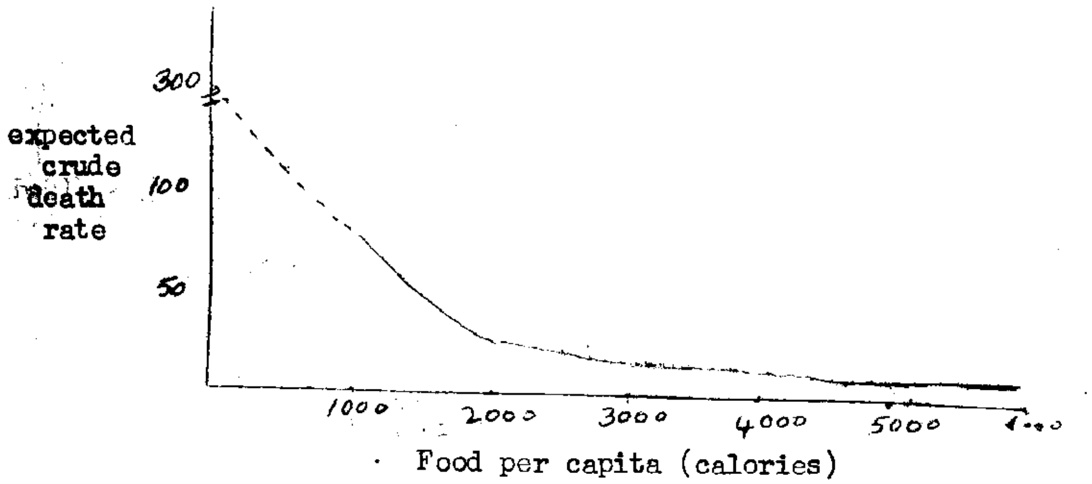
Thus the death rate is determined from the following set of equations:

$$DR = FM \times (1-MED)$$

where FM = expected death rate in a population based on their food intake. This figure is obtained from the function shown in Figure 9.

MED = medical care provided to the population

Fig. 9

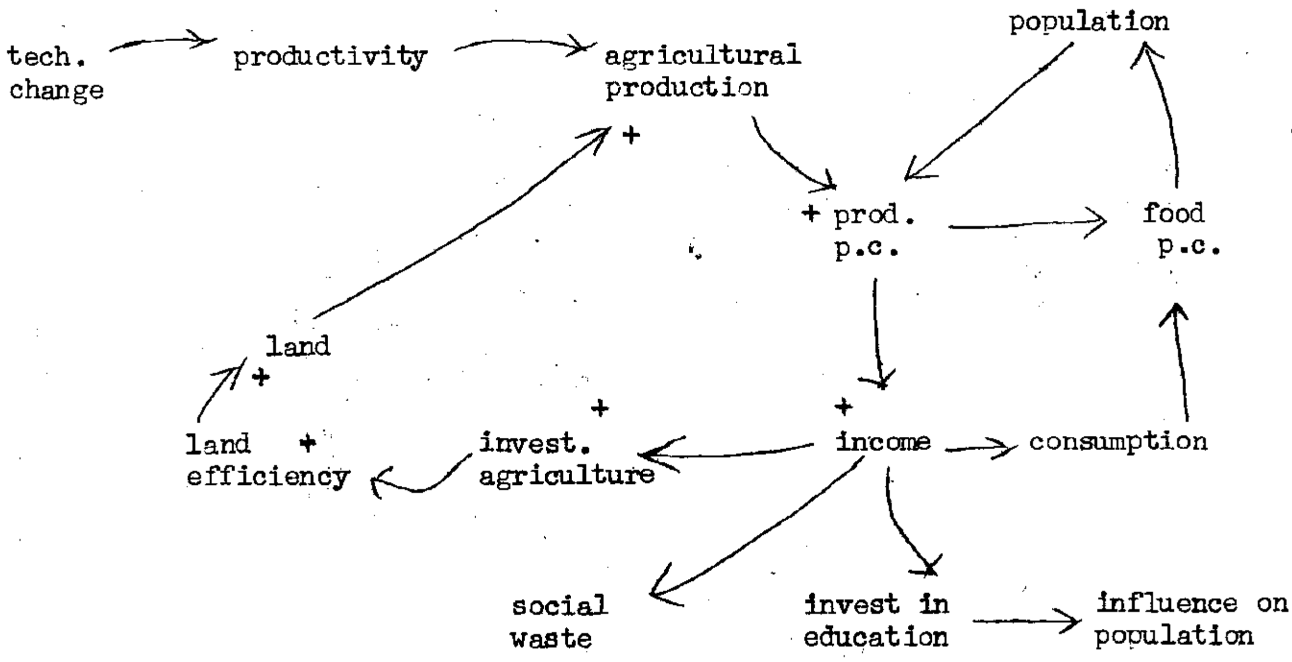


MED, the other factor which reduces the death risk, is very generally called medical care without specifying its various components. The term medical care here simply means any mechanism through which the death risk could be reduced by certain amounts. The more pertinent dynamics related to how, and at what cost, one can achieve such a reduction in mortality, is beyond the scope of this model.

Resource Dynamics in the Village

The village, as described in this model, is more or less a closed system in which subsistance depends on whatever the people of the village can produce within the village and within its own resources. Since cultivable land is the basic source of livelihood in an agricultural village, it is assumed to represent all the resources available in the village. Land productivity and income of the village are measured in calories produced. The following diagram shows the most elementary interactions between population and resources in an agricultural village.

Fig. 10



After satisfying the basic food requirement of the population the surplus food is used as income which can be either consumed or invested in four ways: it can be used to improve diet, be invested in improving agriculture, be invested in education facilities, or spent on social events such as marriages and festivals, which will be considered as 'waste' from society's point of view. The proportion of income to be spent on any or all of these categories will be determined according to the traditional expenditure pattern. We will introduce policies to increase land productivity or increase education levels in the village, as a part of government programs for village development and then observe the impact of these policies on birth and death rates, population, migration, and other characteristics of the village life in short and long time periods.

A detailed flow diagram for the village model and its mathematical formulation are presented in Appendix A.

In the following section, we will discuss the simulated behavior of the village model and its sensitivity with regard to a few selected policies. The discussion will be focused on the roles of birth, death and migration in population control of the village and how they change under different policies regarding health, education and family planning.

Discussion of Model Output

In this section we will discuss some simulation results, their validity and implications. Our objective is to reproduce the behavior of a historic village, a closed system in which large scale migration does not take place. We will then simulate the model under different conditions and policies designed to "modernize" the village and observe the resulting population dynamics. The model is assumed to be 'valid' if the simulated behavior seems to agree with the known behavior of an Indian village.

1. The Basic Run: In this run, the model simulates a stable village system which resembles in some of the major trends to the "historic" Indian village. Since then several external forces have exerted pressures on village population. The force which is active in the basic run (figure 11) is random fluctuations in agricultural production. During good years the population grows rapidly and during poor years it sharply declines. On balance, the population growth is slight. Average birth and death rates are high and people live at a bare subsistence level.

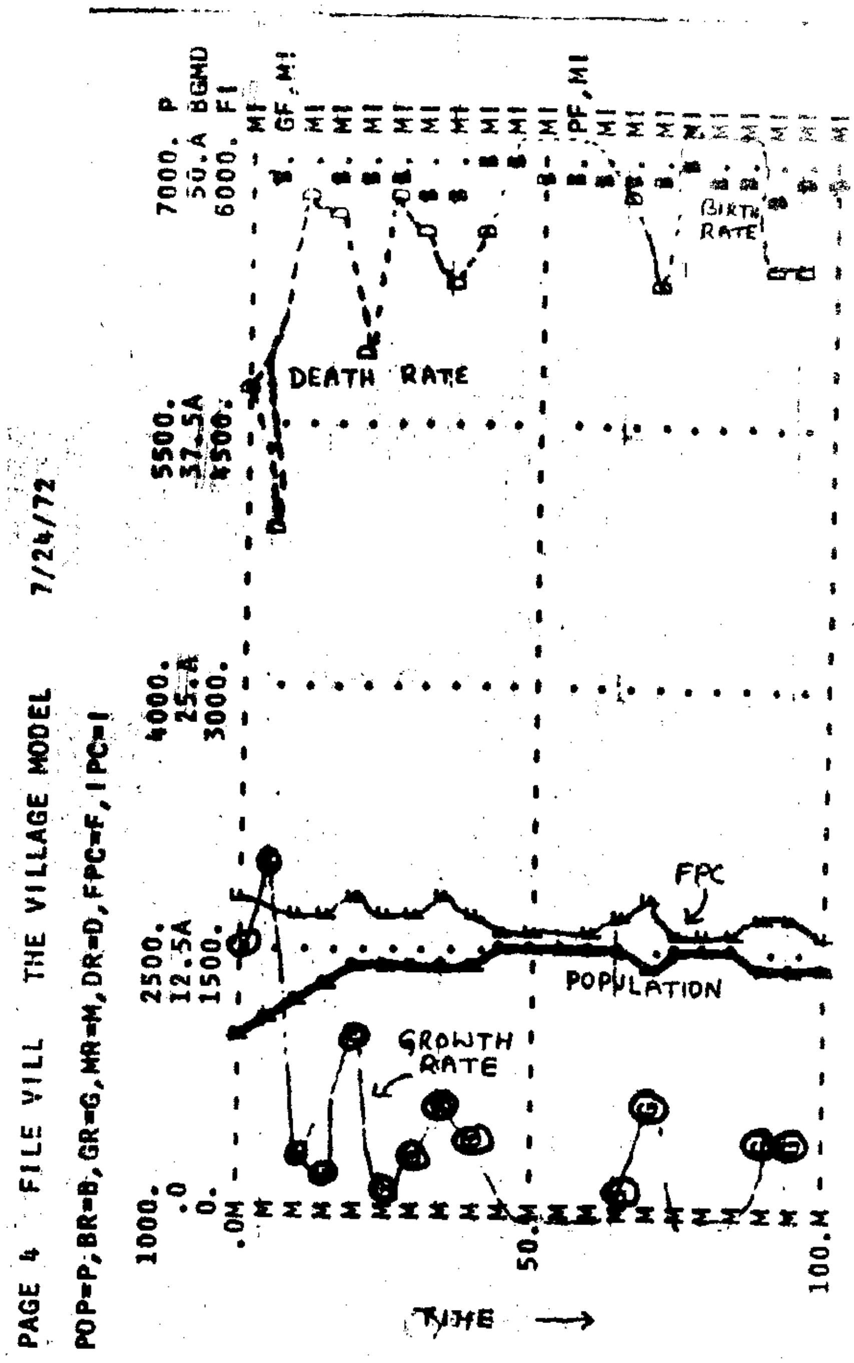
2. Introduction of Medical Care:

To this stable village system, we will introduce 'medical care' to reduce the death rate by 50 percent gradually over 50 years. Also food production is increased by 2 percent per year. Figure 12 shows the simulated behavior of a village under those conditions and assuming no migration.

Figure 11

Basic run: Population dynamics in pre-historic village system

TIME E+00	DFS E+00	MORT E+00	RBR E+00	EDU E+00	TFS E+00
.0	3333	41246	.16626	0.	7.0976
20.	4578	41459	.16164	0.	7.1054
40.	6664	42444	.15518	0.	6.9204
60.	6980	43218	.15508	0.	6.7368
80.	7427	43459	.15505	0.	6.6812
100.	7480	43150	.15509	0.	6.7525



P - Population
B - birth rate
D - death rate
G - natural growth rate
F - Food P.C.
M - Migration Rate

Figure 12

Introduction of medical care, no migration

TIME E+00	)FS E+00	MORT E+00	ABR E+00	EDU E+00	TFS E+00
.0	8.3333	.40000	17405	0.	7.3140
20.	8.1277	.32882	17251	0.	7.0509
40.	7.4317	.25687	17250	0.	6.6031
60.	6.7396	.22769	16609	0.	6.0838
80.	6.5158	.23558	16319	0.	5.8415
100.	6.5389	.23892	16071	0.	5.7710

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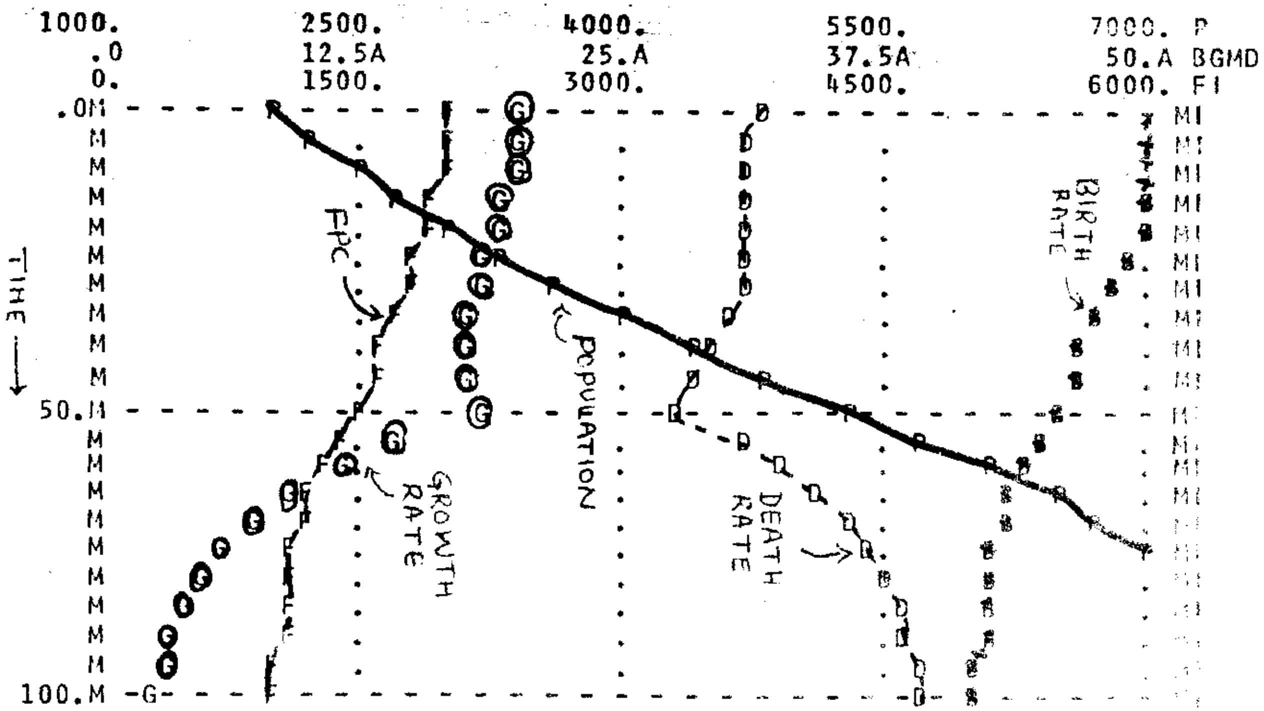

Figure 13

Introduction of medical care and migration

TIME E+00	DFS E+00	MORT E+00	ABR E+00	EDU E+00	TFS E+00
.0	8.3333	40000	17405	0	,.3140
20.	8.1172	32239	17763	0	7.1864
40.	7.3593	24335	18625	0	6.9563
60.	6.6214	20487	19567	0	6.7086
80.	6.3297	20482	20086	0	6.6541
100.	6.29[illegible]3	20481	20155	0	6.6470

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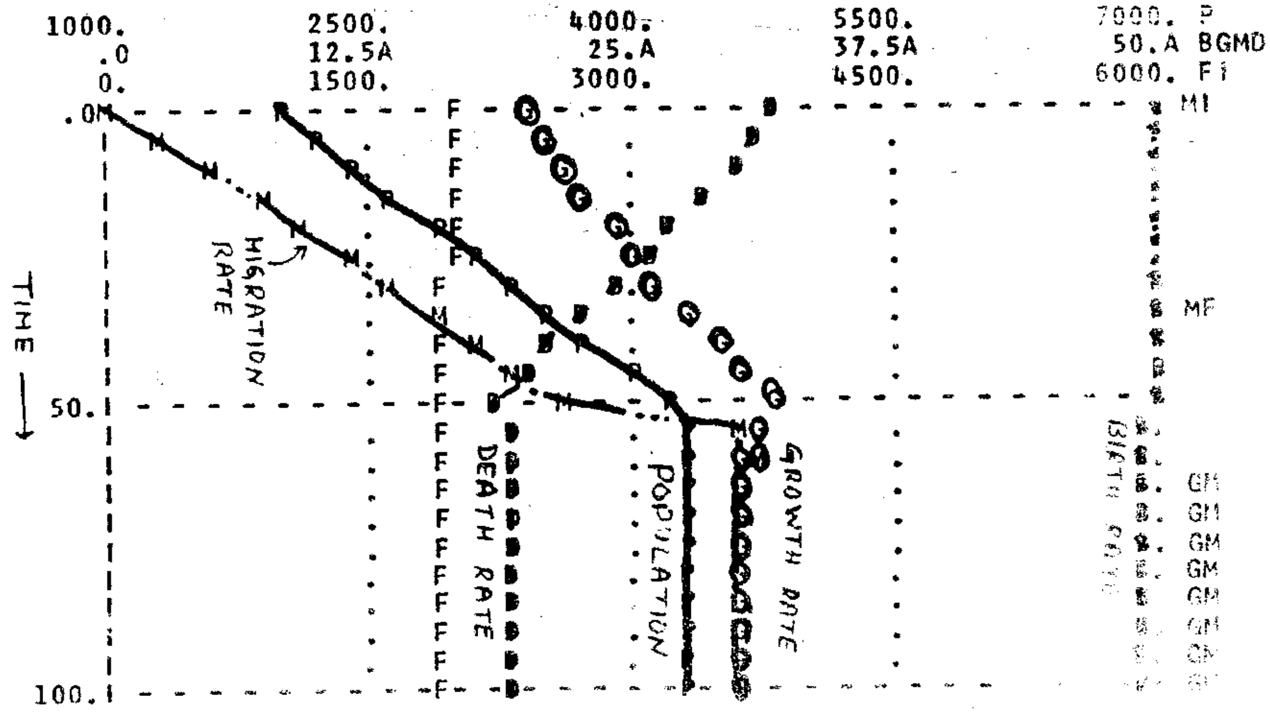

As expected, population grows rapidly with a drop in mortality and slight drop in the birth rate. This population growth, however, slows down as food becomes scarce and death rate rises again. Wyon defines this dynamics as 'population pressure'(26).

3. Medical Care and Migration:

When population pressure manifests itself, people are compelled to take agricultural, fiscal or other measures in an attempt to provide for too many people from too few resources. One such measure is migration from the village. To test how effective this measure is in controlling village population, a certain proportion of excess population in the village model is removed every year as out migrants. The excess population is determined as follows:

Excess population = Actual population - Sustainable population,

$$\text{and Sustainable population} = \frac{\text{total food production}}{\text{minimum food required per person}}$$

The migration rate is assumed to be unfform over both, ages and sexes.

In figure 13, we assume, in addition to the medical care and increased food productivity, 50 percent of the excess population can migrate each year. The results are summarized on page 24.

The natural growth, i.e. the excess of births over deaths, in this village is more rapid than it was without the outmigration. However, the population size remains constant and out migration compensates for most of the natural increase.

The long standing disparities between the population growth rates of villages and those of urban areas imply that in most Indian villages some kind of 'migration policy' did exist, though perhaps not as extreme as assumed in this run. Wyon and Gorden, who also studied migration patterns in a Khanna village observe - "from 1911 to 1961, populations of the seven test villages increased at an average annual rate of 12 per 1,000. In the years since 1921 the death rate in the study area declined by almost 50 percent and the birth rate by about 15 percent. In the absence of some added action (migration) by the inhabitants, the fewer deaths would have resulted in a materially greater growth than that recorded."(27)

If the option to migrate is closed, how will it affect the village population? Obviously, to relieve the village of population pressure, either the death rate should rise, the birth rate should fall or both. Ideally, one would like to see a sufficient fall in birth rate to compensate for the decline in death rate.

4. Introduction of family planning:

There are many theories and hypotheses about how to achieve such a balance through birth control alone. The present family planning program in India is based on an assumption that "if people can avoid unwanted pregnancy, and can be made to want fewer children through education and low infant mortality, the villages can contain their population without resorting to migration." We applied this assumption to the village model, in which

1) mortality is reduced by 50 percent over 50 year periods
2) all unwanted pregnancies are eliminated
3) education level is raised to an average of 7-9 years instantaneously

and observed its behavior (figures 14, 15). In figure 14, migration is absent while in figure 15, 50 percent of the excess population is assumed to be migrating out. A comparison of these two runs shows that even if people can avoid all unwanted pregnancies, they may not be able to avoid population pressure. If migration is not feasible (as in figure 14), population control will be achieved more through increased death rates rather than through lowering of birth rates.

The above results are based on the assumption that the village is a closed system where food and other supplies cannot be imported and also that its causal structure will not change substantially in the near future. However, in the case of social systems, the causal structure andthe way people make decisions often change, though gradually, to adapt to the changing environment though our ability to foresee such changes is limited. The implications of such changes to the village system and to the model will be discussed later in this paper.

The various simulation runs, under this assumption, point out that the population control in the villages will be achieved more through migration and death than through control of births. The reason being that in the present structure, the decision to have children is influenced more by familial considerations than by larger social considerations. Hence, when death rate rises, because of food and other scarcity, the individual desired family size and, therefore, births

Figure 14

Introduction of family planning and education with policy of no migration

TIME E+00	DFS E+00	MORT E+00	ABR E+00	EDU E+00	IFS E+00
.0	4.8571	.30000	.15232	2.5000	1.3054
20.	4.7483	.22713	.15217	2.5000	1.2633
40.	4.4013	.16800	.15187	2.5000	1.0505
60.	4.1003	.14744	.15164	2.5000	3.8677
80.	4.0095	.15808	.15167	2.5000	3.6724
100.	4.0357	.16240	.15170	2.5000	3.6344

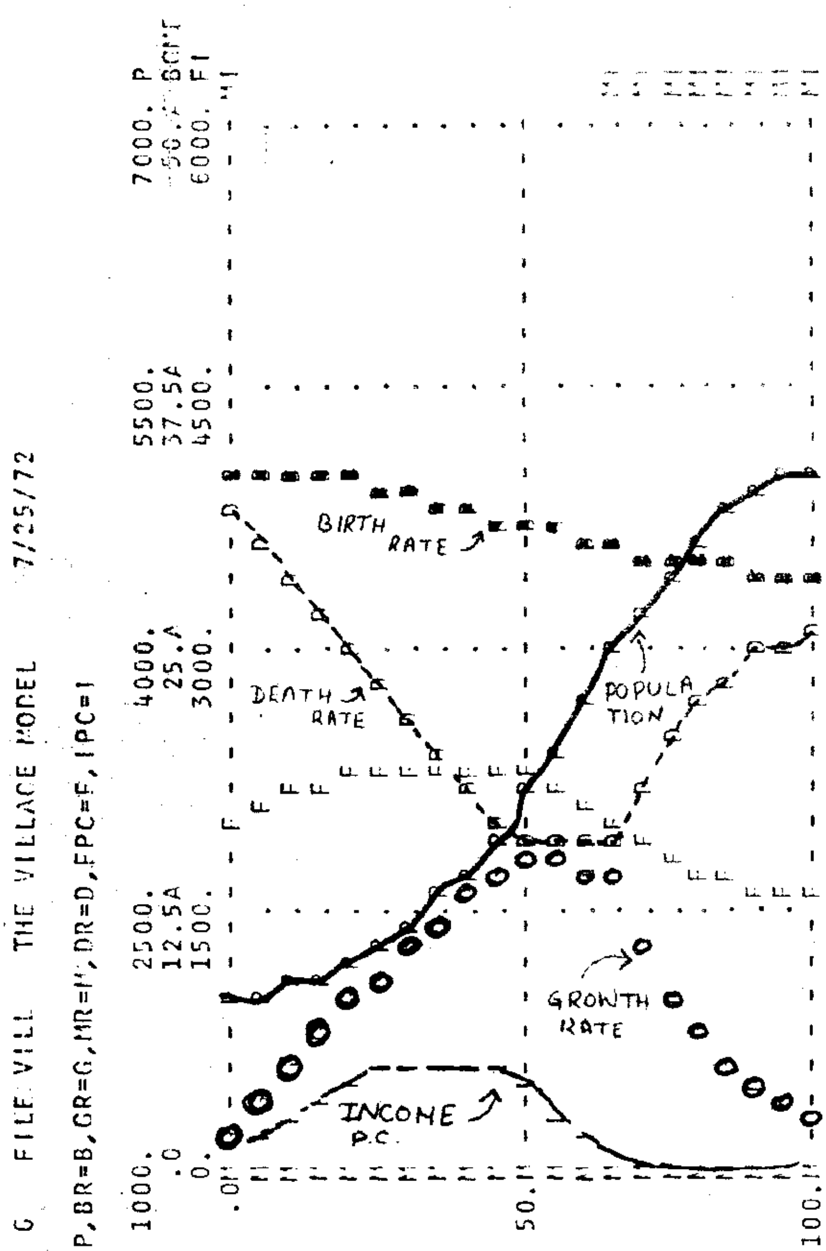

Figure 15

Introduction of family planning, education, and 50 percent of the excess population outmigrates

TIME E+00	DFS E+00	MORT E+00	ABR E+00	EDU E+00	TFS E+00
.0	4.8571	30000	.15232	2.5000	4.3054
20.	4.7483	22713	.15217	2.5000	4.2633
40.	4.4013	16869	.15187	2.5000	4.0505
60.	4.1008	14744	.15164	2.5000	3.8677
80.	4.0065	15152	.15159	2.5000	3.7603
100.	4.0062	15152	.15159	2.5000	3.7601

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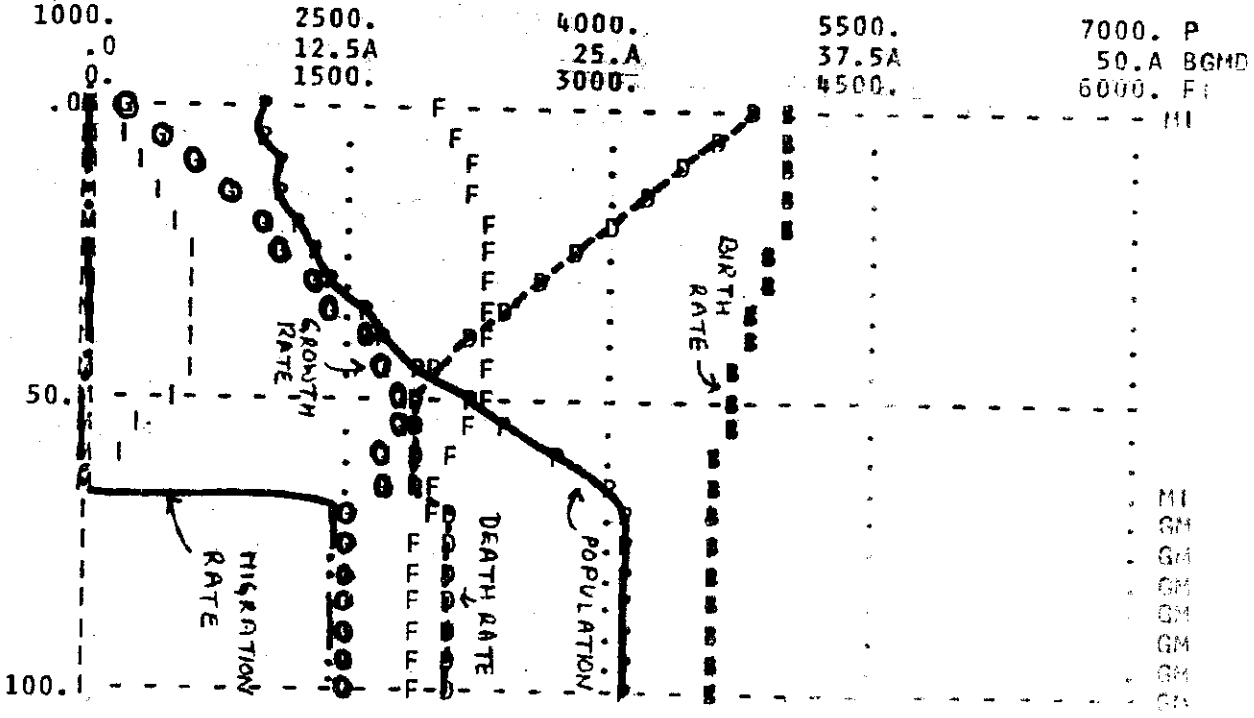

increase to compensate for dying children. Unless this cycle is somehow broken or weakened in the model, the village population does not reach at a level of low births and deaths and no migration. This implies a need for structural changes in that system - in its institutions, traditions, and values. In each society the cultural norms about vital matters such as family size, marriage, timing of intercourse and abortion are deeply imbedded in social customs and institutions, and changes in fertility are unlikely with prior or at least simultaneous changes in those institutions. Now, we will focus on the impact of a few other policies which are either practiced or recommended for population control.

5. Effect of Increase in Age at Marriage:

In this model, we will try to investigate how effective the policy of 'increase in marriage age' is in reducing fertility. After simulating the model several times under identical socio-economic conditions* but gradually increasing the age at marriage from 15 to 22 years, we found that the influence of late marriage on either birth rate or population size is not significant until it is raised to atleast 21 years which brings about 30 percent reduction in birth rate (fig.16, 17). More important, the behavior modes of population dynamics do not change even when age at marriage is increased to 21 years. However, we cannot conclude that it is an ineffective measure of population control, since the model is too simple to take into account the increasing mean generation gap resulted from increasing marriage age and its effect on population growth. Also, this seems like an 'efficient' measure, in the sense that women who marry late can attain their desired family size with perhaps fewer induced abortions and relatively ineffective contraception. However, this efficiency cannot be achieved unless marriage age is raised to a sufficiently high level (figure 18).

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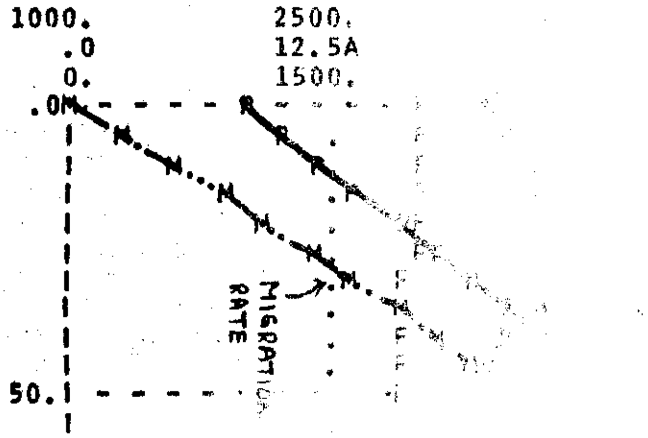
* i.e. 50 percent reduction in mortality over 50 years, 2 percent increase in food production per year, no education, and 50 percent of the excess population migrate every year.


1000.
.0
0.
.0
50.
2500.
12.5A
1500.
MIGRATION RATE

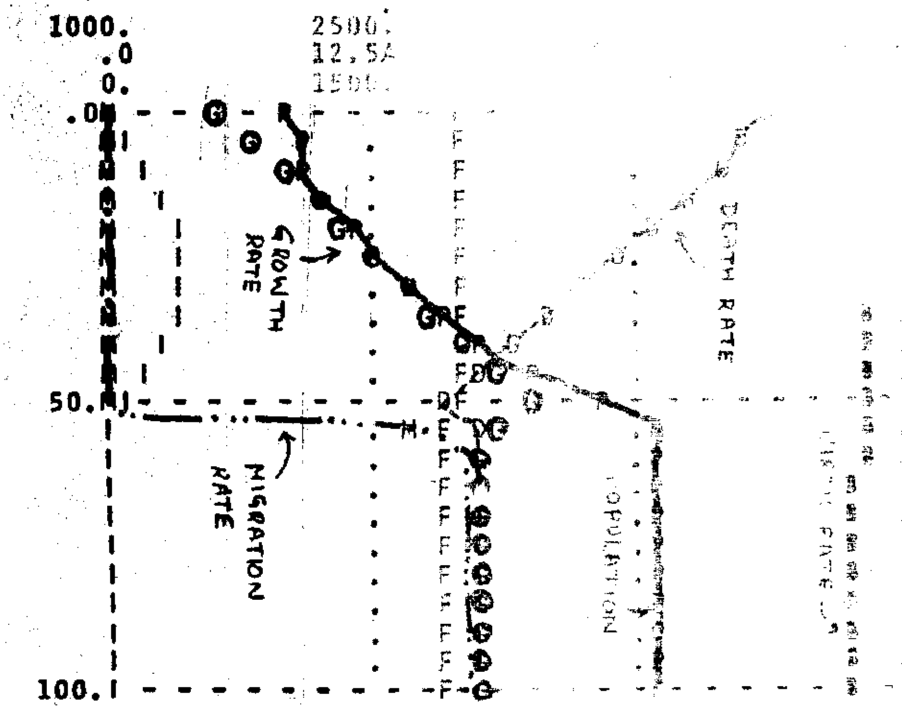
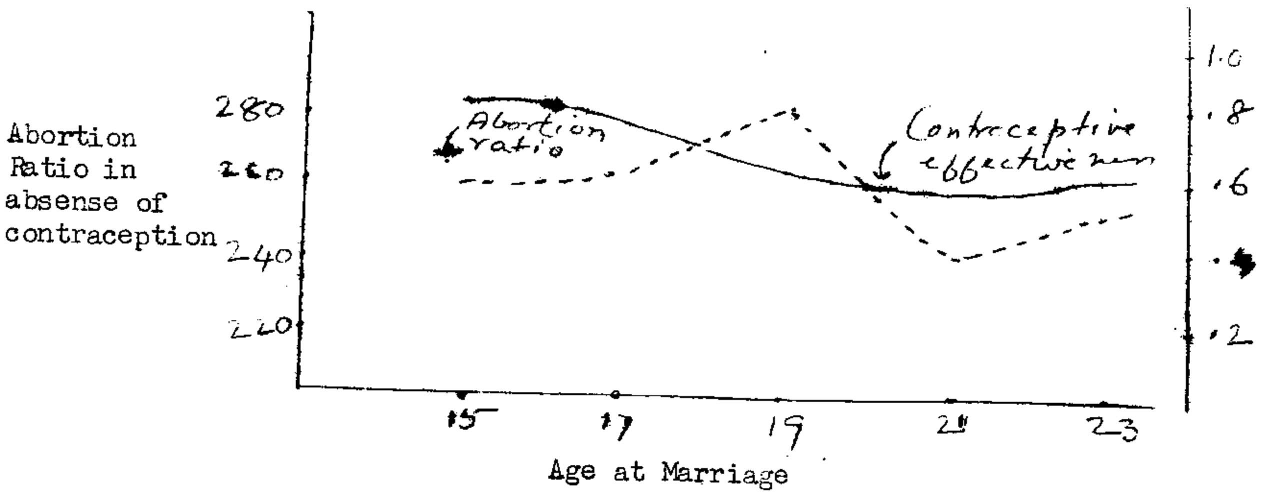

1000.
.0
0.
.0
50.
100.
2500.
12.5A
1500.
GROWTH RATE
DEATH RATE
MIGRATION RATE
POPULATION

Fig. 18



6. The Impact of Health, Education and Family Planning Programs

With a model as crude as the one presented here, one cannot measure the relative cost effctiveness of health, education and family planning programs. These programs are introduced in the model to get an idea of their impact on the population dynamics in a village. The resulting behavior of the village system under these programs leads us to the following general conclusions:

(i) It appears that the causal relationships in population dynamics in a village are such that the population control at the village level is achieved through migration, and through increased deaths rather than through control of births. This implies that the programs specifically designed for birth control may fail, not only because of the deficiency in the programs but because, some of the forces within the village system are not conducive to the success of these programs.

(ii) A nutrition program along with successful family planning does not seem to be the answer to population control, as it is often believed. Figure 19 shows the simulated population dynamics in which

1. death rate is reduced by 50%
2. food production is increased by 2 percent per year

Figure 19

The impact of nutrition and family planning programs in a village with no migration

TIME E+00	DFS E+00	MORT E+00	ABR E+00	EDU E+00	TFS E+00
.0	4.6575	.27000	.15206	2.5000	4.2011
20.	4.5791	.21123	.15199	2.5000	4.1510
40.	4.3077	.15791	.15176	2.5000	3.9865
60.	4.0444	.13458	.15155	2.5000	3.8290
80.	3.9525	.14811	.15156	2.5000	3.7684
100.	3.9907	.15723	.15165	2.5000	3.6715

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POP=P, BR=B, GR=G, MR=M, DR=D, FPC=F, IPC=I

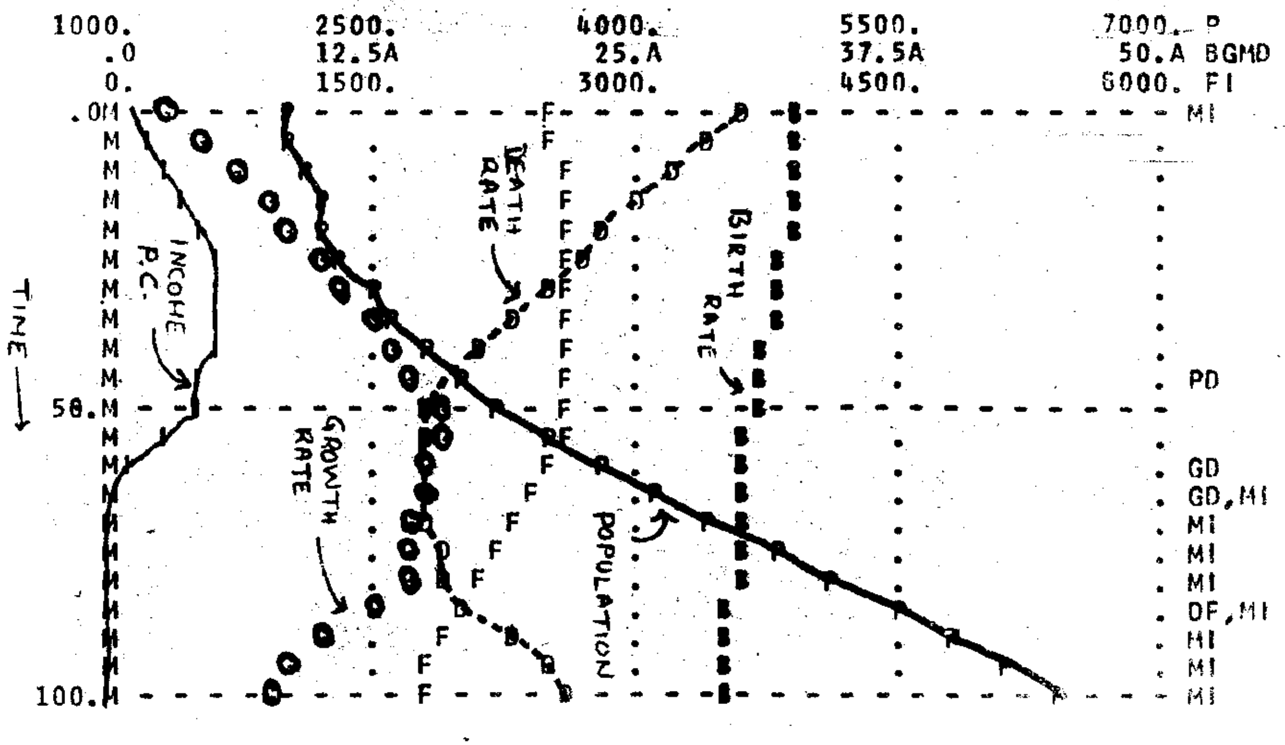


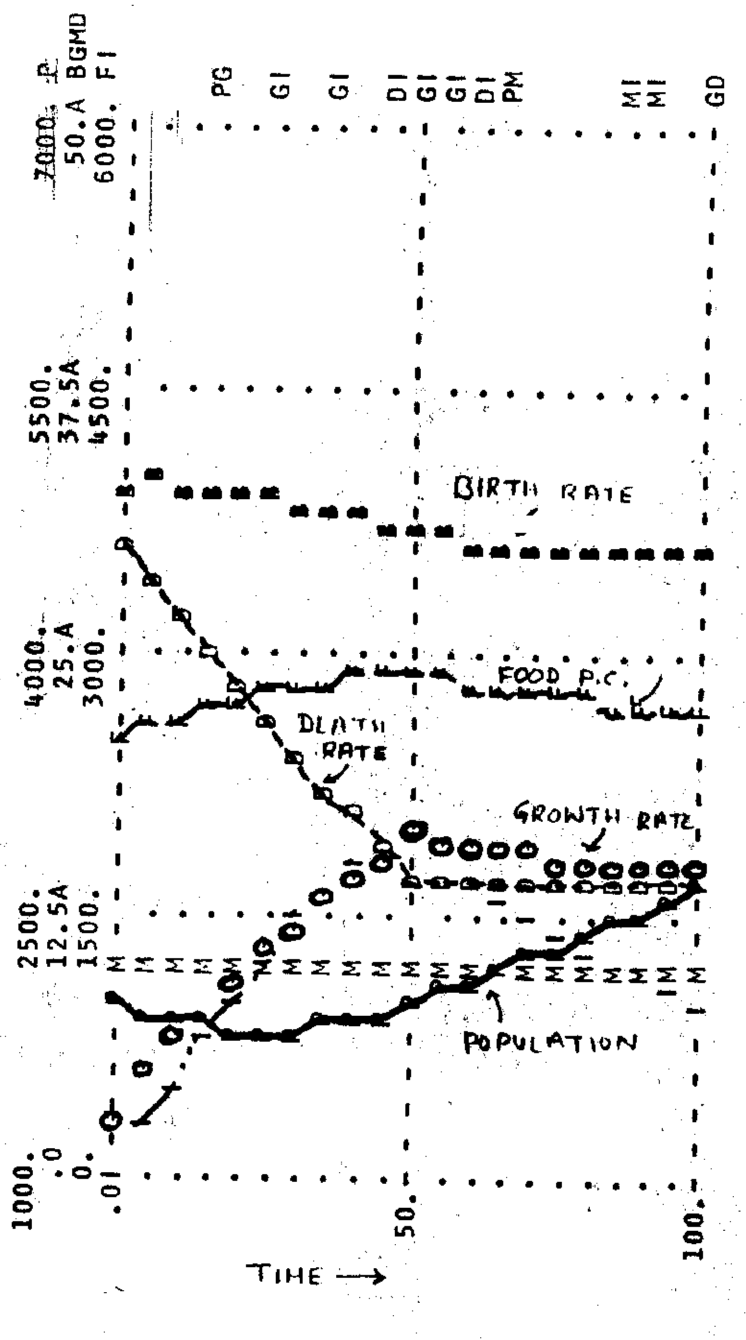
Figure 20

The impact of nutrition and family planning programs when migration rate is constant 10 per 1000

TIME E+00	DFS E+00	MORT E+00	ABR E+00	EDU E+00	TFS E+00
.0	4.6575	.27000	15206	2.5000	4.2011
20.	4.5726	.20602	15197	2.5000	4.1443
40.	4.2799	.14916	15171	2.5000	3.9647
60.	4.0049	.12455	15146	2.5000	3.7994
80.	3.9006	.12697	15149	2.5000	3.7342
100.	3.8956	.12899	15150	2.5000	3.7322

PAGE 46 FILE VILL THE VILLAGE MODEL 7/24/72

POP=P, BR=B, GR=G, MR=M, DR=D, FPC=F, IPC=I



3. family planning is successful in the sense that people can attain their desired family size by means of contraception
4. average education level is 5-7 years of schooling
5. has a 'feeding program' to add about 500 calories per day to normal diet in the village.

Even then the population continues to grow rapidly, birth rate declines only gradually and death rate has to rise up to control the population if the option to migrate is not open. However, these results do not imply that health and family planning, education and other similar programs in the village system are not useful. They are necessary to improve the standard of living, but they are not sufficient to maintain the balance between population and resources in the village. The reasons why these programs are not successful lie in the structure of this system. The structure represented in this model leads us to the conclusion that programs to control births alone, may not be able to control the population in the villages unless fairly drastic structural changes take place in that society. Examples of such change are: changes in the family system, in women's role in the society, in familial and social rewards that are associated with smaller families. Further expansion of the model which incorporates such structural changes is necessary to understand various implications of these changes on the village system.

Limitations and Extensions of the Model

In this section we will list some limitations and criticisms of the model. The major criticism of this model is that it cannot be validated using formal mathematical techniques. We agree with the spirit of this criticism.

We assume that the model is valid if the behavior modes are intuitively satisfactory. The reasons for adopting such 'soft' criteria are:

1. This model is an attempt to formalize a mental model. Since mental models are usually qualitative, we wish to avoid formal mathematical techniques such as indexing and standardization to formulate the model.

2. The data used in this model comes from a variety of sources such as pieces of information from Khanna or other similar studies, educated guesses and hypotheses, including judgements and intuitions. Since we often use such data in our mental models, we feel it will be appropriate to incorporate them formally, though it will mean a great deal of empirical inaccuracy in the model.

For those reasons, we feel that it is extremely difficult and perhaps even inappropriate to use sophisticated mathematical techniques to validate this model.

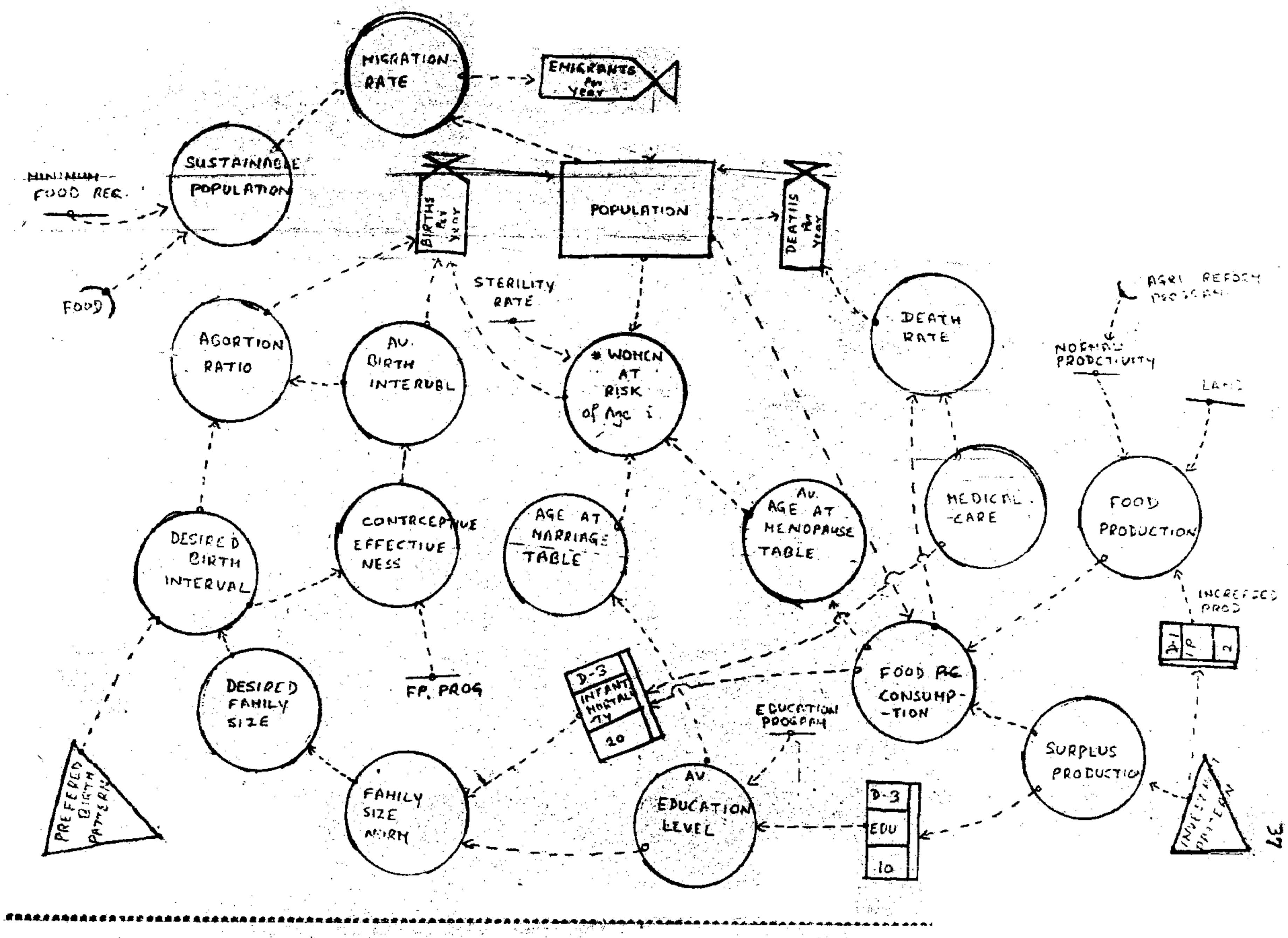
Besides the limitations of statistical validity there are at least two others which are more conceptual in nature:

1. It is a model of population dynamics. However, its structure is essentially stable. It is rigid, constrained by present state of our knowledge, and influenced by model builder's biases. Also, it has no built-in mechanism to incorporate the structural changes which occur in a real system over time. This limitation weakens the ability of the model to predict the behavior of a village under different policies introduced in the model. We feel that it is possible to provide the user of this model an ability to introduce structural changes, new elements and new relations in the model over different periods of time. This extension of the model is easy to achieve and will increase its usefulness to a policy-maker.

2. It is a simple representation of a very complex system. Naturally it does not contain all the elements of the real system. Also, one may get a feeling of an imbalance of aggregation and details in the various parts of the model. The part dealing with fertility behavior is developed into greater detail compared to the other parts of the model. This imbalance is mainly due the researchers expertise in one area and a lack of it in others. A great deal of study and understanding of all parts of this system are necessary to attain an appropriate level of aggregation in the various parts of the system.

Though, in our opinion, the model in its present form is not useful for predicting the impact of various 'policies' on specific villages, it can be used as a communication medium for policy-makers and social scientists. It provides a method for expressing one's mental model in a precise form that can be understood by most people. Since there are as many mental models of a village as there are people concerned and interested in its problems, we feel that there is a need for a mechanism to make mental models explicit for comparison and analysis. The model presented in this paper is an example. It can be changed, expanded and improved upon. But even in its present crude form, we think it can be used to open up a dialogue between policy-makers and people more knowledgeable about the system. It is also an educational tool. With a model such as this, one can learn to integrate systematically the information available about the various parts of a system and to gain a better understanding of its problems and their solutions.

THE VILLAGE MODEL FLOW: DIAGRAM



```
* THE VILLAGE MODEL
*
L POP.K=POP.J+(DT)(B.JK-D.JK-M.JK)
N POP=POPN
C POPN=2000
R B.KL=B1.K+B2.K+B3.K
R D.KL=DR.K*POP.K
A B1.K=(WR1.K/BI1.K)*(1-AB1.K)
A B2.K=(WR2.K/BI2.K)*(1-AB2.K)
A B3.K=(WR3.K/BI3.K)*(1-AB3.K)
R M.KL=MR.K*POP.K
*
*
* EST.NUMBER OF WOMEN AT RISK
A WR1.K=(AM1.K)*FP1.K
A WR2.K=(FR2)*(POP.K)*(1-ST2)
A WR3.K=AM3.K*FP3.K
A FP1.K=(FR1)*(POP.K)*(1-ST1)
A FP3.K=(FR3)*(POP.K)*(1-ST3)
C FR1=.091
C FR2=.075
C FR3=.031
C ST1=.04
C ST2=.06
C ST3=.06
A AM1.K=TABLE(AMT1,AGE.K,15,25,2)
T AMT1=1/.8/.6/.4/.3/.1
A AM3.K=TABLE(AMT3,AG.K,35,50,3
T AMT3=.2/.5/.6/.8/.9/1
A AGE.K=TABLE(AGET.EDU.K,0,5,1)*SW1+LAM
T AGET=15/17/18/19/21/22
C SW1=1
C LAM=0
A AG.K=TABLE(AGT,FPC.K/MFR,0,3,.5)
T AGT=35/40/42/44/46/47/48
*
* EST.BIRTH-INTERVAL/WOMAN BY AGE.
A BI1.K=INF.K+(F/(1-CE1.K))
A BI2.K=INF.K+(F/(1-CE2.K))
A BI3.K=INF.K+(F/(1-CE3.K))
A INF.K=TABLE(INFT,FPC.K/MFR,0,3,.5)
T INFT=6/3/2.3/1.8/1.5/1.5/1.3
C F=.5
A CE1.K=MIN(R1.K,.979)*SUC1
A CE2.K=MIN(R2.K,.979)*SUC2
A CE3.K=MIN(R3.K,.979)*SUC3
C SUC1=0
C SUC2=0
C SUC3=0
A R1.K=1-(F/(DBI1.K-INF.K))
A R2.K=1-(F/(DBI2.K-INF.K))
A R3.K=1-(F/(DBI3.K-INF.K))
*
* EST. OF ABORTION RISK/YEAR/PREG.
A AB1.K=TABLE(ABT1,BI1.K/DBI1.K,0,2,.2)
```

```
T ABT1=.35/.30/.20/.18/.15/.15/.15/.15/.15/.15/.15/.15
A AB2.K=TABLE(ABT2.BI2.K/DBI2.K,0,2,.2)
T ABT2=.5/.4/.35/.3/.2/.15/.15/.15/.15/.15/.15
A AB3.K=TABLE(ABT3,BI3.K/DBI3.K,0,2,.2)
T ABT3=.60/.5/.45/.4/.3/.2/.2/.2/.2/.2/.2
A PREG.K= (WR1.K/BI1.K)+(WR2.K/BI2.K)+(WR3.K/BI3.K)
S ABR.K=(PREG.K-(B1.K+B2.K+B3.K))/PREG.K
*
* EST. DESIRED FAMILY SIZE
A DFS.K=CDFS+SW3*DFSN.K/(1-MORTD.K)
C CDFS=0
C SW3=1
A MORTD.K=DELAY 3(MORT.K,MPD)
C MPD=20
A DFSN.K=TABLE(DFSNT,EDUD.K,0,5,1)
A EDUD.K=DELAY3(EDU.K,10)
T DFSNT=5/4/3.8/3/2.5/2.3
A MORT.K=MORTN*EDUM.K*FPCM.K*(1-MEDM.K)
C MORTN=.4
A EDUM.K=TABLE(EDUMT,EDU.K,0,5,1)
T EDUMT=1/.9/.8/.7/.6/.5
A MEDM.K=MDE+RAMP(RS,RT)+RAMP(MS,MT)
C MS=0
C MT=0
C MDE=0
C RS=0
C RT=0
A FPCM.K=TABLE(FPCMT,FPC.K/MFR,0,3,.5
C MFR=2000
T FPCMT=2/1.2/1/.8/.5/.3/.1
*
*DESIRED BIRTH INTERVAL
A DFS1.K=CLIP(LDF1.K,UDF1.K,AGE.K,21)
A LDF1.K=TABLE(LDFT1,DFS.K,2,10,2)
T LDFT=1/1/1.5/2/2
A UDF1.K=TABLE(UDFT1,DFS.K,2,10,2)
T UDFT1=2/2/2/3/3
A DFS2.K=CLIP(LDF2.K,UDF2.K,AGE.K,21)
A LDF2.K=TABLE(LDFT2,DFS.K,2,10,2)
T LDFT2=1/3/3/4/4
A UDF2.K=TABLE(UDFT2,DFS.K,2,10,2)
T UDFT2=.4/2/3/3/4
A DFS3.K=CLIP(LDF3.K,UDF3.K,AGE.K,21)
A LDF3.K=TABLE(LDFT3,DFS.K,2,10,2)
T LDFT3=.4/.4/1.5/2/4
A UDF3.K=TABLE(UDFT3,DFS.K,2,10,2)
T UDFT3=.4/.4/1/2/3
A DBI1.K=MAX((24-AGE.K)/DFS1.K,(INF.K+F))
A DBI2.K=MAX(10/DFS2.K,(INF.K+F))
A DBI3.K=MAX((AG.K-35)/DFS3.K,(INF.K+F))
*
* EST. NUMBER OF DEATHS
A DR.K=DRN*FM.K*(1-MFDM.K)
C DRN=.04
```

```
T FMT=5/2/.8/.7/.6/.5/.5
*
* EST.NUMBER OF MIGRANTS
* ECONOMIC AND MIGRATION SECTOR
A OUT.K=((POP.K-MAXP.K)*PPM)/POP.K
A MR.K=MAX(OUT.K,0)*SW2+CMR
C SW2=1
C CMR=0
A MAXP.K=FOOD.K/MFR
C PPM=0
*
* RESOURCE SECTOR
A FOOD.K=(LAND*PROD*LE.K)+NORMRN(MEAN,DEV)
C LAND=1000
C PROD=4000
C MEAN=0
C DEV=0
A LE.K=TABLE(LET,IVP.K,0,4000,500)*AEP.K
T LET=1/1.15/1.25/1.5/1.75/2.0/2.5/2.7/3.0
A FPC.K=CLIP(EFPC.K,MFPC.K,SUF.K,0)+NSP
C NSP=0
A MFPC.K=FOOD.K/POP.K
A EFPC.K=MFR+IVF.K
A IVF.K=IPC.K*PIF.K
A PP.K=IPC.K*PIP.K
A IVP.K=DELAY1(PP.K,3)
A EDU.K=TABLE(EDUT,IVE.K,0,4000,500) +EP.K
T EDUT=0/1/1.5/2/3.5/3/3.3/3.5/3.8
A IVE.K=IPC.K*PIE.K
A PIF.K=PIFN+RAMP(RS3,RT3)
C PIFN=0
C RS3=0
C RT3=0
A PIP.K=PIPN+RAMP(RS4,RT4)
C PIPN=0
C RT4=0
C RS4=0
A PIE.K=PIEN+RAMP(RS5,RT5)
C PIEN=0
C RS5=0
C RT5=0
A EP.K=EPN+RAMP(RS7,RT7)
C EPN=0
C RS7=0
C RT7=0
A AEP.K=AEPN+RAMP(RS6,RT6)+RAMP(MS6,MT6)
C MS6=0
C MT6=0
C AEPN=1
C RS6=0
C RT6=0
A SUF.K=(FOOD.K-(MFR*PCP.K))/POP.K
A IPC.K=MAX(SUF.K,0)
N IPC=IPCN
C IPCN=0
```

```
*
*
S BR.K=B.JK/POP.K
S GR.K=BR.K-DB.K
A F1.K=B1.K/(POP.K*FR1)
A F2.K=B2.K/(POP.K*FR2)
A F3.K=B3.K/(POP.K*FR3)
S TFS.K=(F1.K+F2.K+F3.K)*10
PRINT 1)DFS/2)MCRT/3)AER/4)FDU/5)TFS
C PRTPER=20
PLOT POP=P(1000,7000)/BR=B,GR=G,MR=M,DR=D(0,.050)/FPC=F,IFC=I(0,60
C PLTPER=5
C LENGTH=100
C DT=1
```

APPENDIX B

FOOTNOTES:

[1]Effectiveness of contraception required to extend the actual birth interval to the desired level is obtained as follows.

If DBI = desired birth interval

INF = infantile period

then (DBI - INF) is the length of the period when a woman wants to avoid pregnancy.

If F is the period of exposure and EC effectiveness of contraception then $(DBI - INF) = \frac{F}{(1 - EC)}$ and rearranging this formula we get $EC = 1 - \frac{F}{(DBI - INF)}$

[2]The changes made in the program in various simulation runs are listed below:

Fig. 11 Basic Run

Dev = 200000

Fig. 12 Introduction of Medical Care

RS	MS	MT	RS6	MS6	MT6
.01	-.01	50	.02	-.02	50

Fig. 13 Medical care with migration

RS	MS	MT	RS6	MS6	MT6	PPM
.01	-.01	50	.02	-.02	50	.5

Fig.14 Successful family planning, no migration

RS	MS	MT	RS6	MS6	MT6	EPN
.01	-.01	50	.02	-.02	50	2.5

SUC 1	SUC 2	SUC 3
1.0	1.0	1.0

Fig.15 Successful family planning,constant and low migration rate

RS	MS	MT	RS6	MS6	MT6	EPN
.01	-.01	50	.02	-.02	50	2.5

SUC1	SUC2	SUC3	SW2	OMR
1.0	1.0	1.0	0	.006

Fig.16 Changing age at marriage

	RS	MS	MT	RS6	MS6	MT6	LAM	SWI	PPM
	.01	-.01	50	.02	-.02	50	15	0	.5
Fig.17	.01	-.01	50	.02	-.2	50	21	0	.5

Fig.19 Nutrition and family planning

RS	MS	MT	RS6	MS6	MT6
.01	-.01	50	.02	-.02	50

PIFN	EPN	NSP	SUC1	SUC2	SUC3
.2	2.5	500	1.0	1.0	1.0

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