COMPARATIVE STUDIES OF POPULATION GROWTH PROJECTIONS FOR DIFFERENT SOCIO-ECONOMIC REGIONS OF THE COUNTRY

A DISSERTATION

submitted in partial fulfilment of the requirements for the award of the degree of

MASTER OF ENGINEERING

in

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(System Engineering and Operations Research)

By

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CERTIFICATE

Certified that the dissertation entitled "Comparative Studies of Population growth Projections for different Socio-economic regions of the Country" which is being submitted by Mr. Anil Kumar Joshi, in partial fulfilment for the award of degree of Master of Engineering in Electrical Engineering (System Engineering and Operations Research) of the University of Roorkee is a record of student's own work carried out by him under my guidance and supervision. The matter presented in this dissertation has not been submitted for the award of any other degree or diploma.

This is futher to certify that he worked for a period of about six months from August 1984 to January 1985 for preparing this dissertation at this University.

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A C K N O W L E D G E M E N T

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A.K.Joshi

(Anil Kumar Joshi)

A B S T R A C T

Population growth is causing problems of almost unmanageable proportions for developing countries. The population explosion has generated great interest in long term population policy. This work is an attempt to simulate the effect of control efforts on the Indian population and on population of some states which have been selected for typical socio-economic characteristics. The study is done by introducing decline in future birth rates by various methods of control. Sample Registration System 1978 data have been used. Population levels upto the year 2038 have been determined in five year intervals. The population projections have also been carried out by considering declining child mortality rates, the decrease being uniform with time.

C O N T E N T S

CHAPTER ONE

WHY THIS WORK

"The most distressing experience for a writer is when he approaches his readers with a problem. Visits for subscriptions to charities are not half so irritable as the intrusions on the peace of mind of an occupied and self-satisfied public by faddists who put up their umbrellas and insist that it is raining when every good man of world knows that the sun is shining".

P.K.Wattal
The Population Problem of India

growth rates of 2 to 3 per cent and even higher have in most cases, negated major benefits which might have accrued from the developmental process; and for a country even to stand still on a per capita basis it is necessary that achievements of social and economic development must at least match population growth.

Many apprehensions about population growth are based on the fear that the world or individual countries are too small to contain the population already in sight, let along those of continued trends. But probably the race against time is more urgent than that against space. There is no way of telling how many billions may in future be sustained by this earth. The rate of population growth is of more immediate concern. Given time, there is no doubt that the world economy could accomodate to populatic several times larger than the present ones. In time, the capital may be formed; in time, the necessary social reforms will be undertaken. But as things stand, the developing world faces a transitional period of uncertain length in which time will be exceedingly short. Mortality will continue to decline, and populations will increase at rates which will absorb the bulk of the resources that could otherwise be deployed to meet the irrepressible demand for modernisation development. Millions will be burnout of phase with history.

It seems clear now that something can be done, and even that in time something will be done to reduce the gravity of this problem. No country that accepts the powers of modern society to combat death will in the end be unable to control birth. The only question is how soon.

1.2 ZERO POPULATION GROWTH : INDISPENSABLE IN FUTURE

Zero population growth, as platitude, sales slogan or urgent goal, has caught the public by storm-and included in that public are many biologists and economists, as well as a considerable number of sociologists and demographers.

Zero population growth represents the state when the rate of growth of a closed population is zero, i.e. the rise due to new birth is balanced by the deaths. From one point of view, favouring zero population growth is somewhat like favouring the laws of motion. Zero growth is then not simply a desirable goal, it is the only possibility in a finite world. One cannot object to people who favour the inevitable.

In general in the less developed regions the economy rests heavily on subsistence agriculture and other extractive industries. Per-capita Income and literacy rates are very low, birth rates very high and death rates are high. The population levels are already too large for reduction

of poverty on the basis of a traditional subsistence agriculture. The only Hope of achieving reasonable per-capita income, litracy rate and health lies in the modernisation of economy. Such modernisation entails heavy investment in production, equipments, transport education and health. Rapid progress in this direction is considerably deterred by the necessity of meeting the costs of rapid population growth at the same time.

It seems difficult to exaggerate the importance of reducing the rate of population growth as soon as possible. A rapid decline of fertility for some decades until there is even a small negative increase would be desirable for less developed countries like India. But zero population growth, as a meaningful proposal in the immediate future, is idle talk. It could only be achieved by a rise in death rate which no one will accept as a goal of its policy.

1.3 INDIAN POPULATION SOME FACTS

The population of India touched the 686 million mark in 1981 and is currently growing at the rate of nearly 1.1 million persons per month. About 20 million babies are born each year, and about 7 million persons die, bringing about a net annual increase in population of 13 million a little less than the population of Australia (1).

India accounts for nearly 14 per cent of the world population but occupies only 2.5 per cent of the land

area (1). The average density of population in India was 216 per square Km. in 1981 (more than double of what it was in 1901) but two States, Kerala and West Bengal, had a density of above 600 and another three states, Bihar, Tamil Nadu and Utter Pradesh, above 350 persons per square kilometre (9). The density of India is more than 40 per cent higher than that of Europe excluding the soviet Union an area which itself has a high population density and more than seven times that of the United States of America.

India's death rate is still high when compared to some Asian and all of the Western countries. It can be expected that the present death rate of 14 would continue to decline and could go down to around 10 largely due to the control of various diseases. But further decline may be difficult unless the nutritive content of the diet of the average population increases. As a result of decline in death rate, expectation of life has increased. While in the 1921-31 decade an infant could hope to live up to 27 years, today it is expected to live up to about 55 years. Whereas less than 40 children out of 1000 born die in the first year in some Asian and most of the Western countries. The number of such deaths in India is 127 (12). Of the deaths occurring in the first year, nearly 60 per cent die in the first quarter, about 23 per cent occur in the first week and 43 per cent die in the first month (1). Male infant mortality is higher than female infant mortality

a fact which is observed generally all over the world. Also, infant deaths are higher, when mothers are younger, that is, below age 20 or comparatively older, that is above age 34. Infant deaths are also higher when maternity takes place repeatedly and in quick succession, a fact that shall be taken up for detailed examination in course of this work.

The birth rate was estimated to be around over 49 per thousand upto the 1911-21 decade and it slowly declined to 45 during the 1931-41 decade. The birth rate declined to around 42 in the 1951-61 decade and further slided down to 32.3 according to the sample registration syster Data of 1978. One of the consequences of high birth rate is that India has an age-structure which is typical of the under developed countries, having a very broad base and a tapering top. Nearly 40 per cent of India's population is below the age of 15 and only a shade below 13 per dent above the age of 50. (9). Thus 53 per cent of the population depends upon 47 per cent of the population in the productive ages between 15 to 50 years indicating that the "dependency ratio" is more than one, while it is around 0.75 in developed countries.

A very large proportion of India's population lives in rural areas. The urban population of India has grown from only 9.5 per cent in 1891 to 23.3 per cent in 1981. Roughly 82 per cent of India's urban population reside in

cities having a population of 20,000 and more and around 52 per cent or reside in cities having a population of 100,000 or more according to 1971 census. (1). These percentages, since then, must have risen.

There are more males than females in India. The number of females per 1,000 males has been declining and was 941 in 1961 and 932 in 1971 and has further gone down to 928 in 1981. This is partly due to higher mortality of female children and sizeable maternal mortality. This emphasises the fact that demographically India has not entered the modern industrial age with its complimentary characteristics of increasing risk of male lives and reduced risks of female lives.

Literacy which is defined as the ability to read and write with understanding increased slowly in India from 5.8 to 8 per cent during the period 1891 to 1931. But it increased faster thereafter to 16.6 per cent in 1951, 29.40 per cent in 1971 and 36.23 per cent in 1981. (9). It was found in 1981 that 72 per cent of females in rural areas and 46 per cent in urban areas aged 5 and over were illiterate, whereas the male percentages were 53 and 26 respectively. The corresponding figures for 1961 were 90 per cent and 60 per cent for females and 66 per dent and 34 per cent for males (9).

1.4 INDIA'S TEEMING MILLIONS : IMPLICATIONS OF RAPID POPULATION INCREASE

The rapid population increase poses a serious threat to our development efforts. The task of providing food, schools, employment, health facilities, housing, etc., for the increasing numbers is staggering. The population question is not merely quantitative but also qualitative in nature as the implications of population growth upon the quality of life and the well being of the people are vitally important. A few illustrations are given below to bring out the socio-economic effects of the perspective population growth in developing countries.

Persistent high fertility causes important health problems not only because economic improvements, which are essential for good health, get restricted but also because it poses an immediate health problem for the mother and her children. In India, as in most of developing countries, married women aged 17 to 37 are characterised by continuous nutritional drain from repeated pregenancies and lactation resulting in the 'maternal depletion' and increased risk of 'maternal mortality' which increases with every pregenancy beyond the third. Premature curtailment of breast feeding and of infant care by an intervening pregnancy is an important factor contributing to high infant mortali Again, children who survive in families where there are too many children arriving too fast are likely to be stunted

prematurely in their growth and underdeveloped due to lack of nutritive food.

Rapid population growth has rendered the available food supply inadequate in nutritive quantity for a healthy and active life. Growth retardation, with children often lagging behind in physical and mental development for an average of three or four years and persisting high mortality rates from malnutrition and infections indicate that the problem of nutritive food availability in adequate quantity required immediate solution. Retarded development and poor health are responsible for low stamina and low physical activity. Low physical activity results in low productivity, which in turn causes more poverty and inadequate food supply. Unless this vicious circle is broken, future generations will have reduced stature, lower body weights, lower level of physical capacity and consequently reduced working efficiency

During the last two decades India has made praiseworthy efforts to increase food production. But any gains have largely been offset by increase in population and therefore per capita food consumption has increased at a very moderate pace. The "Green Revolution" has provided much needed relief and has given a breathing space, but it does not provide a long-period solution. Reduction of population growth rates could reduce the proportion of population dependent of agriculture by facilitating a shift

of population from agriculture to non-agricultural occupations. This shift, together with the associated increase in the market of agriculture products, would make possible increase in agricultural productivity and income.

Employment is another area of serious concern on account of rapid population growth. The working population will grow rapidly in the years to come. The sharp increase in the working population is chiefly due to the growing number of young people but an increase in the length of working life as a result of decline in mortality is also a contributing factor. The need for expanding employment opportunities for the growing numbers of young people will become even more urgent in the future. The rate at which the young people are at present entring the labour force in India is such that new job opportunities have to be created for about two-thirds of them. The number of job-seekers will continue to increase in the future, and the effect of a decline in the birth rate will be felt only after a lapse of fifteen years.

A demographic factor of considerable importance is the high dependency ratio in India. The dependency ratio is over one compared to 0.75 for developed nations. Little decline in this ratio can be expected unless a major decline in fertility takes place.

Another major problem is of providing schooling to the growing number of school going children. The number of children of school going age (5 - 14 years of age) was 179 million in 1981 which is over 25 per cent of the total population. This percentage is around 18 for developed countries.(1). The educational problems are not confined to the young population only as only 41 per cent of people above the age of 15 years were literate in 1981.(9). Inspite of vigorous literacy campaigns the absolute number of illiterates is still rising owing to rapid population growth.

The high rate of internal migration to urban areas and the very rapid rate of growth of cities and towns has put tremendous pressure on housing. India is desperately trying to cope with the growth of urban population. Not only housing, but problems of drinking water, sewage disposal, sanitation, transport, etc. are becoming acuter and will require larger investments.

1.5 FAMILY PLANNING EFFORTS IN INDIA

Economic planners and government administrators have come to realise that rapid population growth is not a simple problem of the relationship between man and the land he occupies. It is rather a multitude of problems associated with employment, education, health services,

transportation, migration, housing, industrialisation, agricultural productivity and above all, that of increasing per-capita income. The goal of a family planning programme, therefore, is not merely to reduce, increase or stabilise the number of people, but to make possible a richer and fuller quality of life for the people.

India was the first country in the world to adopt an official policy favouring family planning in 1951. Since the begining of the first Five Year Plan in 1951, the Government has been actively supporting this movement. In the First Plan 21 rural and 126 urban family planning clinics were opened. There were tremendous shortages of trained personnel and it was thought that the main needs were educational advances so that people could be motivated to adopt family planning measures. In 1956 after limited progress under the First Plan, the central Family Planning Board was set up and the state Family Planning Committees were gradually appointed in each state (2).

In the Second Plan period (1957-62) over 1030 rural and 400 urban family planning clinics were established. Sterlisation was just begining and in this period 122,000 men and women under-went operations. The Third Plan offerred 100 per cent financial assistance to state governments for training, staff and facilities for sterlisation. In successive plans the family planning

programme was allocated increasing amounts of money. In the early 1970s in fact some states were not able to spend all the money alloted to them - they could not construct centres and sub-centres fast enough, they could not fill the posts sanctioned. The programme continued spending large sums rising from Rs. 134 million in 1966-67 to Rs. 797 million in 1972-73.(2).

The 1974-75 debate over where family planning should go next ended up with the 1976 National Population Policy which assumed that much stronger measures were required to bring clients into the programme and that the government would carry them out. India began in 1976 an extraordinary experiment in family planning which was different from the moderation of previous policies. The suspension of the normal political process under the Emergency of 1975 coupled with the lukewarm response to earlier programmes were the chief actuating factors. The government's commitment to reach a birth rate of 25 per thousand by 1984 was reiterated. Direct measures to achieve this included raising the legal minimum age at marriage to eighteen for females and twenty one for males; introducing 'population values' in the educational system; drawing all government departments into 'motivating of citizens to adopt responsible reproductive behaviour', increasing the monetary incentives for

sterlisation; offering group incentives to Zila and Panchayat Samities, teacher, cooperatives, labour in the organised sector and development of new media strategies.

The initial results were a high level of recorded numbers of sterlisations. The original target of four million for 1976-77 was reached by September 1976. The 'excesses' in Family Planning Programme were reflected in the popular elections of 1977 and the new government reviewed the family planning programme and did away with the compulsive practices. Of late, there has been a awakening in the literate part of the population and family planning measures are being voluntary adopted. However, much is to be done in this field, more pronouncedly in the rural sector of the population where family sizes are still large.

1.6 TWO SOCIOLOGICAL FACTORS : STATUS OF WOMEN AND SEXUAL ABSTINENCE

The accomplishment of family planning efforts will be rendered very much easier in the habitat of the thought and behaviour of men in a society which realises complete social equality of men and women, gives the latter a dignity and independence of person and by giving the woman a new role in the working of society as a whole,

assigns to private intimacies a new meaning and importance, work and home, children and ecstatic living performance of a new role in society, all find their place in this new habitat of thought and behaviour. When women take their place in the whole new pattern of living, grow up to its requirements and be adequately equipped for their new role, then they will not only rock the cradle to rule the world but in their own way exercise their formative function as mothers.

It was a premise of Malthus' argument on over-population that passion between the sexes is necessary and will remain in the present state. As a good Christian, Malthus was against contraceptives. So was Mahatma Gandhi, "The union is meant not for pleasure but for bringing forth progeny". Sexual abstinence was the only way to control births, in his view which has been discarded by most of our people and rightly so; and the fact is clearly established by the consensus now available in our country. Sexual union without any desire for progeny is not only absolutely necessary but extremely desireble, and re-production is only one though very important function of sex. De-linking sex and reproduction is prime objective of contreception and in it is implicit the cardinal view that even without reproduction sexual union is not only perfectly right but is a very enriching feet of personal experience.

In this work, Chapter 2 deals primarily with the development of a proper demographic model for population projections. Mortality and fortility, the most important components of a demographic model have been studied in the Indian context. The concept of an optimum population for a land size also comes up for discussion.

The data selection part comes in Chapter 3 where the criteria for selecting typical states for population projections are enunciated. The introduction of decline in future child mortality rates is presented with the desirability of such measure also being explained. Fortility rates are studied with respect to religion and educational status.

The simulation results of the demographic model for India and the selected six states are presented in Chapter 4 for arbitrary fortility control and also Family planning efforts. The results are given for both cases; assuming constant mortality rates and also for the case of declining child mortality rates.

The whole work is summed up in the concluding Chapter 5.

CHAPTER TWO

THE POPULATION MODEL

"Nature's vast frame, the web of human thing,
Birth and the grave, that are not as they were".

Shelley, 'Alastor'

2.1 MODELLING :

A model is defined as the body of information about a system gathered for the purpose of studying the system. Since the purpose of the study will determine the nature of information that is gathered, there is no unique model of a system. Different models for the same system will be produced by different analysts interested in different aspects of the system.

Models can be separated into physical models and mathematical models. Physical models are based on some analogy between such systems as electrical and hydraulic. The system activities are reflected in the physical laws that drive the model. Mathematical models use symbolic notation and mathematical equations to represent a system. The system activities are represented by mathematical functions.

The model concept can be used as an aid in system studies that involve the interaction between components of the system. It involves a living interaction with the system, a relationship which can be modified depending upon that is required. The model formulated can be altered depending upon the requirements of results that have to be obtained. Thus a single system can be simulated by a variety of models.

Modelling plays an important role in understanding the dynamics of the system. Once a satisfactory model for a

given system is developed, the properties and behaviour of the system can be studied. Modelling is a part of the overall research programme to gain deeper understanding of the system. Modelling cannot provide new knowledge about the system, but can serve to integrate the available knowledge of the system.

Models are valuable to the extent that they raise new questions, suggest new relationship and lead to the new experiments that might not otherwise have been considered. In most of the cases models predict new relevant properties of the system. Models also suggest constraints existing in the system being modelled. Thus the model computes, extrapolates and predicts the new facts which accerlerate the process of learning about the actual system.

The selection of a particular type of model depends upon the easiness, simplicity required the accuracy needed, the purpose of study, the data available and other such factors. In the context of current study, the choice is restricted to a mathematical model. In fact a mathematical model is one which can be simulated on a computer.

A 'good computer model' is one which satisfies three criteria to be useful in education and research.

1. It must agree structurally with the actual system but must be modest in size.
2. It's parameter must be estimable or measurable.
3. It must fit computer simulation capabilities.

For an engineer the introduction of model provides a link between descriptive and experimental data. The existence

of a mathematical model provides a mean for rapid experimentation and understanding of the system functions which may not be possible otherwise. For those involved in research work a mathematical model provides a method of summarising what is known about a system and communicating the information to others.

Before introducing the model used in this work it shall be prudent to examine mortality and fertility in the Indian context.

2.2 MORTALITY :

Death is a principal "vital event" for which vital statistics are collected and compited are live births, foetal deaths, marriages and divorces. The definition of a "death" excludes deaths prior to (live) birth. These are so called foetal deaths. There are a great number of measures of mortality based on death statistics. The simplest and commonest measure of mortality is the crude death rate. The crude death rate is defined as the number of deaths in a year per 1,000 of the mid-year population. The principal characteristic of a "crude" rate is that all ages are represented in it.

The crude death rate gives only a very general indication of the level of mortaility and its changes. There is also need for measures that describe the specific components of the overall number of deaths and the crude rate. Various type of specific death ratios and rates are of interest both in themselves and for their value in the analysis of the total number of deaths and the crude rate. Age is the most important

variable in the analysis of mortality. The age-specific death rate is defined conventionally as the number of deaths of persons of a given age during a year per 1,000 of the mid year population at that age. Age-specific death rates are usually computed for 5 or 10 year age groups.

India is known to have a high death rate till the first quarter of this century. Registered death rates of that period are gross under estimates. There has been a decline of about 50 per cent in the death rate during the 40 year period from 1916 to 1956. The death rate in India in 1961 was around 21 which came down to around 14-15 in 1971 and stands at 14.3 in 1981. (1), (15).

Infant mortality rate (probability of death in first year of life) is considered to be a fairly sensitive index of the health condition of a country. It is affected both by the biological and environmental conditions. Though it is difficult to control the biological (endogenous) causes of infant deaths, the environmental (exogenous) causes, like nutrition and pre-natal care, sanitary conditions, control of diseases to which infants are highly prone, etc., can be controlled, and this reflects the health measures undertaken by the community, government and other agencies.

The infant mortality rate in India is still high, even though it has declined by nearly 50 per cent during the last 50 years. The infant mortality rates were 290.0 and 284.6 for males and females respectively in 1911 and it has come down to 124 and 134 according to sample Registration

System Data of 1978 (1), (12).

The age of the mothers, order of birth, time interval between births, etc. also play significant role in determining the level of infant mortality. The shape of the curve of the infant deaths by age of the mother is U shaped, that is, it is high when the mother is young, that is, below age 20, falls gradually to a minimum between ages 25-30 and rises again, slowly in the begining and more steeply thereafter. Similar is the case when birth orders are considered. Infant mortality is fairly high in the case of first order births and reaches the minimum for the second order births. Thereafter, it rises slowly to the fifth order and sharply thereafter for the higher orders of birth. It has also been found that the time interval between births at almost all ages of the mother and also the order of births affect the size of the infant deaths.

2.3 FERTILITY :

Crude birth rate is the simplest measure of fertility. It is defined as the number of births in a year per 1,000 of the mid-year population. It again gives only a very general indication of fertility. Age-specific fertility rate is much more informative. It is defined as the number of births in a year per 1000 of the midyear population of females of a specific age. These rates are, again, calculated usually in 5 years age groups.

Indian fertility is higher as compared to the developed countries, but relatively lower than that of

other developing countries. It is higher than the developed countries because of univerality of marriages, lower age at marriage, limited use of contra ceptives, low level of literacy, poor level of the living of the masses and the traditional way of life among 80 per cent of the population residing in the rural areas. It is lower than that of the developing countries because of high incidence of widowhood and negligible number of widow remarriages, avoidence of coitus for a long period of time after a child birth and during religious periods and longer duration of lactation amenorhea.

In India, because of early marriage, a woman tends to have her first child at an early age and continues to be very fertile during the first half of her reproductive period. Fertility has its basis in history - a response to past high levels of mortality. If it has not declined much in the recent past, that is because a number of other contributory factors continue to favour high fertility. The age at marriage is low; Hindus need sons to light their funeral pyres; various religious in India; while not prohibiting contraception, may give a dispesition to high fertility, parents need children to look after them in old age; they often see immediate economic or social advantage in large families. And in situations where life offers little but hardship to the majority, sexual pleasure and the joy children can bring are one of the few sources of satisfaction. The preference of Indian parents for male children serves to some extent as a common explanation for high fertility.

2.4 POPULATION PROJECTIONS : The Basic Demographic Model :

Population projections can be regarded as extrapolations of present demographic data. Conventionally, projections into future make no attempt to speculate about possibilities as a natural disaster, war, famine, epidemic or mass migration because these are essentially unforseeable. A distinction should be made between projections and forecasts. When the author or the subsequent user of a projection is willing to describe it as indicating the most likely population at a given data, then he has made a forecast. At the other extreme, a model worked out to illustrate certain analytical relationships, on assumptions that are described has highly unlikely, would not be regarded as constituting a forecast of future population growth. It is apparent that all forecasts are projections, but not all projections are forecasts. Population projections may be prepared for total population of nations, their principal geographic subdivisions, or specific locations within them. The principal characteristics for which projections need to be made are age and sex.

The principal uses of population projections relate to government or private planning. The less advanced countries of the world have recognised the necessity of making concrete, comprehensive plans for achieving specific goals of public policy related to accerlerating their social and economic development. A first step in planning is to study relevant aspects of the population and economy both at the present time and in the recent past. As the United Nations notes,

"such study provides a basis for projections representing plausible future courses of development under the assumption that future conditions will evolve in an orderly manner from those of present and past".

A demographic model of population projections, specially suited for study of population dynamics in Indian context has been developed. The population characteristics for a certain span of time have been analysed by a discrete time age model based on following facts and assumptions :

1. It has been assumed population system is a closed system i.e. no person is to migrate to other countries and no foreigner is allowed to remain in India as her citizen.

2. The whole of population is divided into different age groups as 0-5, 5-9 etc. (0-4 implying children who have not completed 5 years and so on). The last age group is of people aged 60 and above. It is obvious that after a given span of 5 years, the population of any particular age group (synthetic cohort in demographic terminology) shall be the population of its previous age group minus deaths in that groups; the first and last age groups excepted. The population of the age group of people aged 60 and above after five years shall be that of its previous age group minus deaths in that group, added to the population of this very group now minus the deaths in the group.

3. In the first age group i.e. 0-4 years, the population will be of children born during last 5 years. The population of this group will depend on survival of children, female population in different age groups and their fertility.

4. Mortality rates have declined considerably in the earlier decades after independence. The decline has since slowed down a bit. Mortality coefficients are assumed to be constant throught the duration of our study in one part of the work. A decline in the mortality rates of first age group has also been introduced, a factor which shall be again coming up for discussion later.

5. Only female population is being considered in the model. The total population can be determined by assuming a suitable male-female ratio.

The basic equation is

$$P(i+1, j+1) = P(i,j) - AMU(i,j) \times P(i,j) \qquad (2.1)$$

Where

P(i,j) = No. of persons (Females) in the age group (i-1) h to i(h) at the instant to + jh

i = 1,2,3 ...13

j = 1,2,3 ...13

h = basic time interval (5 years here)

AMU (i,j) = Mortality coefficient, death per unit of one person (Female) of age i, at the time interval, j, in the interval (i-1) h to ih during h years.

The equation 2.1 has an initial condition

as 6 $P(1,1+1) = U(i)$ (2.2)

For $j = 1,2 \ldots 13$

Here $U(j)$ is the number of children (Females) born during the period of $+jh$ to to $+(j+1)$ and surviving upto the end of this period. The number of children born and surviving during interval h is given by :

$$U(j) = \sum_{j=1}^{N} S.f.h.\ SM(i,i)\ P(i,i) \quad (2.3)$$

$SM(i,i)$ is fertility of a women of age i and at time interval j.

S = Survival ratio during to + jh to to $+(j+1)h$

f = Female proportion of total births.

S is taken to be equal to 0.94 and f as 0.48 in the work.

A computer programme to calculate population of different age groups has been developed on the basis of flow diagram shown in Fig.2.1.

Population model has been simulated for different methods of fertility control.

2.5 CHOICE OF FERTILITY CONTROL :

The important factor which effects the population growth is the fertility pattern. It describes the age-specific fertility of women. To check the population, it is necessary to control the fertility by different control efforts.

(i) Exponential Decay :

In this model fertility decays from an initial value at a rate proportional to the current values.

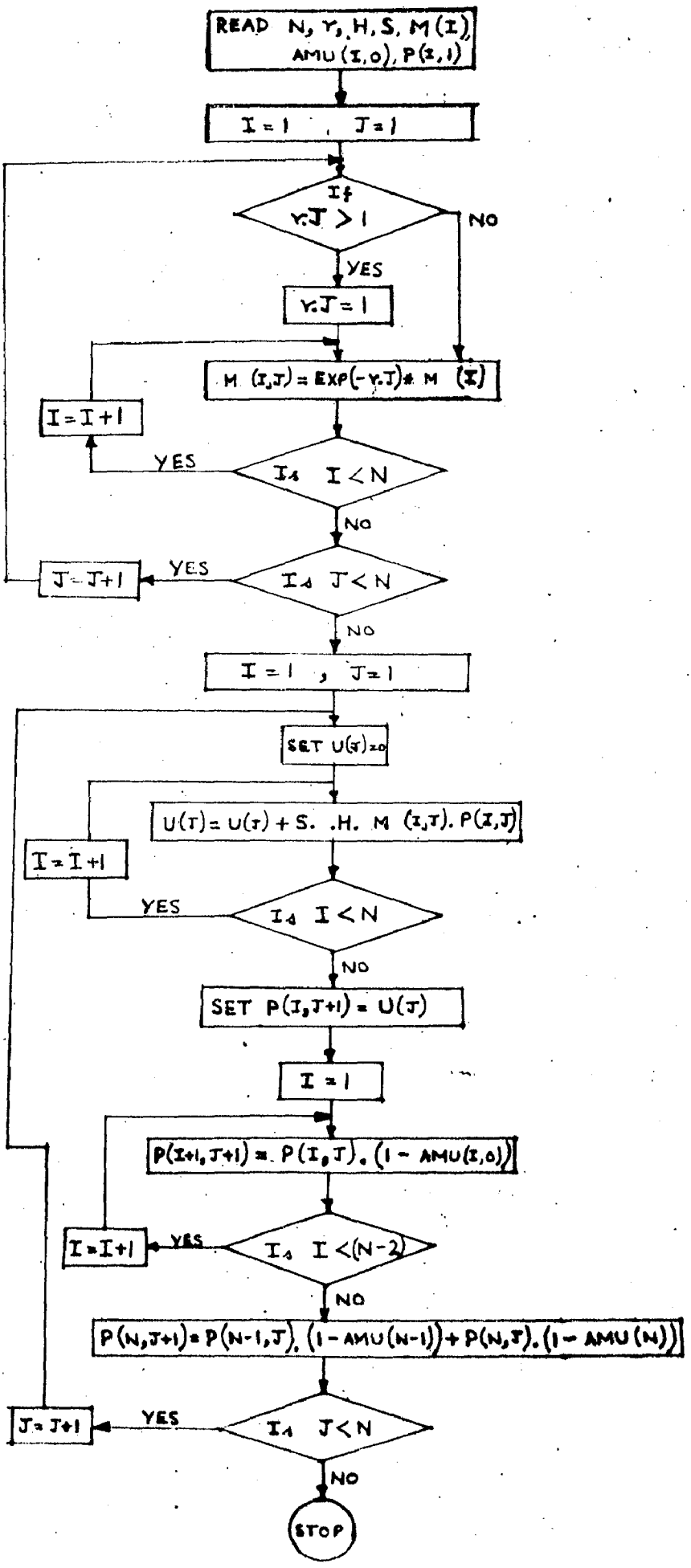

FIG 2.1 FLOW CHART

the change in fertility pattern may be expressed as :

$$SM(i,j) = SMN(i)\, e^{-rj} \qquad (2.4)$$

Here we will assume that the pattern of fertility will not vary with time but the level may be increased or decreased as a whole. In the above relationship $SM(i,j)$ is the fertility of age group i at time interval j and $SMN(i)$ is initial age-specific fertility rate of that group, r is arbitrary control factor. The characteristic of the model is that the level $SMN(i)$ is divided by a constant factor after a given interval of time. An increase in the value of r means a sharper decrease in the value of $SM(i,j)$ with time. In practice a lower bound on fertility rates also has to be used. The rate of decrease cannot exceed an upper limit which depends on the efforts as well as the social norms. In Indian context, the percentage of birth due to first two children was about 37 per cent in 1971 so it is reasonable to expect that the fertility levels should be reduced with 37 percent of initial level as the lower bound.

(ii) Family Planning Efforts :

India is the first nation which recognised population control as one of the gradients to accerlerate development and set out to reduce the birth rates through an official family planning programme.

The simple model with uniform decay in fertility pattern is not realistic. We can start with the assumption that married couples do not want more than a limited number of children. As long as the couples don't have the 2 or 3

children, they want, their fertility shall be roughly the same as that in the natural regime. The birth control efforts shall, thus, manifest strongly at the later part of fertility pattern. This can be closely approximated by the expression :

$$SM(i,j+1) = SM(i,j)\ Exp(\ am(j).\ (1-Exp(5.ak(I-4))))$$

The value of parameter aK has been suggested to be 0.03269 for India.

Family planning has been studied in two ways :

(1) am(j), family planning effort, has been changed for different time intervals, it is increased from an initial value over five year intervals and then the value is held constant for the remaining period.

(2) The family planning effort has been fixed at a level for all time intervals.

(iii) Minimum age of marriage :

The minimum age at marriage plays an important role in fertility control. An increase in the age at marriage controls the birth rates in the initial fertile age group. To find out the impact of increase in the minimum age of marriage it is essential to have the percentage of married, divorced, widowed or separated population to determine marital fertility for different age groups. The unavailability of this data for individual Indian States has resulted in non-inclusion of this study in the work.

2.6 THE CONCEPT OF THE OPTIMUM POPULATION :

In attempting to analyse the complex and intricate interrelationships between population and the economy, a very intriguing question comes up ; "What size of population is economically most advantageous in given circumstances?".

The theory of an optimum population size is the outgrowth of the synthesis of two different bodies of generally accepted economic theory. On the one hand there is the notion tha a growing population results in an enlarged market and a greater division of labour, and consequently brings about an increase in production per capita. On the other hand there is the doctrine of diminishing returns, which holds that if other factors are held constant, productivity per capita will diminish if the number of people working given resources increases beyond a certain point. From a combination of these two doctrines, it logically follows that there must be a point where the two opposing tendencies are in equilibrium; an optimum point at which a given (optimum) size of population results in maximum productivity per capita. Two further concepts follow from this premise; if the size of population exceeds the optimum point that provides the highest possible level of per capita output, the area is overpopulated, and conversely, if population size is below the optimum, the area is underpopulated.

It should also be pointed out that the optimum point is never static but continually shifts, because the quantity and quality of resources and technology are constantly changing. It is clear, therefore, that empirical measurement of the

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It should also be pointed out that the optimum point is never static but continually shifts, because the quantity and quality of resources and technology are constantly changing. It is clear, therefore, that empirical measurement of the

optimum population presents enormous difficulties, and it is not surprising that to date no satisfactory indicators of overpopulation or under population have been devised, inspite of frequent attempts to do so. The theory of the optimum population is an ideal - typical construct that enables us to understand hypothetically the influence of population size on economic productivity. At the present state of knowledge, however, the optimum cannot be translated into emperical terms of any precision, and therefore it does not lend itself as an instrument of practical population policy, despite the tempting policy implications inherent in its very terminology.

CHAPTER THREE

THE DATA SELECTION

"Early marriage is a poison gas excluded by the rotting corpse of capitalism"

Wall Poster 1960s

3.1 DATA BASE :

The Sample Registration system of 1978 provided the data for use in this work. 1981 Census data has not been used as all the relevant volumes of this census have yet not been taken out. For a statewise study of the population, it is required that the age specific fertility rates, age specific mortality rates, number of females in different age groups etc. are available for individual states of the Union of India. Non-availability of this data 1981 census warranted the use of SRS 1978 figures.

It was initially decided to carry out population projections for India and five states. The selection of the states is based on typical socio-economic pattern. The five states of representative character are Kerala, Maharashtra, Punjab, Uttar Pradesh and Orissa. The crude birth rates, death rates, population density rates and literacy rates for each of these states in India are shown in table 3.1

TABLE 3.1

State	Birth rate	Death rate	Population density (Per Sq.Km.)	Literacy rate
Kerala	25.2	6.6	635	69.75
Maharashtra	26.9	10.1	204	45.77
Punjab	29.4	11.6	331	38.69
Uttar Pradesh	40.4	21.4	377	25.44
Orissa	32.9	14.1	169	30.58
India	33.3	14.5	216	34.46

(12), (15)

The typical nature of the states selected is easy to understand, Kerala has a very high population density and literacy rate (both being highest in India) it has birth rates and death rates well below the All India average. Maharashtra and Punjab both have high per capita incomes, both being the 'richest' of Indian States. But Maharashtra has a more urban nature than Punjab, the former being the most urbanised of Indian states. Its level of literacy is considerably quite higher than Punjab. Uttar-Pradesh and Orissa are two of our poorest states, both essentially rural in nature. Of the two U.P. is much more density populated and has a lower level of literacy; but has a higher per-capita income. Orissa has birth and death rates comparable to all India average while Uttar Pradesh has the highest birth and death rates among the states selected. A very interesting features emerges when we contrast Uttar-Pradesh with Kerala, Kerala is even more density populated than Uttar Pradesh but has strikingly high literacy rate and lower birth and death rates. Kerala has also a higher per-capita income. This contrasting feature underscores the importance of carrying out population projections on a state-wise basis too.

Gujarat has been selected as the sixth state the influencing factor being its birth and death rates, the birth rate standing at 35.8 being above the all-India average while the death rate of 12.6 falls <u>below</u> the all-India average thus marking a departure from the pattern of corresponding rates of other states selected for study. Thus we can safely

conclude that the population of Gujarat shall increase at a much faster rate compared to other states or India.

The data required for carrying out population projections is presented in tables 3.2, 3.3 and 3.4. The number of females in different age groups is expressed on a per unit basis, that is the total female population in 1978 is assumed to be 1 and their age distribution expressed in fractions of it. An advantage of this approach is that the future population is determined again on a per unit basis and it becomes easier to understand the magnitude of population growth.

TABLE 3.2

Age-specific fertility rates 1978

Age Group	India	Kerala	Maharashtra	Punjab	Orissa	Uttar Pradesh	Gujar
15-19	89	45	82	23	95	100	66
20-24	249	180	238	226	261	279	297
25-29	232	165	190	244	235	284	268
30-34	170	106	116	170	164	254	183
35-39	99	65	53	89	87	152	92
40-44	45	19	20	39	26	88	39
45-49	16	4	5	10	14	35	13

TABLE 3.3

Age-specific Mortality rates (Females) 1978

Age group	India	Kerala	Maharashtra	Punjab	Orissa	Uttar Pradesh	Gujarat
1-4	52.1	14.7	28.0	44.8	46.5	85.7	49.2
5-9	4.7	1.5	3.7	2.9	5.5	5.2	3.0
10-14	2.0	1.1	2.0	1.0	1.0	2.2	1.2
15-19	3.0	0.6	3.0	1.7	3.2	4.8	3.2
20-24	4.1	1.5	4.5	3.6	3.2	4.6	4.5
25-29	4.1	1.5	4.4	2.5	7.2	6.8	2.9
30-34	3.9	2.1	2.4	2.0	3.3	6.6	5.2
35-39	4.7	2.0	3.4	2.3	3.9	3.7	3.5
40-44	6.7	4.2	4.0	5.9	7.7	6.9	5.5
45-49	7.6	5.3	7.4	6.3	8.0	5.9	4.4
50-54	13.0	6.4	9.0	10.1	13.8	14.9	9.2
55-59	19.9	13.0	18.7	3.5*	24.5	23.0	15.4
60-64	32.4	18.5	30.3	20.0	32.6	39.0	24.8
65-69	47.1	32.1	30.7	20.4	60.4	61.3	42.8
70 and above.	106.0	85.9	91.6	99.8	106.4	87.7	75.6

* Data suspect

Age Group	India	Kerala	Maharashtra	Punjab	Orissa	Uttar Pradesh	Gujarat
0-4	0.1311	0.1127	0.1308	0.1244	0.1290	0.1423	0.1401
5-9	0.1294	0.1160*	0.1318*	0.1132	0.1282	0.1292	0.1295
10-14	0.1249	0.1204*	0.1247	0.1118	0.1341*	0.1183	0.1256
15-19	0.1092	0.1149	0.1058	0.1096	0.1173	0.1044	0.1114
20-24	0.0888	0.1077	0.0892	0.0990	0.0956	0.0954	0.0954
25-29	0.0717	0.0833	0.0746	0.0781	0.0694	0.0709	0.0684
30-34	0.0634	0.0635	0.0663	0.0655	0.0648	0.0597	0.0618
35-39	0.0602	0.0542	0.0628	0.0548	0.0628	0.0608	0.0568
40-44	0.0528	0.0514	0.0536	0.0499	0.0541	0.0524	0.0528
45-49	0.0452	0.0467	0.0466	0.0445	0.0455	0.0463	0.0417
50-54	0.0364	0.0371	0.0363	0.0401	0.0345	0.0374	0.0358
55-59	0.0285	0.0286	0.0287	0.0326	0.0282	0.0298	0.0274
60 and above	0.0584	0.0535	0.0548	0.0765	0.0525	0.0631	0.0533

* Data Suspect (12)

The data marked with an asterisk (*) are suspect. In Table 3.3 the female mortality rate of age group 55-59 of Punjab is very low at 3.5 per thousand and raises doubts about its veracity. Similarily the age-distribution of females shows the number of females in 10-14 age group in Kerala and Orissa to be higher than the preceeding 5-9 age group, a fact which may be erroneous for obvious reasons. Maharashtra and Kerala have a higher proportion of females in the 5-9 age group than the 0-4 age group which is again questionable. Table 5.2 also brings out an increase in female mortality rates in age groups 20-24 and 25-29 years which is attributed to an increased number of female deaths during child-bearing.

3.2 INTRODUCTION OF DECLINING CHILD MORTALITY :

India has an infant mortality rate of 127 (15) and a child mortality rate (0-4 age group) of 52.1. (12). After independence there has been a continuous decline in these mortality rates. Therefore for any realistic study, it shall be prudent to introduce a decline in future child mortality rates. This has been incorporated in the work by allowing an exponential decay in the child mortality rate by the relation.

$$AMU(1,J) = AMU(1) * EXP(-(5xJxd)$$

Where AMU(1) : Mortality rate of females of 0-4 age group

AMU (1,J) : Mortality rate of females of 0-4 age group after J five year interval.

d : Factor controlling the decline in mortality rates.

It has been further assumed that the child mortality rates shall not fall below a lower bound, which is taken to be

equal to 50 per cent of current level. Since exponential of -0.693 is half, 0.693 is put as an upper bond on the value of 5 x J x d.

The relationship between child-mortality and fertility rates is not a figment of imagination, it is based on concrete psychological and sociological behaviour of parents. Parents want not only children but surviving children, and an improvement in child mortality rates shall obviate the 'replacement' and 'risk' effect, the former being the decision of parents to have an additional child in the event of the death of a child already born and a latter being the desire of having more children if the chances of survival are low. As we have introduced fertility control in projection work, the simultaneous induction of child mortality decline is going to give a more realistic overview of future population pattern.

A very strong correlation emerges when we observe the birth rates and child mortality rates of India and the six states selected for study. Table 3.5 gives the above rates on a per unit basis. India's birth rate and child mortality rate serving as the base.

TABLE 3.5

	India	Kerala	Maharashtra	Punjab	Orissa	Uttar Pradesh	Gujarat
Birth rates	1.0000	0.7568	0.8078	0.8829	0.9880	1.2132	1.0751
Child Mortality Rates.	1.0000	0.2821	0.5374	0.8599	0.8925	1.6449	0.9443

These are plotted with child mortality rates on the x-axis and birth rates on the y-axis and a straight line of best, fit, on the basis of method of least squares has been fitted into the data.

The correlation Coefficient $r = \frac{U_{11}}{x\ y}$

U_{11} : Covariance

x, y are the standard deviations

$$r = \frac{xy - \frac{X\ Y}{N}}{\sqrt{(x^2 - (\frac{x}{N})^2)\ (y^2 - \frac{(y)^2}{N})}}$$

$x = 6.7238$

$y = 6.1611$

$xy = 6.2994$

$x^2 = 6.6086$

$y^2 = 6.5018$

$$r = \frac{0.3813944}{\sqrt{(0.1501019)(1.0790638)}} = 0.948$$

3.3 STUDY OF FERTILITY VIS-A-VIS LITERACY :

Tables 3.5 and 3.6 list the distribution of currently Married women and the related births during the last year by education and age at marriage for rural and urban areas.

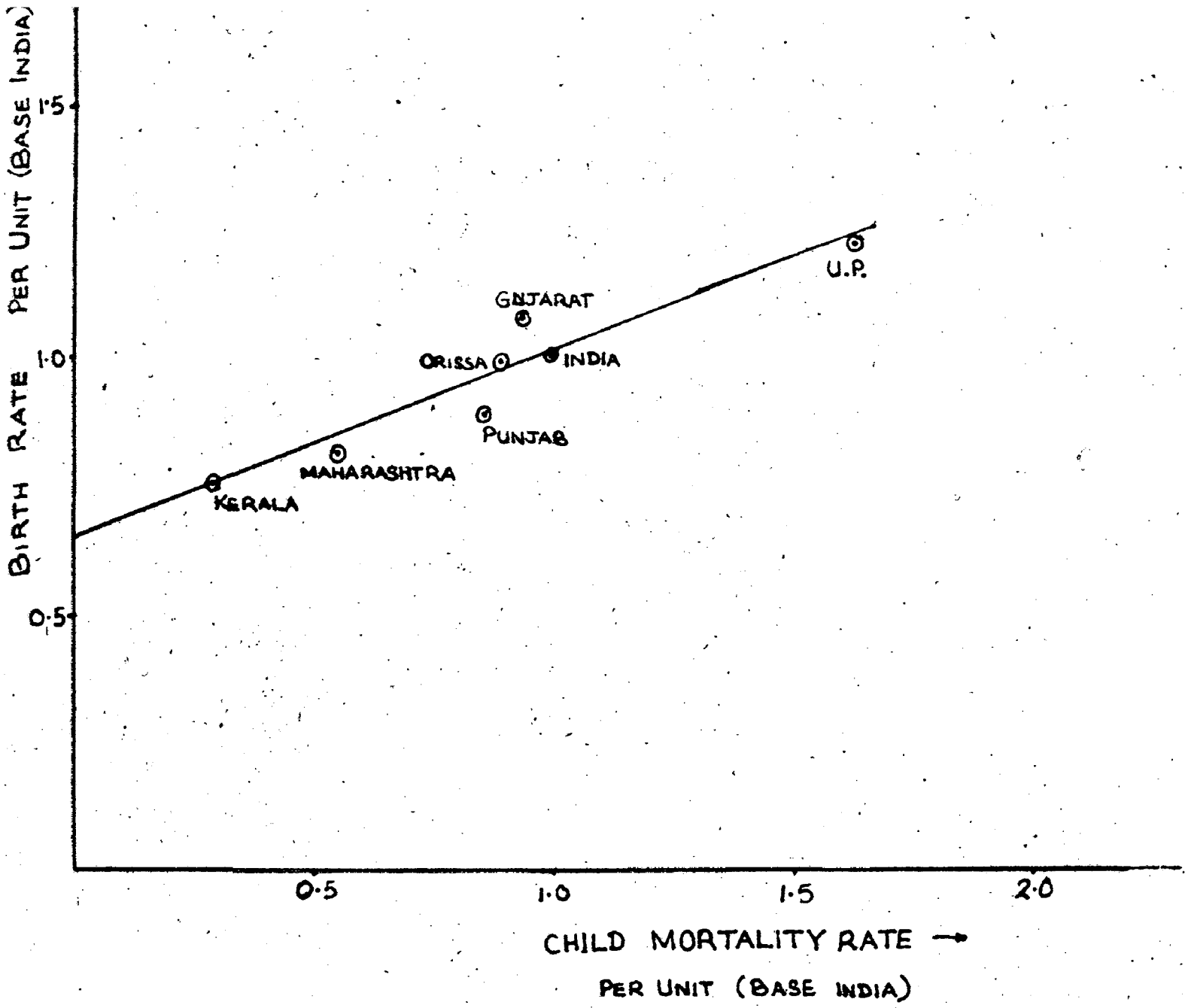

BIRTH RATE PER UNIT (BASE INDIA)
1·5
1·0
0·5
U.P.
GUJARAT
ORISSA
INDIA
PUNJAB
MAHARASHTRA
KERALA
0·5
1·0
1·5
2·0
CHILD MORTALITY RATE →
PER UNIT (BASE INDIA)

Fig. 3.1

TABLE 3.6 Rural Females

Age at Marriage	Level of Education											
	Illiterates			Less than Matriculate			Above Matriculate but less than graduate			Graduates		
	Women	Births	Births/woman	Woman	Births	Births/woman	Women	Births	Births/woman	Women	Births	Birth/woman
All ages	874,325	131434	0.150	106367	20007	0.188	4889	1062	0.217	480	101	0.210
Less than 13	225,239	33316	0.148	11559	1915	0.166	160	22	0.138	14	4	0.285
13-17	453867	74464	0.164	61551	12075	0.196	1428	307	0.215	92	18	0.196
18-22	139522	20857	0.149	26337	5351	0.203	2386	586	0.243	213	48	0.225
23-27	8213	1175	0.143	2184	428	0.196	593	131	0.221	120	25	0.208
Over 28	3428	333	0.097	455	59	0.130	91	12	0.132	15	3	0.200

Source of data : Paper 2 of 1977, 1971 Census Fertility Tables R-IV Part A based on 1 per cent sample. (8)

TABLE 3.7 Urban Females

Age at Marriage	Level of Education: Illiterates			Less than Matriculate			Above Matriculate but less than Graduate			Graduates		
	Women	Births	Birth/ Woman	Women	Births	Birth/ woman	Women	Births	Birth/ woman	Women	Births	Birth/ woman
All ages	125280	16953	0.135	71769	11164	0.156	14478	2376	0.164	3361	505	0.150
Less than 13	19619	2739	0.140	4485	654	0.145	279	47	0.168	36	4	0.111
13-17	66051	9904	0.150	37955	6312	0.166	3651	345	0.094	403	53	0.132
18-22	26538	3768	0.142	21981	3683	0.167	7583	1414	0.188	1627	258	0.158
23-27	1828	219	0.126	1984	307	0.164	1621	305	0.188	887	158	0.178
Above 28	754	62	0.082	477	52	0.109	281	39	0.032	156	24	0.154

Source of Data : Paper 2 of 1977, Census 1971 Fertility tables FIV Part B.
Based on 1 per cent sample (8)

The data point out to a totally unexpected result. The number of birth/woman is increasing with the level of education both for urban and rural females. There is a mild decline in the births/woman for graduates when compared to females who are above matriculate but not graduates but still the ratio remains higher than the illiterate females. Thus this study proves inconclusive.

3.4 STUDY OF FERTILITY VIS-A-VIS RELIGION :

Tables 3.7 and 3.8 list the distribution of currently married women and the related births in the last year by religion and age at marriage for rural and urban areas.

The number of births/woman in a year is maximum for Muslims and least for skkhs; Christians and Hindus coming in between. The pattern is same for both urban and rural females. The ratio of births/woman for Hindus and Sikhs is below that for all religions. There is a decline in this ratio for urban areas for all religions compared to rural areas.

TABLE 3.8

Rural Females

Age at Marriage	RELIGION											
	HINDUISM			ISLAM			SIKHS			CHRISTIANITY		
	Women	Births	Births/ woman	Women	Births	Births/ woman	Women	Births	Births/ woman	Women	Births	Births/ woman
All ages	841850	128508	0.153	93495	15985	0.171	16827	2451	0.146	20337	3336	0.164
Less than 13	213134	31277	0.147	19603	3303	0.168	795	121	0.152	922	123	0.133
13-17	441533	73345	0.166	52819	9756	0.185	7878	1173	0.149	3795	1328	0.167
18-22	134299	21100	0.157	15141	2559	0.169	7226	1084	0.150	8968	1569	0.175
23-27	8194	1269	0.155	925	147	0.159	528	64	0.121	1161	226	0.195
Over 28	2995	302	0.101	449	49	0.109	128	6	0.047	270	32	0.118

Source of Data : Paper 2 of 1977, Census of India 1971 Fertility tables B-1A (8)

There were 152604 births for 989061 women (married at all ages) of all religions giving a ratio of 0.154 births/woman.

TABLE 3.9 Urban Females

Age at Marriage	RELIGION											
	HINDUISM			ISLAM			SIKH			CHRISTIANITY		
	Births	Women	Births/ woman	Births	Women	Births/ woman	Births	Women	Births/ woman	Births	Women	Birt woma
All ages	165326	23041	0.139	33952	5672	0.167	3742	506	0.135	5990	901	0.150
Less than 13	20335	2761	0.136	3100	524	0.169	172	19	0.110	192	33	0.172
13-17	83554	12526	0.150	18143	3331	0.184	1625	216	0.133	1886	302	0.160
18-22	43190	6611	0.153	8775	1569	0.179	1531	248	0.162	2634	418	0.159
23-27	4630	700	0.151	678	123	0.181	176	22	0.125	689	114	0.181
Over 28	1143	114	0.099	252	35	0.139	36	1	0.028	168	18	0.109

Source of Data : Paper 2 of 1977, Census of India 1971, Fertility Tables F IV B(8)

There were 30998 births for 214088 females (married of all ages) of all religions giving a ratio of 0.144 births/woman.

CHAPTER FOUR

SIMULATION RESULTS

"Thou was not born for death, immortal Bird:
No hungry generations tread thee down"

Keats

In previous chapters, the basic demographic model and choice of fertility control have been discussed. The required input data for carrying out the population projections have been tabulated. Based upon these, the effect of various control efforts on the population distribution has been simulated for a period of sixty years in twelve five year intervals. Since the input data is of sample Registration System 1978, the projections simulated are upto year 2038.

4.1 ARBITRARY CONTROL EFFORTS :

The effect of different values of arbitrary control efforts on Indian population is tabulated in table 4.1 and the trajectories are plotted in Fig.4.1. The control effort 'r' has been assigned the values 0, 0.005, 0.010, and 0.014. A lower bond on Fertility levels has been kept so that the fertility does not decline to a value below 37 per cent of initial value. Decline in future child mortality rates has been introduced and the child-mortality decline coefficient 'd' assigned values equal to r, i.e. 0,005, 0.010 and 0.014. (Fertility also declines concurrently at the same rate). Also shown is the population pattern when r equals 0.15 and d equals 0.005.

Similar projections have been carried out for the six selected states of Kerala, Maharashtra, Punjab, Orissa, Uttar-Pradesh and Gujarat.

Here in the Final run, r equals 0.010 and d equals 0.005. The corresponding trajectories for these six states are plotted in Figs. 4.2 to 4.7.

TABLE 4.1

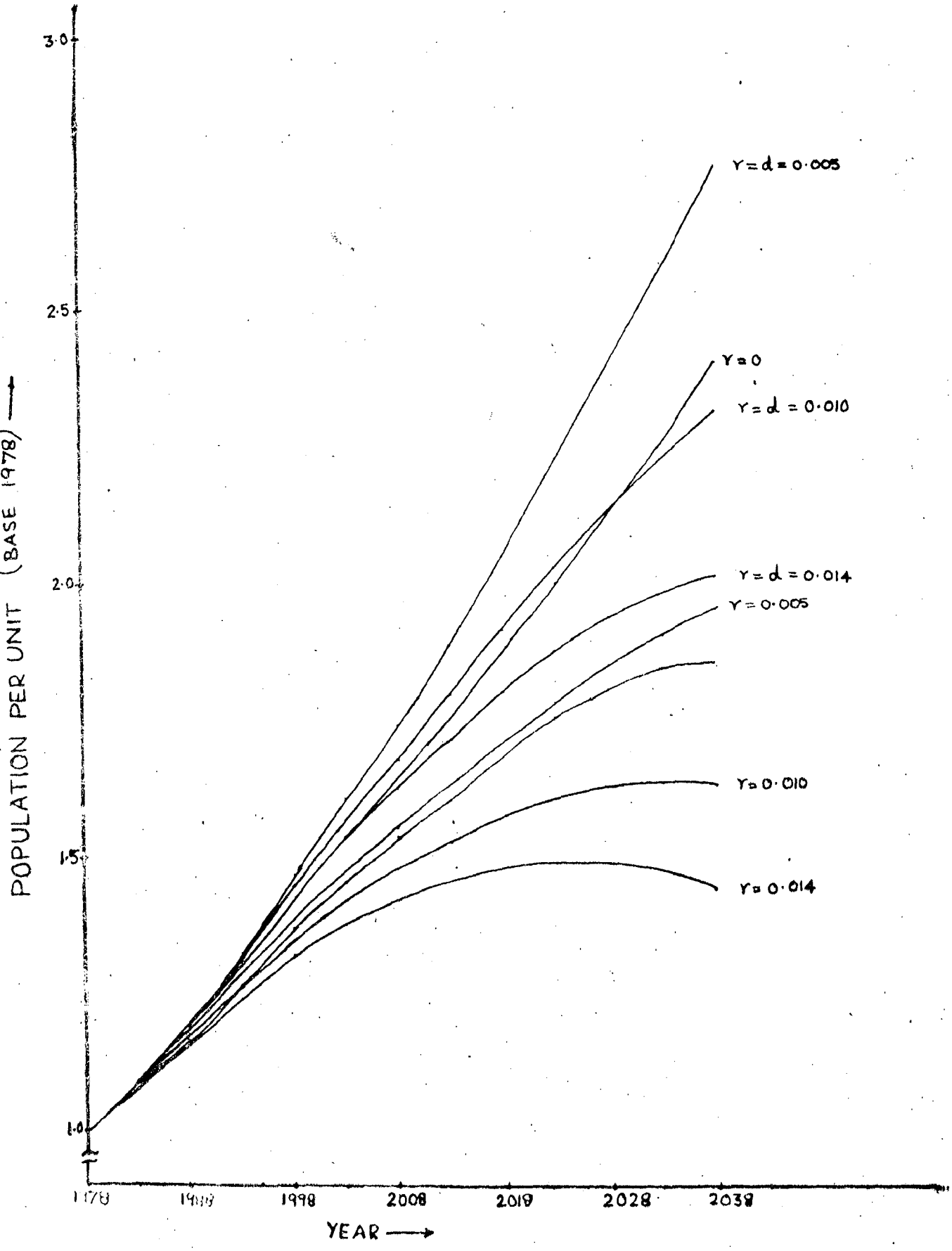
Effect of Arbitrary control efforts on Indian Population

Control Effort		POPULATION (Per Unit)						
Fertility	Child Mortality							
r	d	1978	1988	1998	2008	2018	2028	2038
0.000	0.000	1.000	1.195	1.433	1.645	1.878	2.138	2.403
0.005	0.000	1.000	1.183	1.392	1.558	1.713	1.854	1.959
0.010	0.000	1.000	1.172	1.354	1.482	1.576	1.633	1.638
0.014	0.000	1.000	1.163	1.326	1.427	1.484	1.491	1.443
0.005	0.005	1.000	1.195	1.470	1.743	2.051	2.403	2.753
0.000	0.010	1.000	1.192	1.453	1.683	1.916	2.136	2.306
0.014	0.014	1.000	1.188	1.430	1.626	1.803	1.940	2.009
0.015	0.005	1.000	1.169	1.372	1.537	1.691	1.813	1.861

TABLE 4.2

Effect of Arbitrary Control Efforts on Population (States)

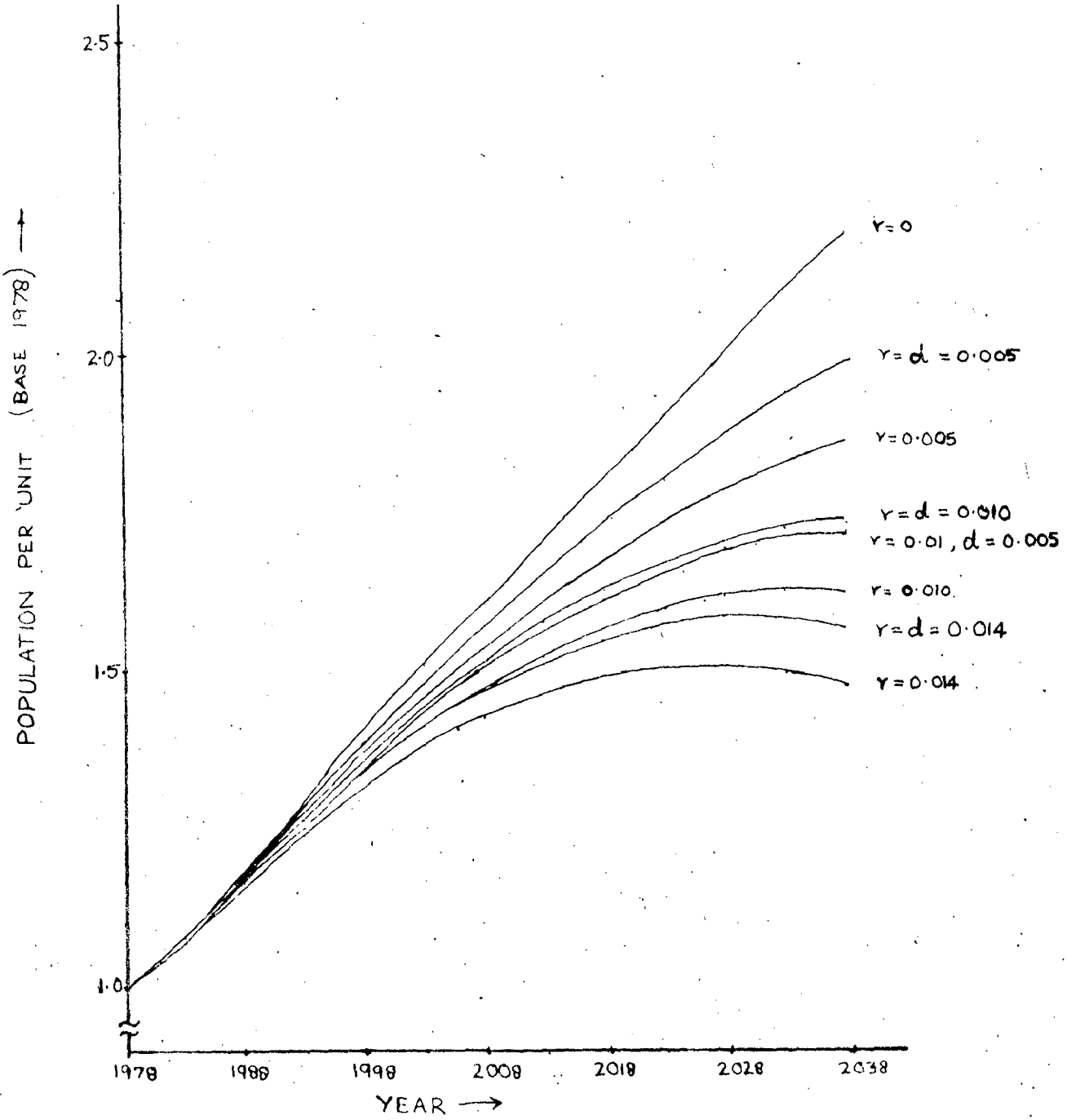
Control Effort		POPULATION IN 2036 (Per Unit, base 1978)					
Fertility r	Child Mortality d	Kerala	Maharashtra	Punjab	Orissa	U.P.	Gujarat
0.000	0.000	2.187	2.292	2.376	2.349	2.245	2.927
0.005	0.000	1.863	1.891	1.993	1.876	1.811	2.378
0.010	0.000	1.625	1.601	1.713	1.535	1.499	1.983
0.014	0.000	1.478	1.425	1.541	1.330	1.312	1.745
0.005	0.005	1.993	2.219	2.554	2.560	3.534	3.273
0.010	0.010	1.737	1.877	2.192	2.141	2.950	2.732
0.014	0.014	1.574	1.660	1.952	1.840	2.534	2.377
0.010	0.005	1.726	1.851	2.144	2.082	2.796	2.659



INDIA

ARBITRARY CONTROL

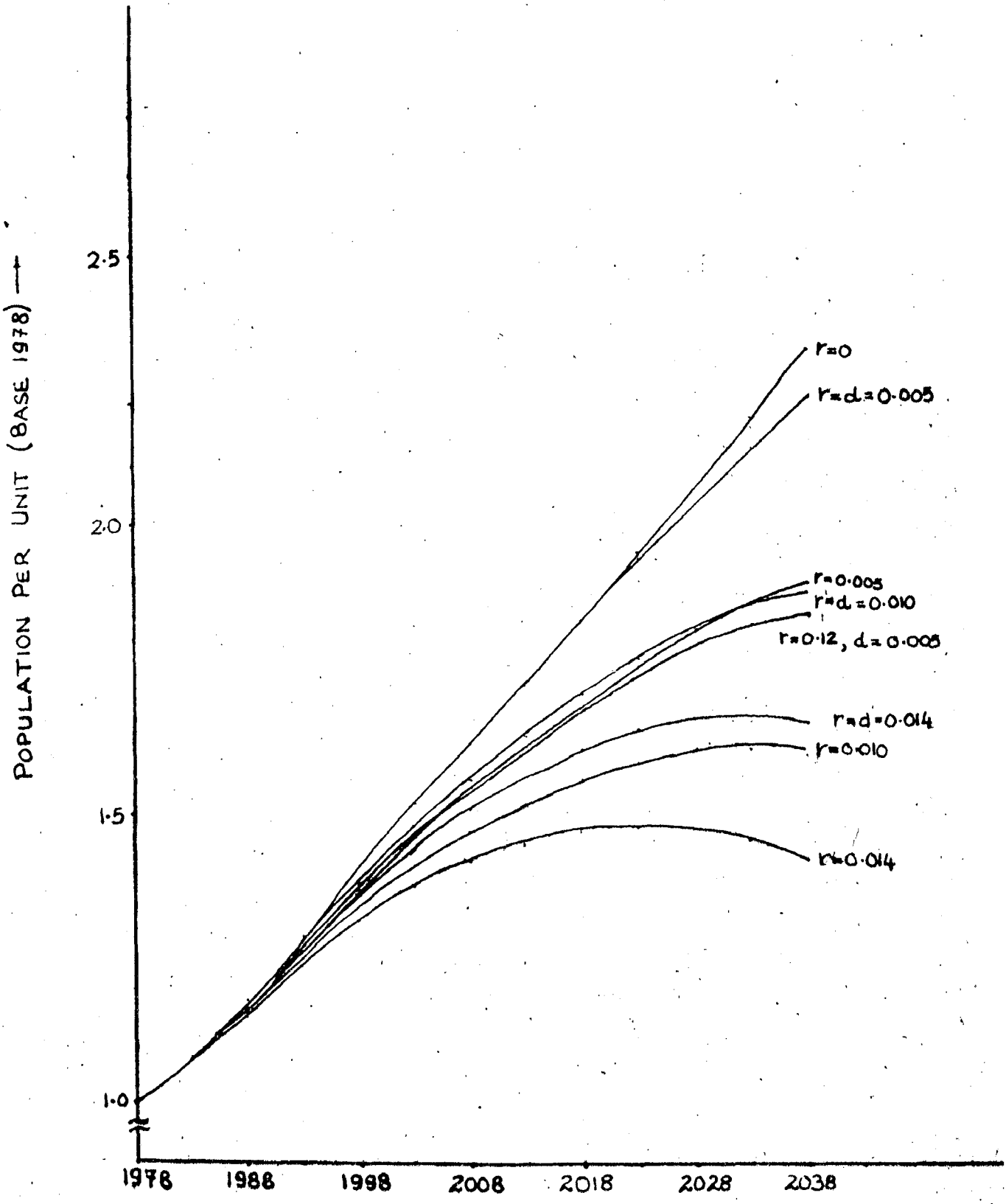
Fig 4·1



KERALA

ARBITRARY CONTROL

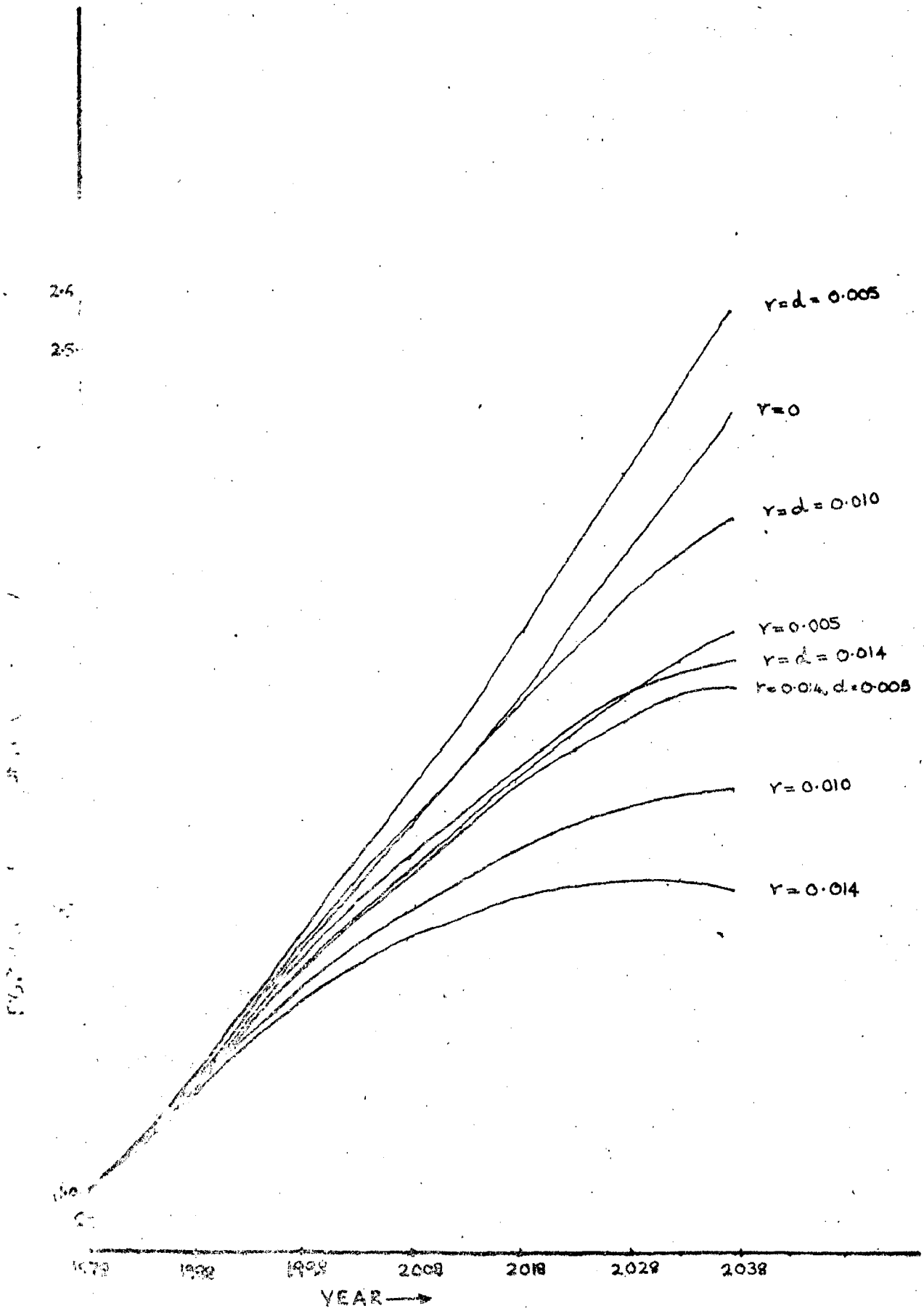
fig 4.2



MAHARASHTRA

ARBITRARY CONTROL

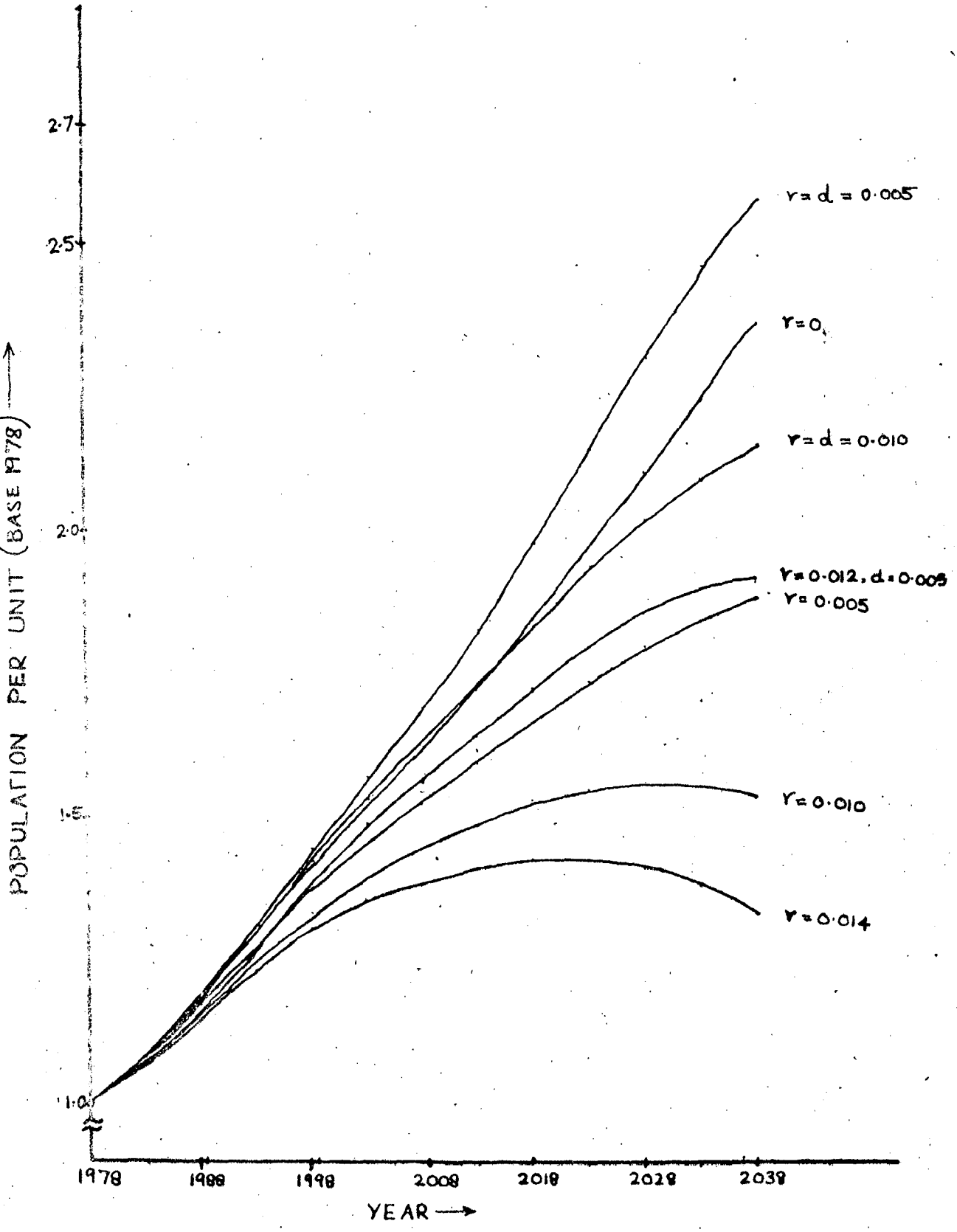
Fig. 4·3



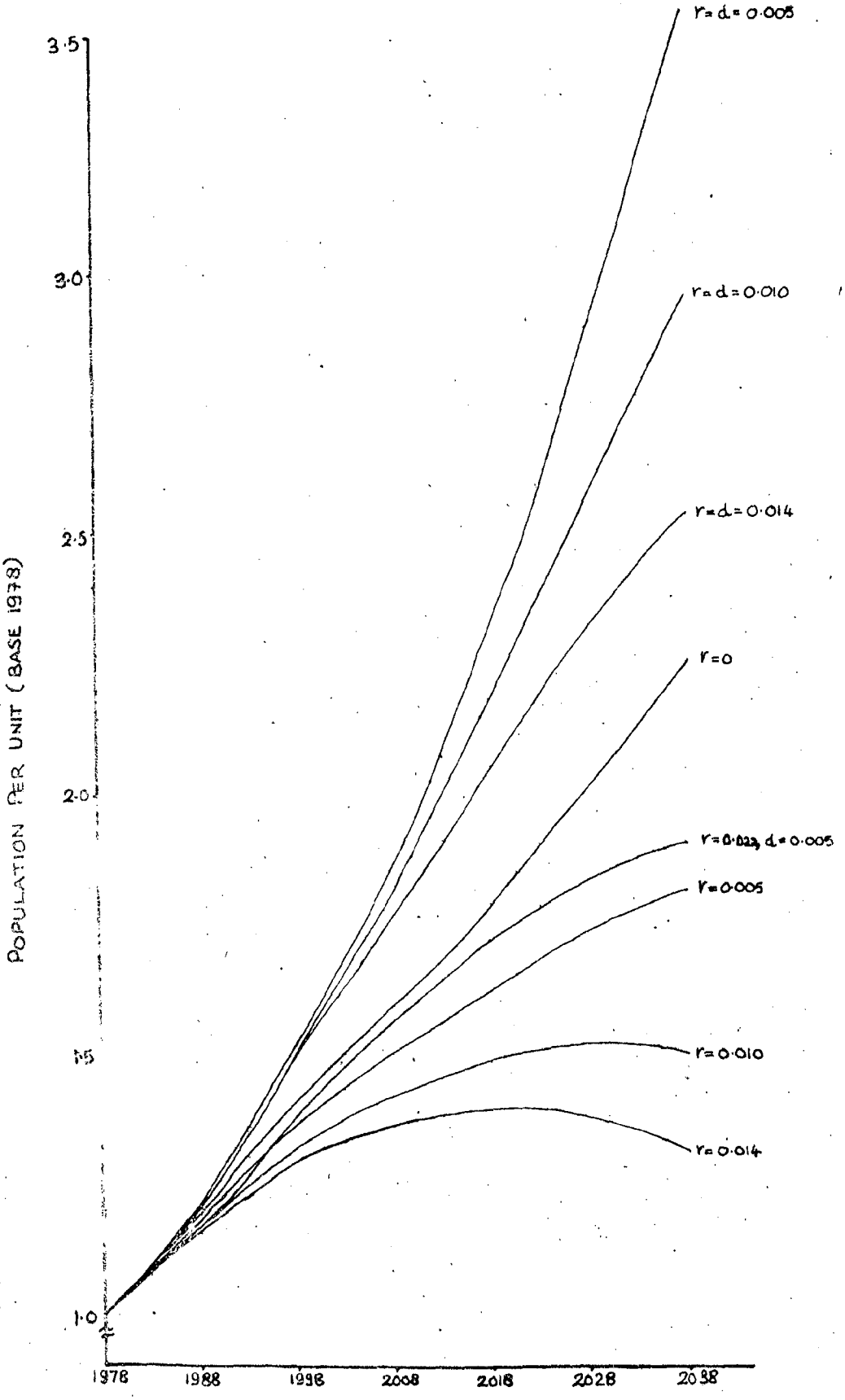
PUNJAB

ARBITRARY CONTROL

Fig 4·4

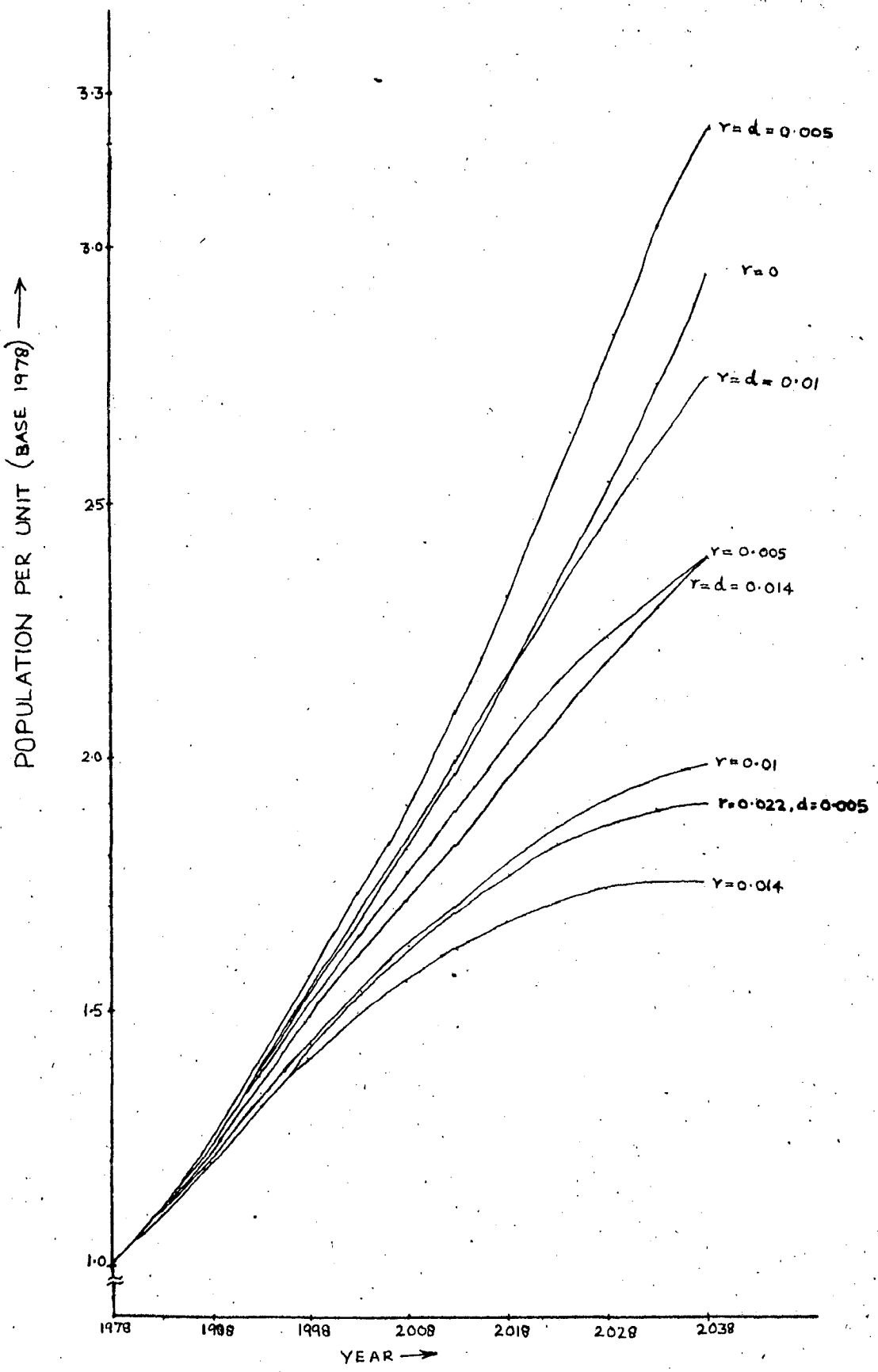


ORISSA
ARBITRARY CONTROL
Sig 4.5



UTTAR PRADESH Fig. 4.6

ARBITRARY CONTROL



GUJARAT

ARBITRARY CONTROL

Fig 4.7

A look at the population projection trajectories brings out the fact that in event of no control, Gujarat shall be having the highest rate of population increase followed by Punjab, Orissa, Maharashtra, Uttar Pradesh and Kerala in that order. However, with induction of exponential decline in fertility rates (without simultaneous decline in child mortality rates) shall alter the order to Gujarat, Punjab, Kerala, Maharashtra, Orissa and Uttar Pradesh for a control effort of 0.014, a fact which can be understood by a study of the 1976, fertility and mortality rates. U.P. and Orissa have high fertility and mortality rates and a control on the former shall lower the population considerably, the decrease being sharper than other states. The introduction of declining child mortality alters the situation as population of states having high child mortality rates as Uttar Pradesh and Orissa increases rapidly.

4.2 FAMILY PLANNING EFFORTS :

Family planning efforts have been studied in two ways :-

1. A constant value of family planning effort 'cm' has been used throughout the study period.

2. Family planning effort has been increased in steps from an initial value for four intervals of 5 year duration. After 25 years it is held at the constant value attained after four such steps. Table 4.3 shows the projected

TABLE 4.3

Family Planning Efforts

Control (cm³	Control d	POPULATION IN 2038 (Per Unit, base 1978) India	Kerala	Maharashtra	Punjab	Orissa	U.P.	Gujarat
0-02(0.02)0.10	0	2.001	1.903	1.979	2.003	1.948	1.804	2.441
0.04(0.04)0.20	0	1.738	1.711	1.763	1.759	1.680	1.532	2.119
0.10(0.02)0.18	0	1.685	1.667	1.717	1.708	1.625	1.478	1.973
0.08	0	1.859	1.790	1.859	1.866	1.803	1.657	2.269
0.12	0	1.672	1.651	1.705	1.693	1.614	1.467	2.043
0.16	0	1.525	1.539	1.579	1.555	1.462	1.320	1.862
0.10(0.03)0.22	0.005	1.904	1.666	1.790	1.836	1.827	1.968	2.297
0.10(0.03)0.22	0.010	2.043	1.689	1.851	1.928	1.957	2.257	2.453
0.10(0.05)0.30	0.005	1.761	1.578	1.681	1.710	1.681	1.788	2.120
0.10(0.05)0.30	0.010	1.886	1.766	1.736	1.791	1.791	2.044	2.259
0.15(0.05)0.35	0.005	1.624	1.490	1.573	1.589	1.542	1.622	1.953
0.15(0.05)0.35	0.010	1.736	1.509	1.623	1.661	1.646	1.897	2.077
0.12	0.005	1.979	1.726	1.843	1.899	1.904	2.069	2.394
0.12	0.010	2.126	1.703	1.907	1.996	2.041	2.377	0.560
0.18	0.005	1.709	1.552	1.638	1.659	1.632	1.731	2.066
0.18	0.010	1.830	1.531	1.691	1.738	1.746	1.978	2.202
0.25	0.005	1.500	1.415	1.484	1.479	1.427	1.464	1.788
0.25	0.010	1.581	1.401	1.503	1.521	1.493	1.654	1.898

population for the year 2038 for India and the six states. Both methods of family planning control have been tabulated. 0.1(0.05)0.3 means that the Family planning effort has been increased from 0.1 to 0.3 in steps of 0.05 for four intervals of 5 years and then held at 0.3. Child-mortality decline is also introduced for two values of d : 0.005 and 0.010.

The population growth trajectories are plotted in Figures 4.8 to 4.28. Gujarat again comes up as the state with the highest rate of population growth the reason obviously being its high fertility and low mortality rates.

4.3 AGE STRUCTURE OF INDIAN POPULATION :

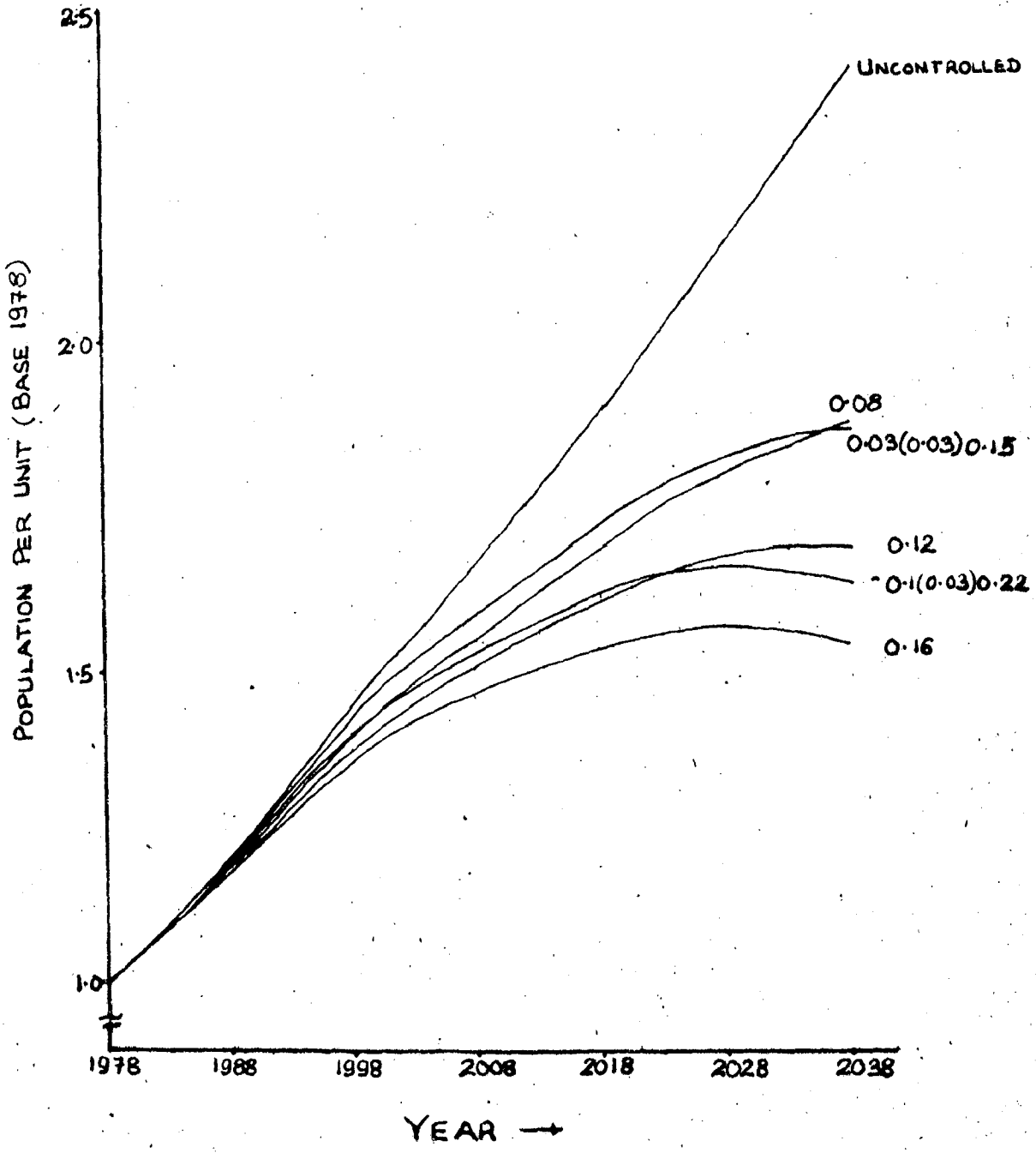
The age structure of population shall be drastically changed in future. Table 4.4 gives the present age-structure of the population (1978 data) together with the age-structure of 2038 population for some control measures as well as the uncontrolled case. Histograms have been plotted in Figs.4.29 and 4.30.

Thus it is seen that the proportion of people (Females) aged 60 and above shall increase in the future. If there is no control on fertility, the age-group 0-4 shall have an almost same proportion of population as present. Therefore in the event of no fertility control the dependency ratio shall rise further than the present value. It shall be roughly 1.25 compared to 1.03 at present. This will further aggravate the population problem. Introduction of population control measures reduces the population levels in the initial age groups.

TABLE 4.4

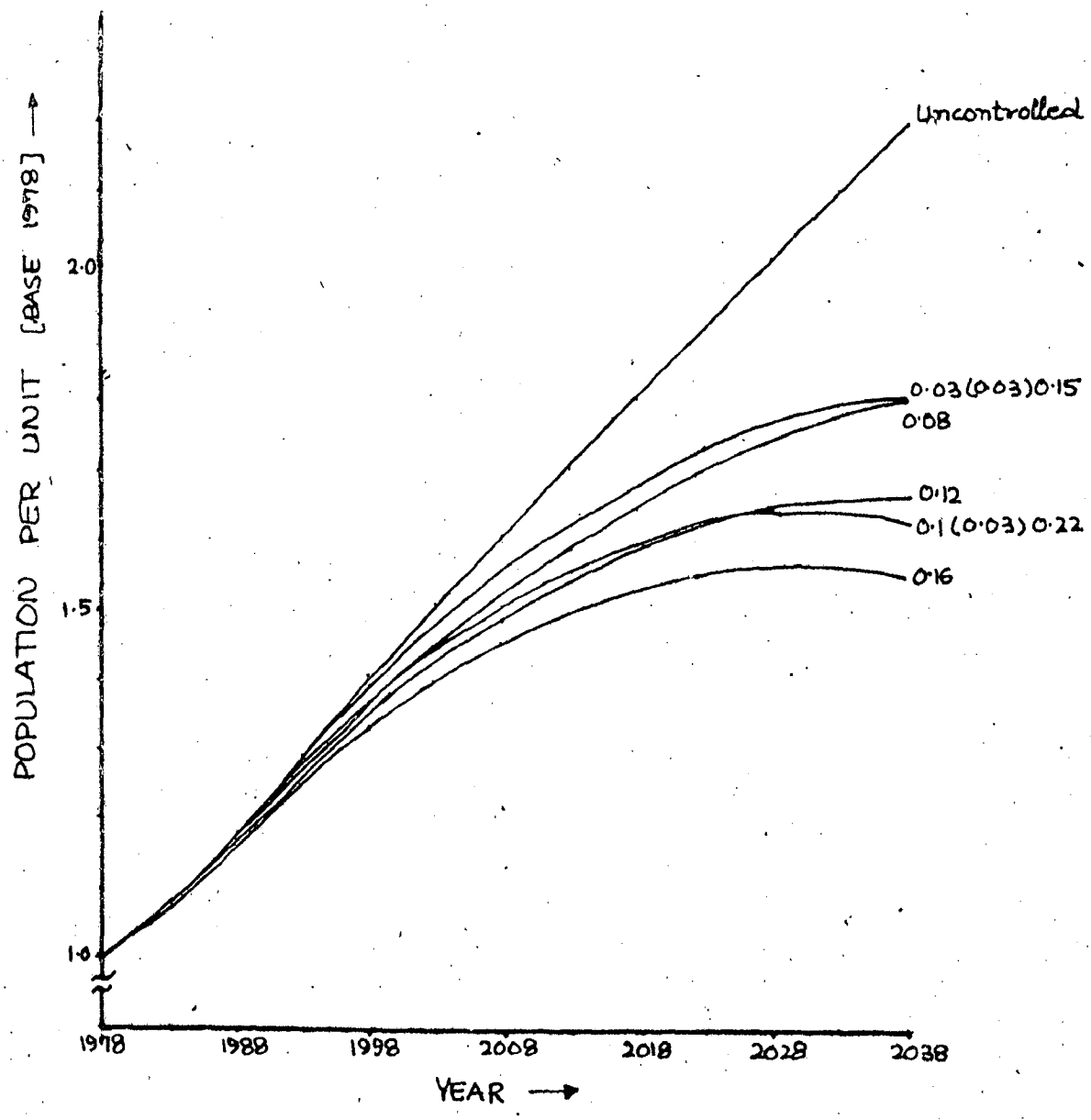
Age-Structure of Indian Population

Age Group	1978	2038 Uncontrolled	Year 2038 0.15(0.05)0.35 d=0.010	2038 0.25 d=0.010	2038 0.03(0.03)0.15 d=0.00	2038 0.10 d=0.00
0-4	0.131	0.131	0.051	0.053	0.084	0.085
5-9	0.129	0.093	0.056	0.057	0.066	0.066
10-14	0.125	0.087	0.062	0.062	0.069	0.068
15-19	0.109	0.082	0.069	0.067	0.072	0.070
20-24	0.089	0.074	0.072	0.069	0.071	0.069
25-29	0.072	0.067	0.070	0.067	0.067	0.066
30-34	0.063	0.062	0.069	0.066	0.066	0.064
35-39	0.060	0.060	0.071	0.068	0.071	0.066
40-44	0.053	0.059	0.077	0.073	0.070	0.069
45-49	0.045	0.054	0.074	0.071	0.067	0.065
50-54	0.036	0.045	0.075	0.072	0.068	0.067
55-59	0.028	0.036	0.072	0.072	0.067	0.068
Over 60	0.058	0.151	0.180	0.201	0.166	0.177



INDIA
FAMILY PLANNING CONTROL ('AM')
CONSTANT CHILD MORTALITY

Fig 4·8

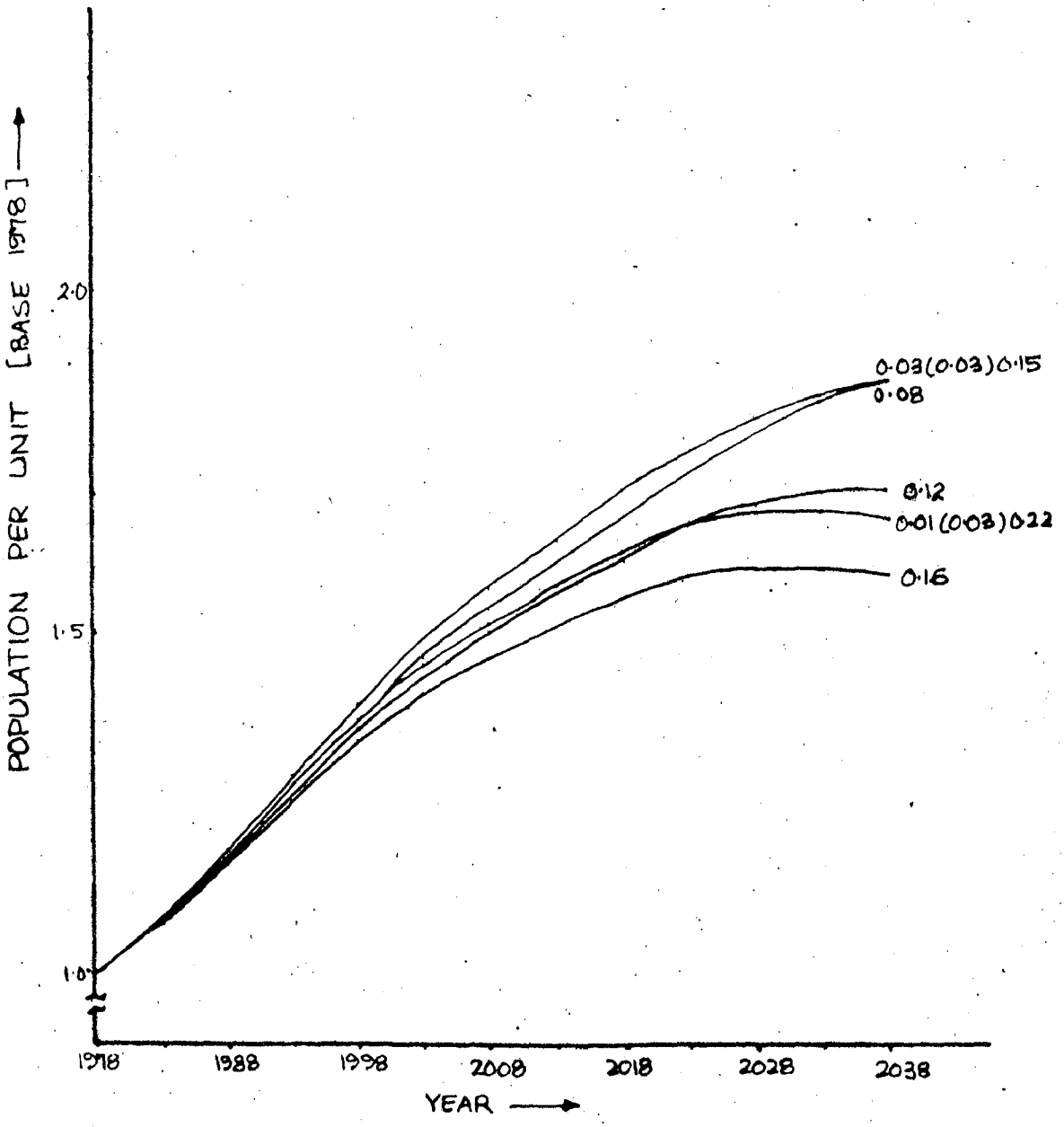


KERALA

FAMILY PLANNING CONTROL (A.M.)

CONSTANT CHILD MORTALITY

Fig 4.9

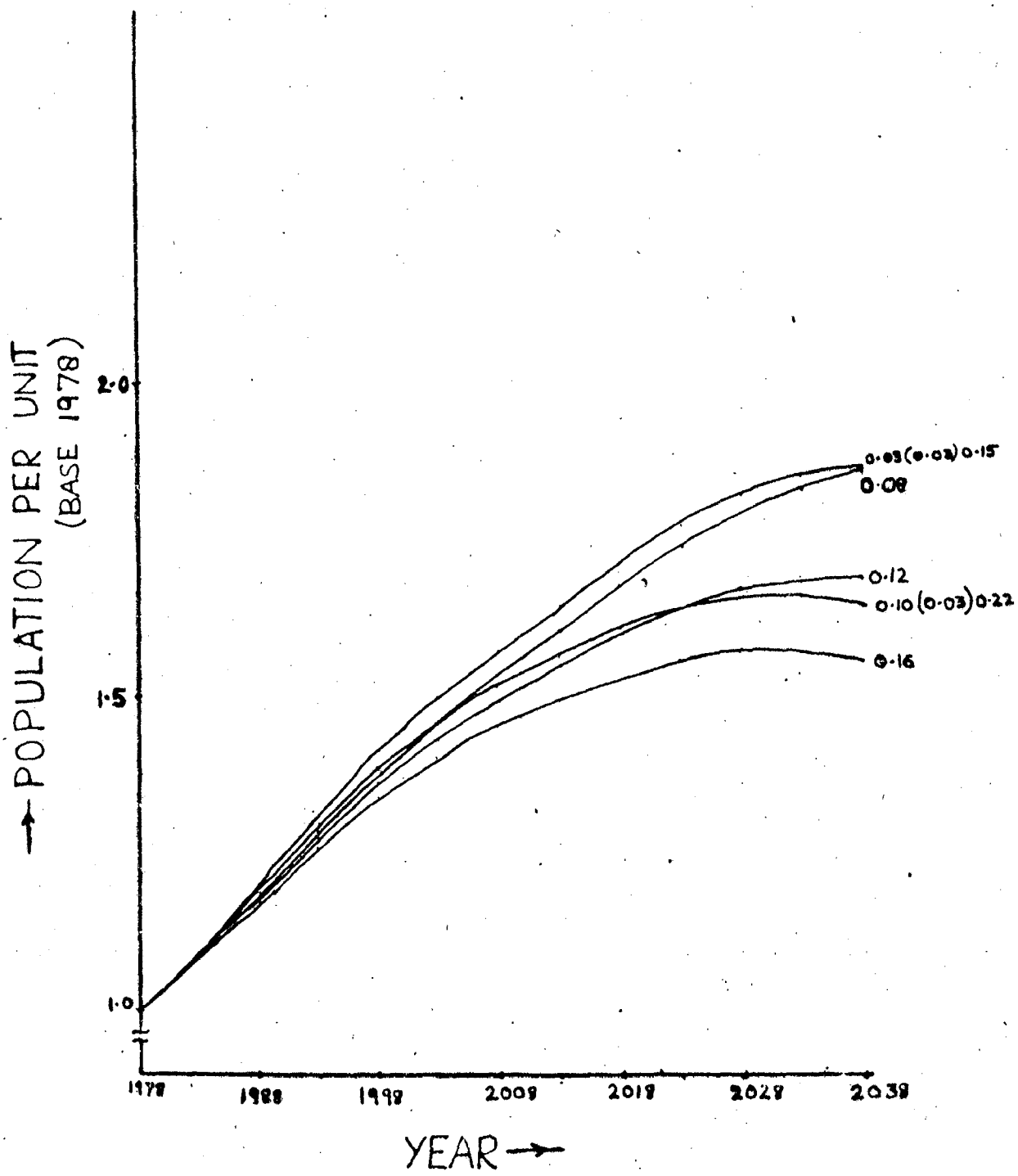


MAHARASTRA

FAMILY PLANNING CONTROL [A·M]

CONSTANT CHILD MORTALITY

fig. 4·10

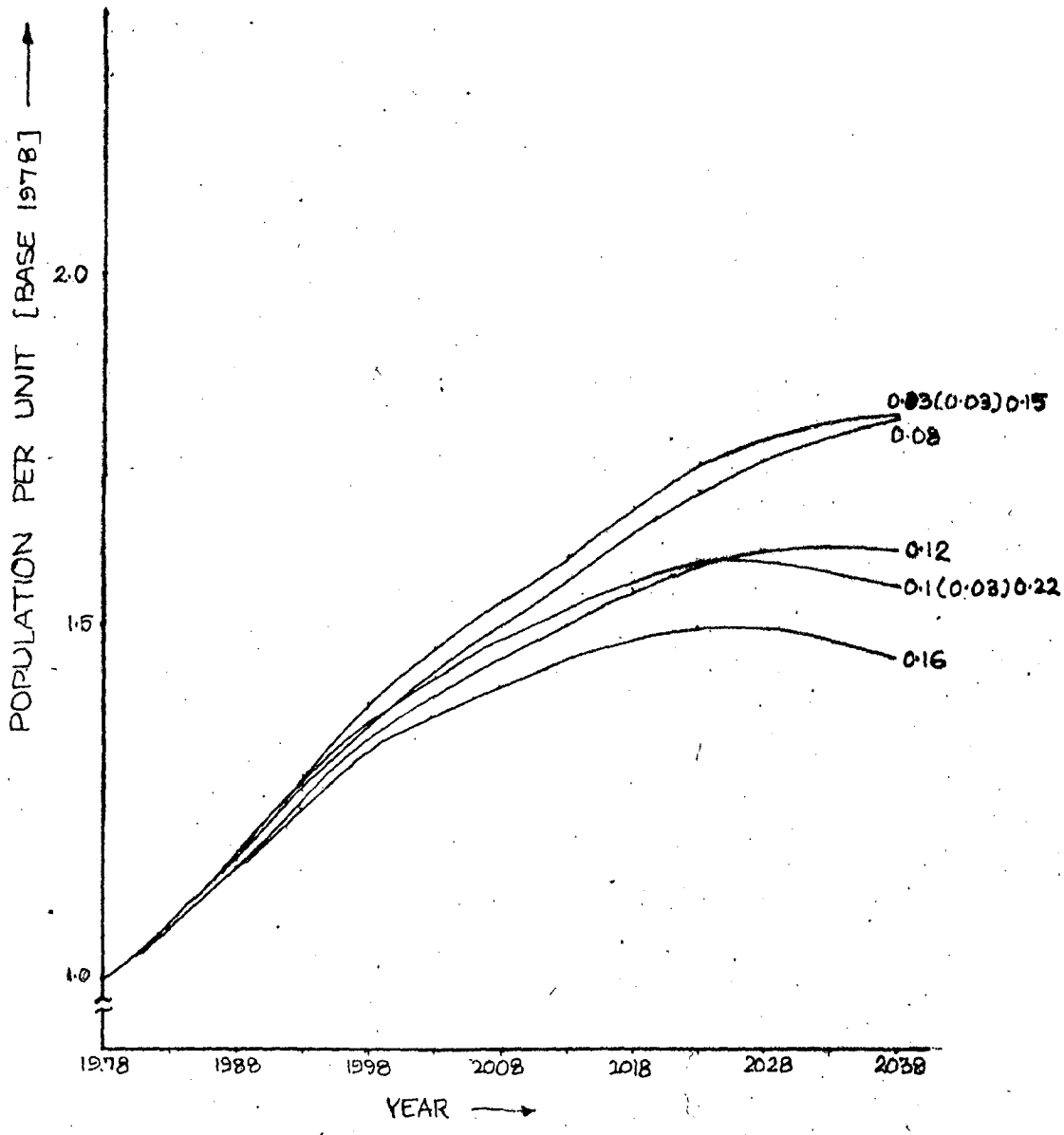


PUNJAB

FAMILY PLANNING CONTROL ('AM')

CONSTANT CHILD MORTALITY

Fig 4·11

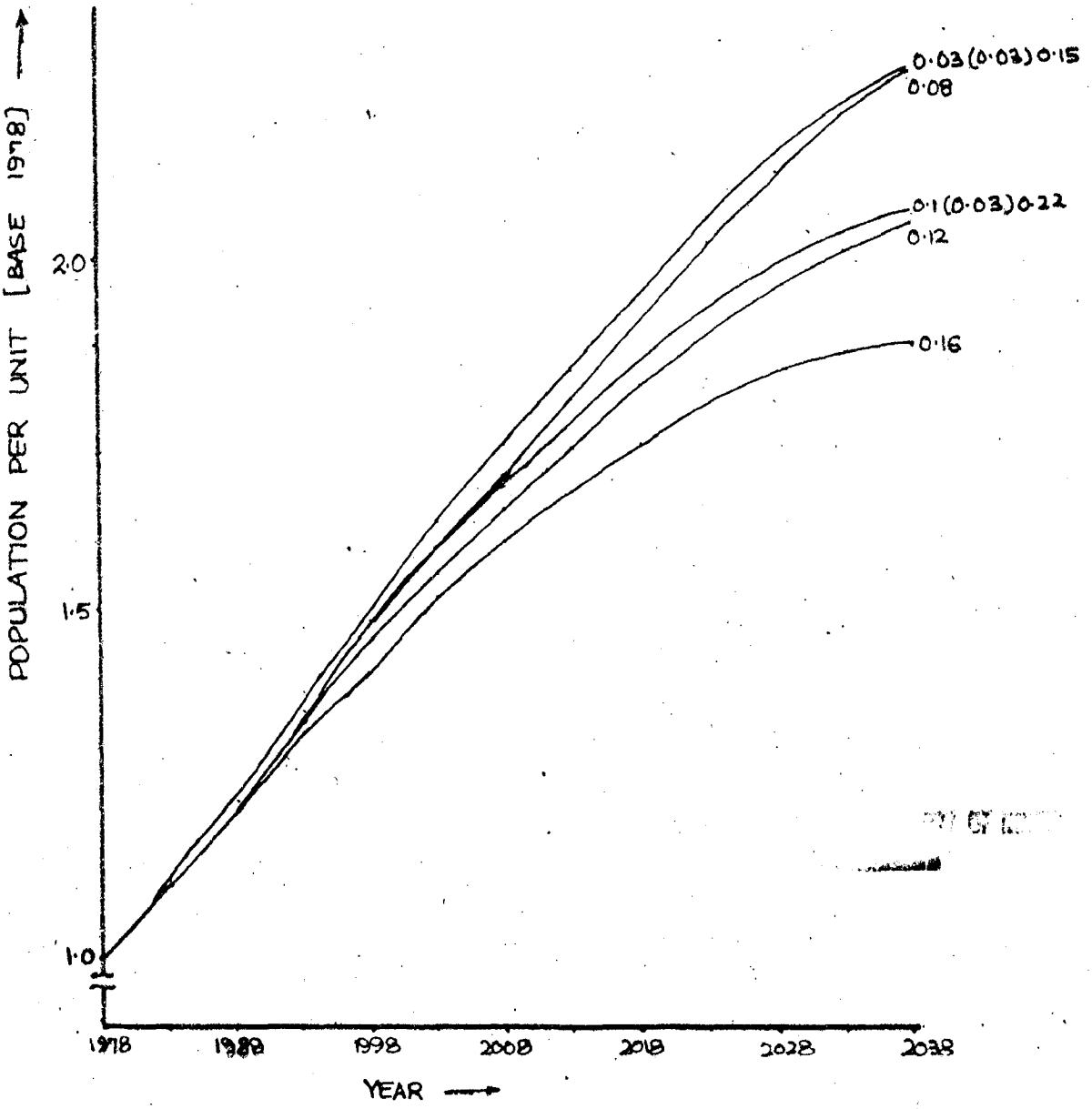


ORISSA

FAMILY PLANNING CONTROL ['A.M']

CONSTANT CHILD MORTALITY

fig. 4·12

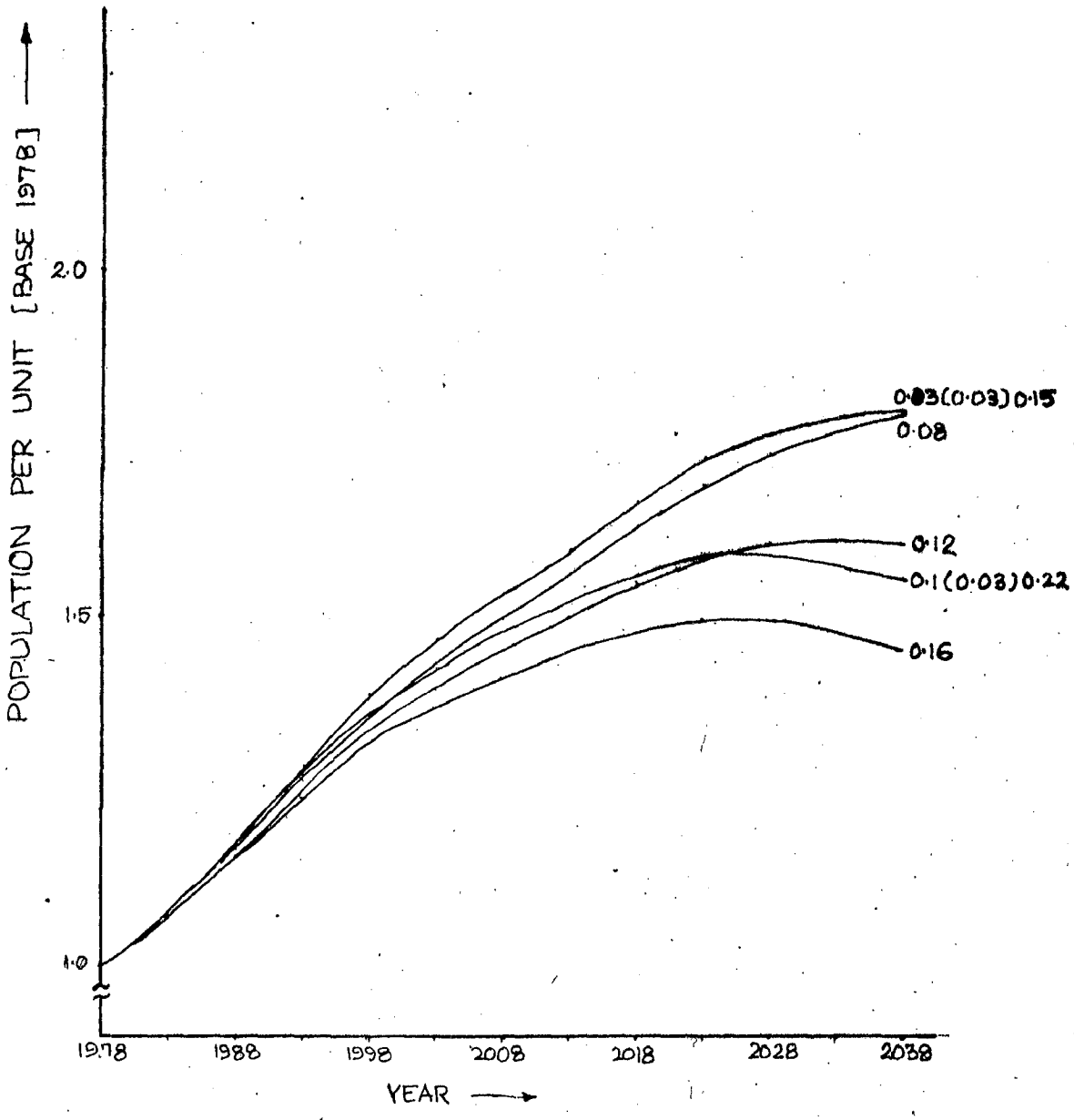


GUJARAT

FAMILY PLANNING CONTROL (A.M.)

CONSTANT CHILD MORTALITY

Fig. 4·14

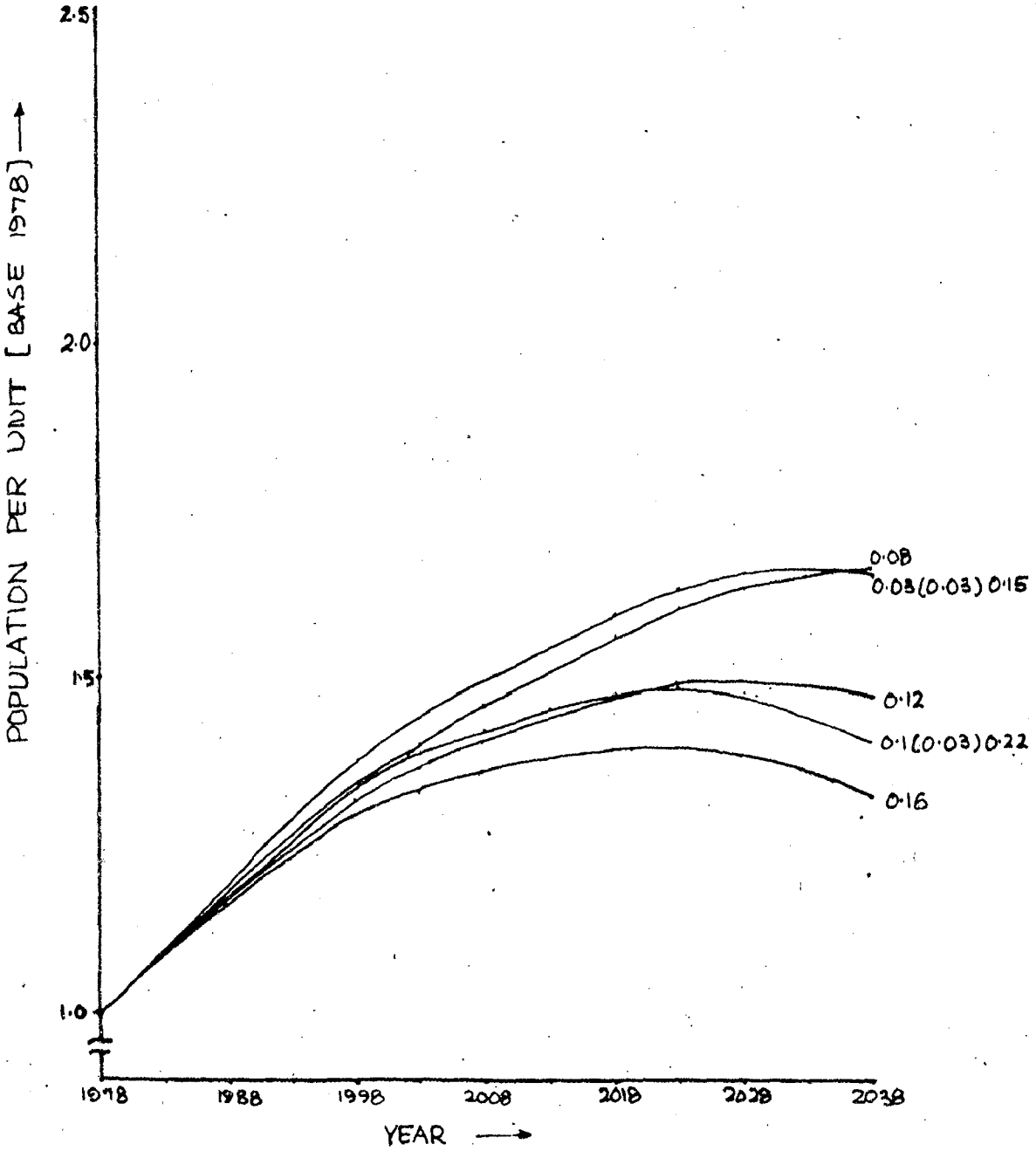


ORISSA

FAMILY PLANNING CONTROL ['A.M']

CONSTANT CHILD MORTALITY

Fig. 4·12

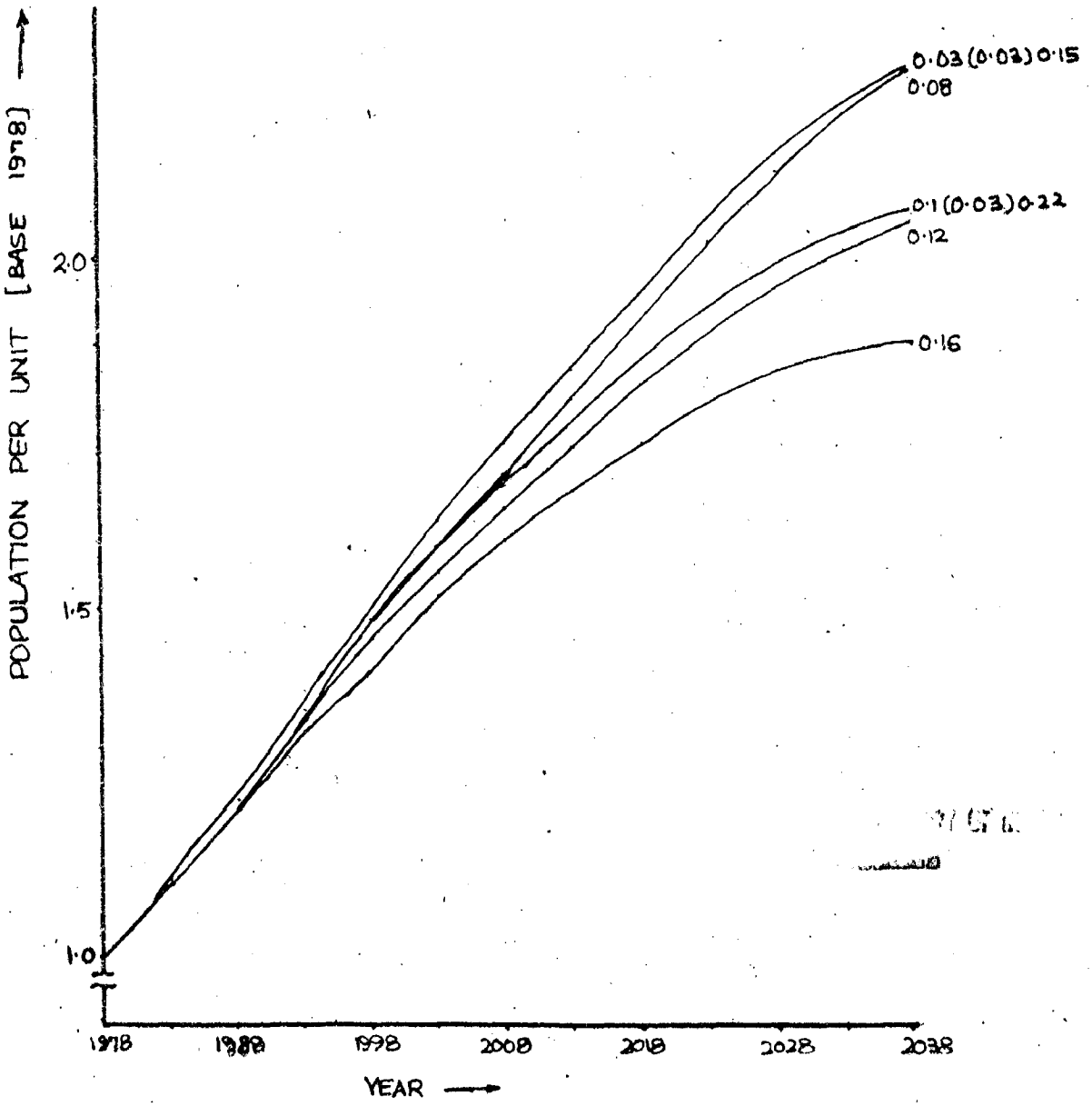


U.P.

FAMILY PLANNING CONTROL [A.M.]

CONSTANT CHILD MORTALITY

Fig. 4·13

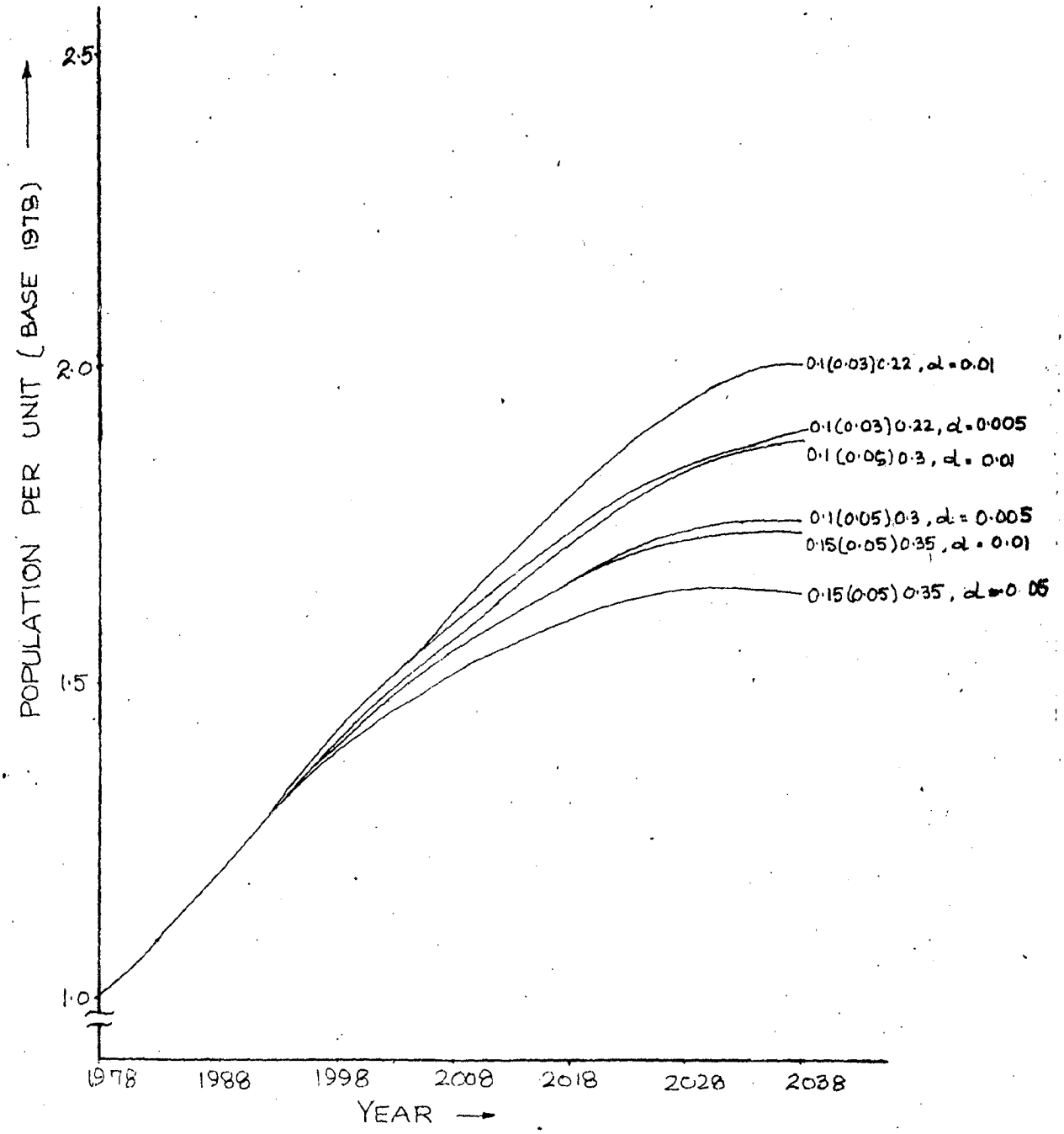


GUJARAT

FAMILY PLANNING CONTROL (A.M.)

CONSTANT CHILD MORTALITY

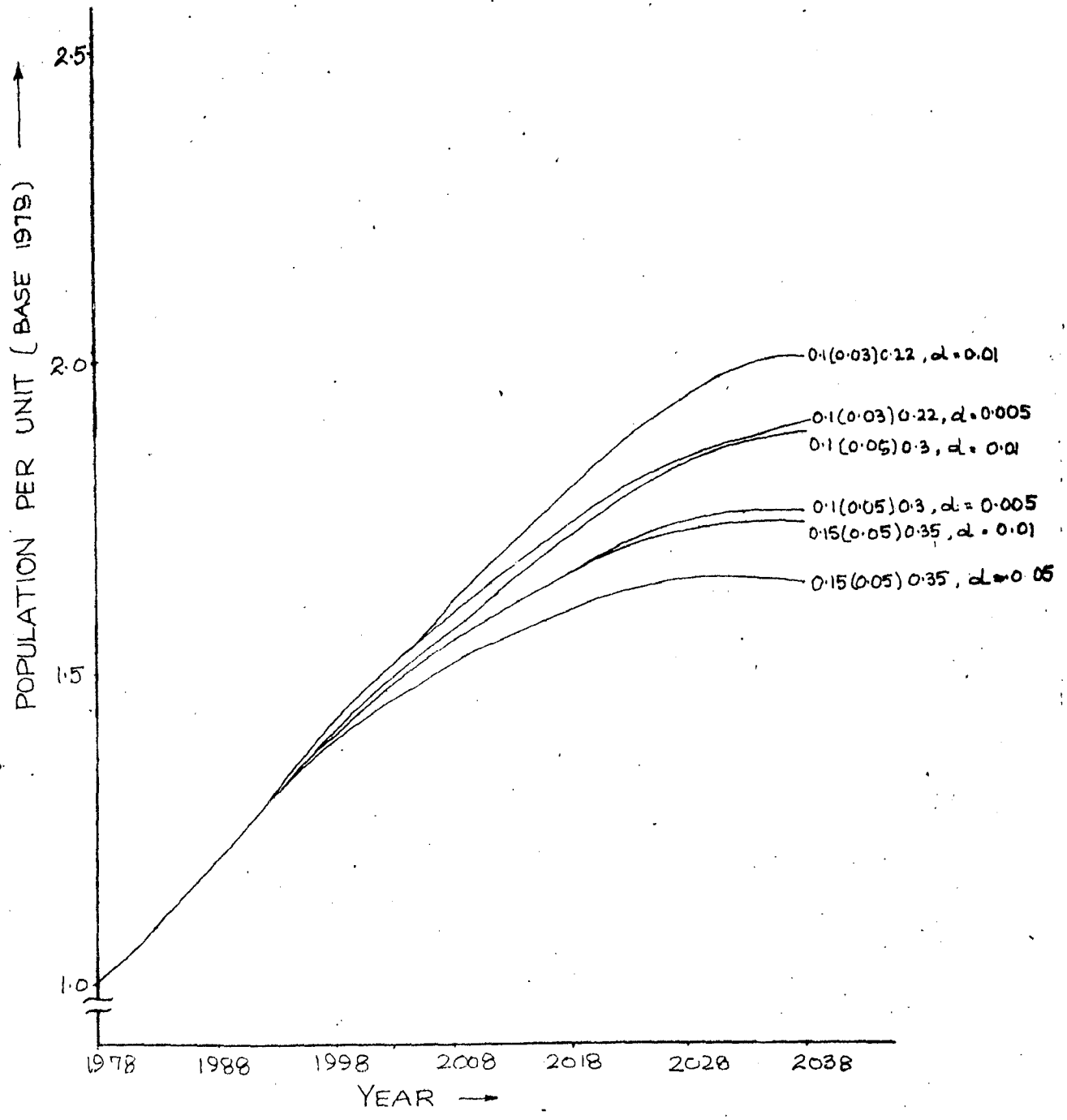
Fig. 4·14



INDIA

FAMILY PLANNING CONTROL ('A·M')

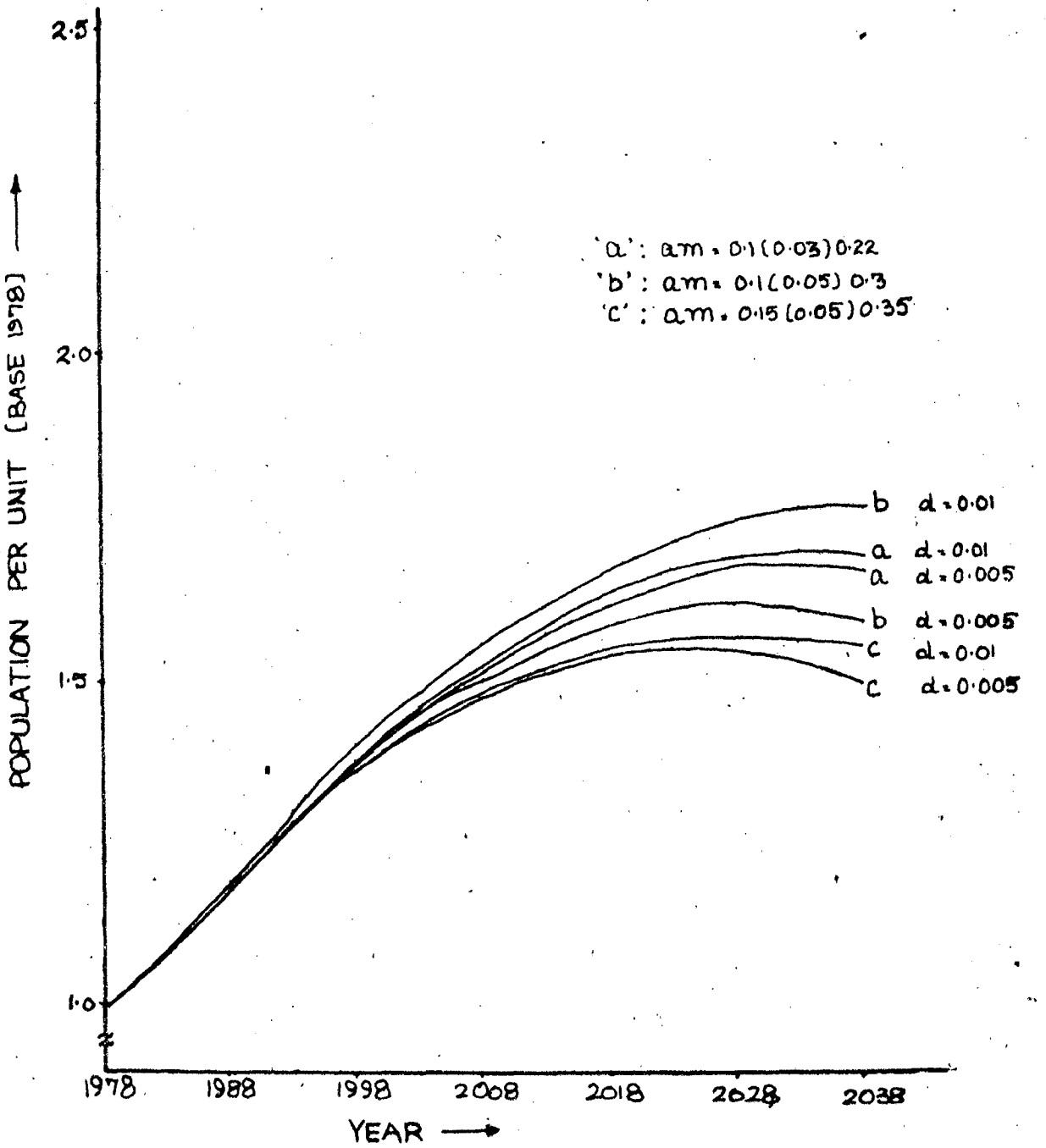
fig. 4·15



INDIA

FAMILY PLANNING CONTROL ('A.M.')

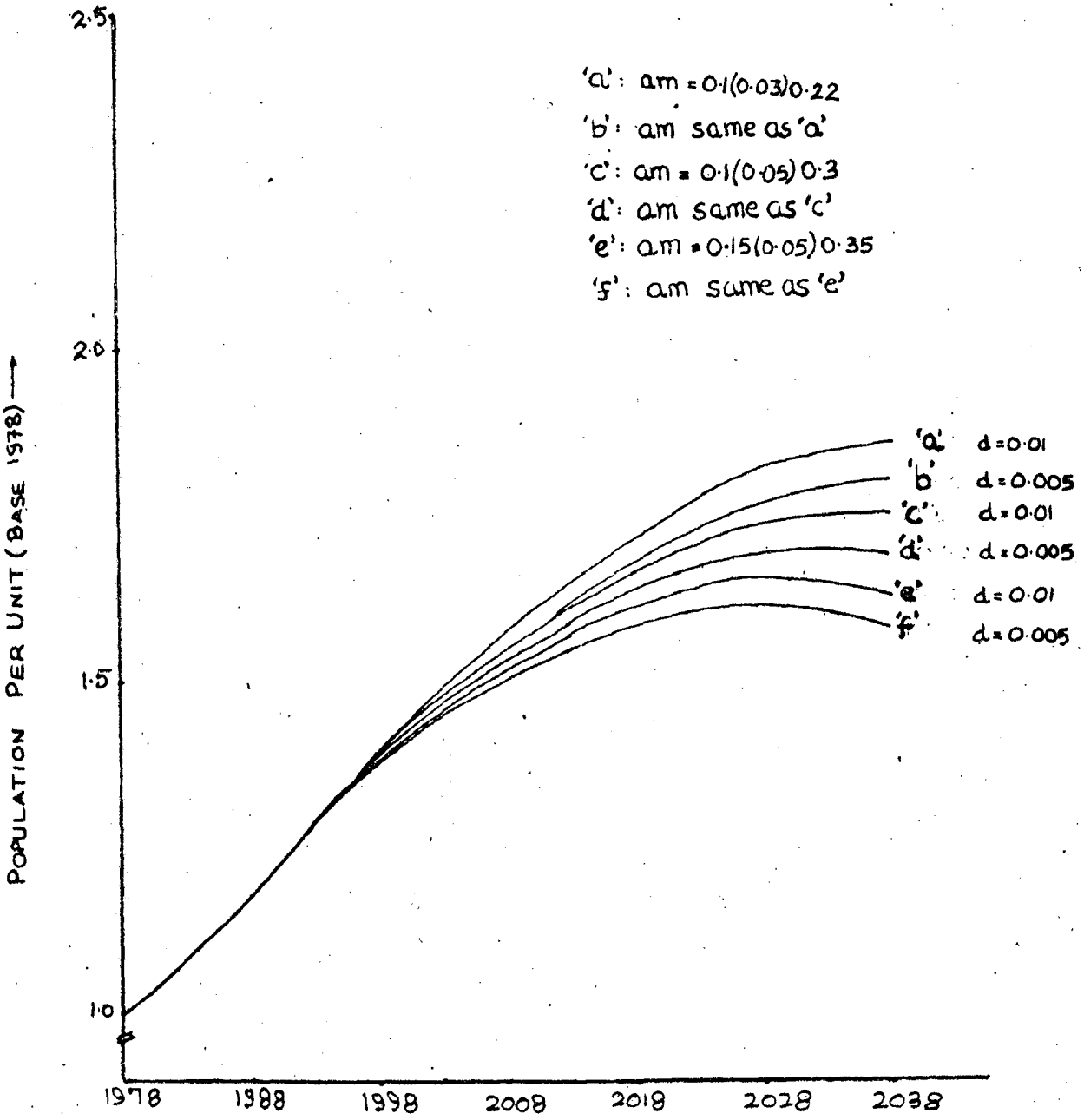
fig. 4·15



KERALA

FAMILY PLANNING CONTROL ['A·M']

Fig. 4·16

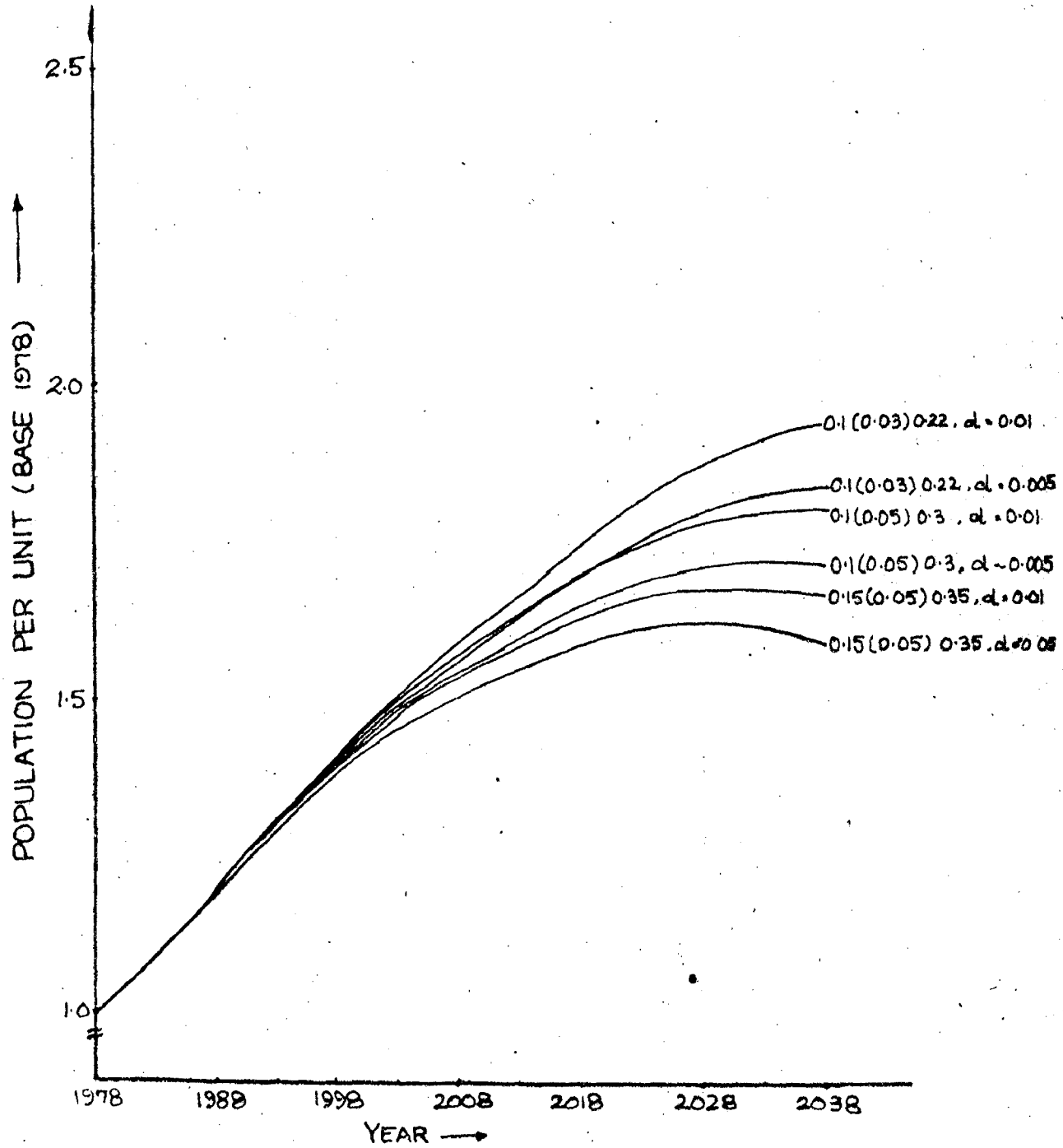


MAHARASHTRA

FAMILY PLANNING CONTROL

'AM'

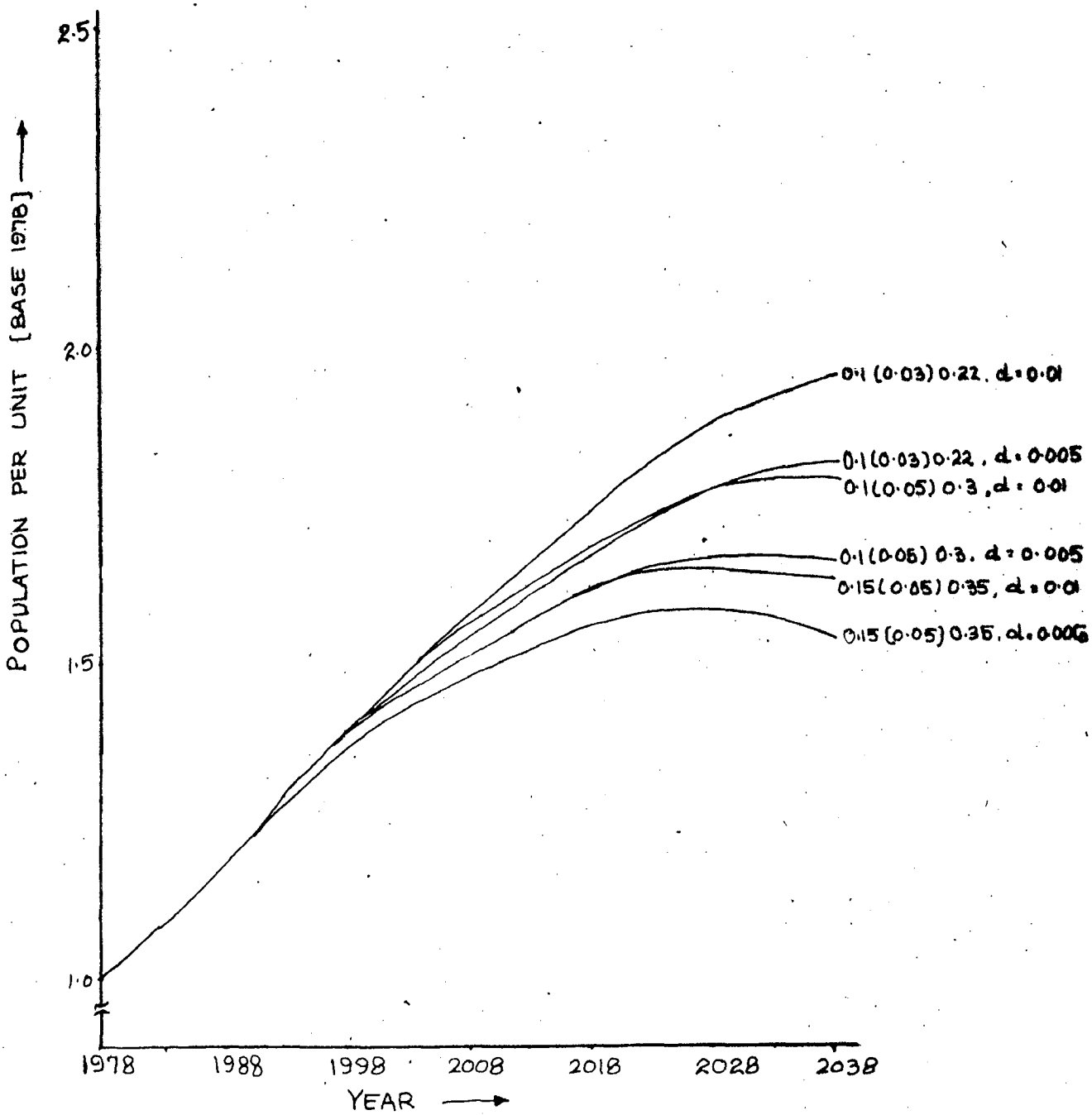
fig. 4·17



PUNJAB

FAMILY PLANNING CONTROL ('A.M)

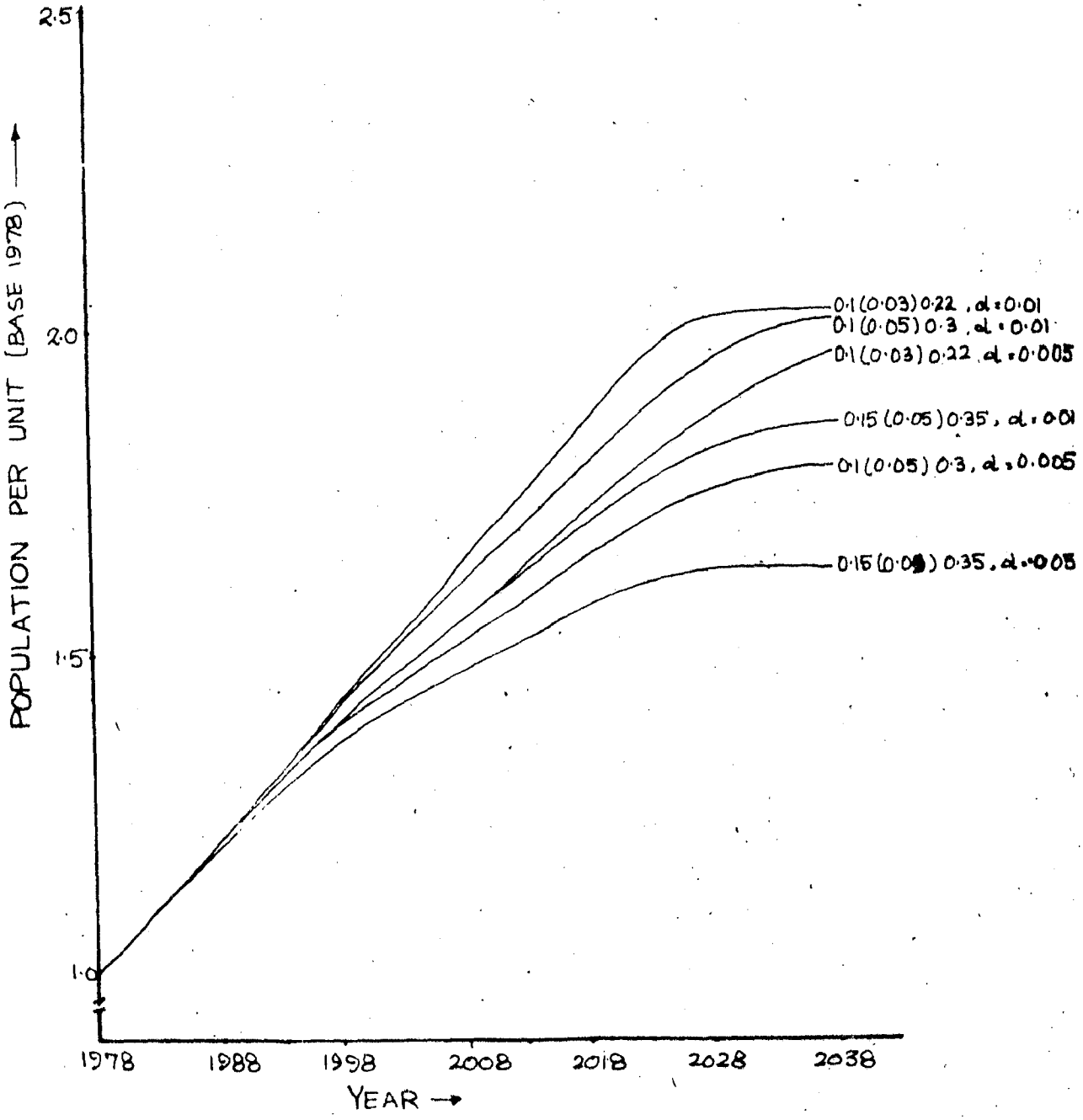
Fig. 4·18



ORISSA

FAMILY PLANNING CONTROL ['A.M']

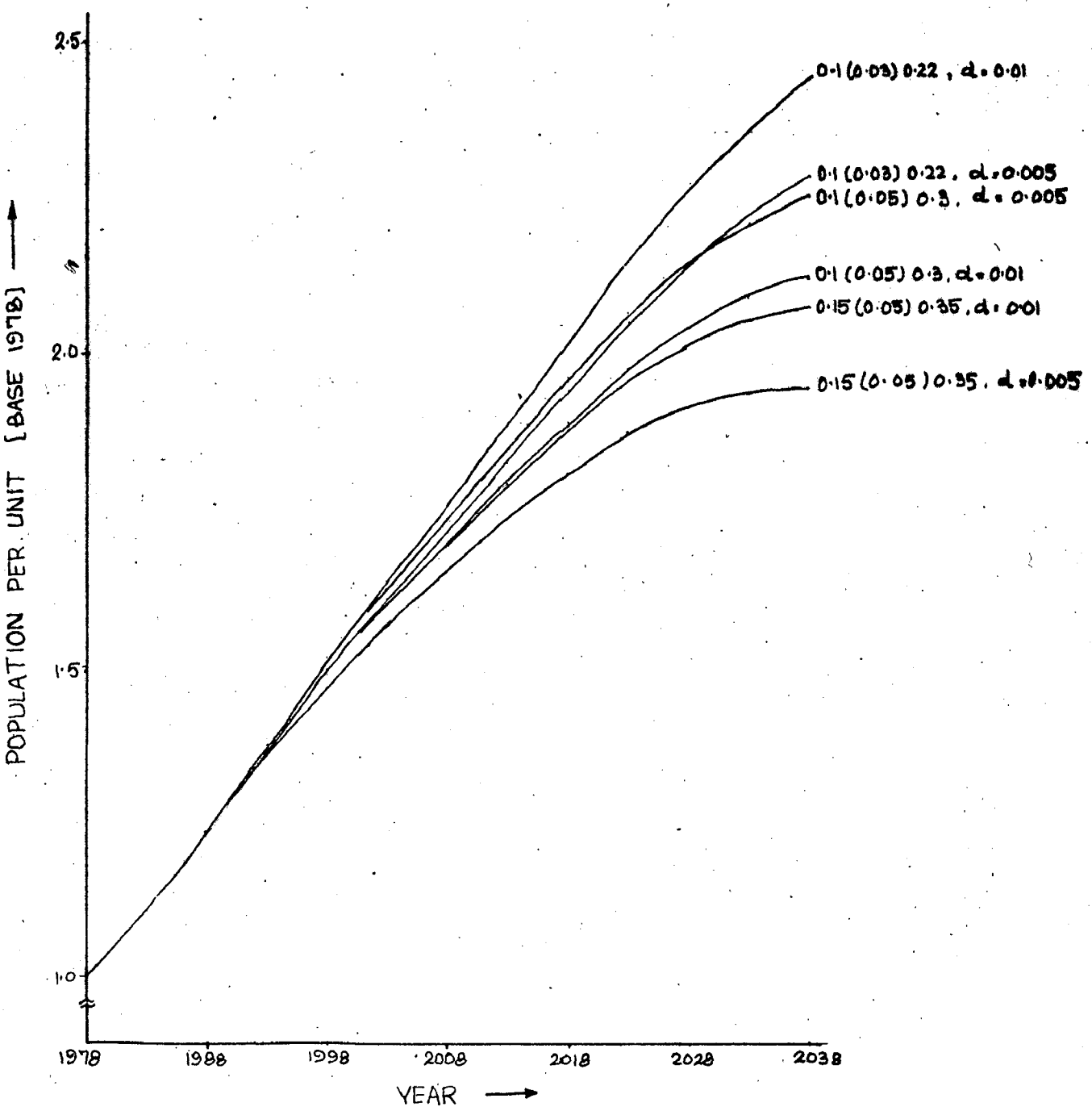
Fig. 4·19



U.P

FAMILY PLANNING CONTROL ('A.M')

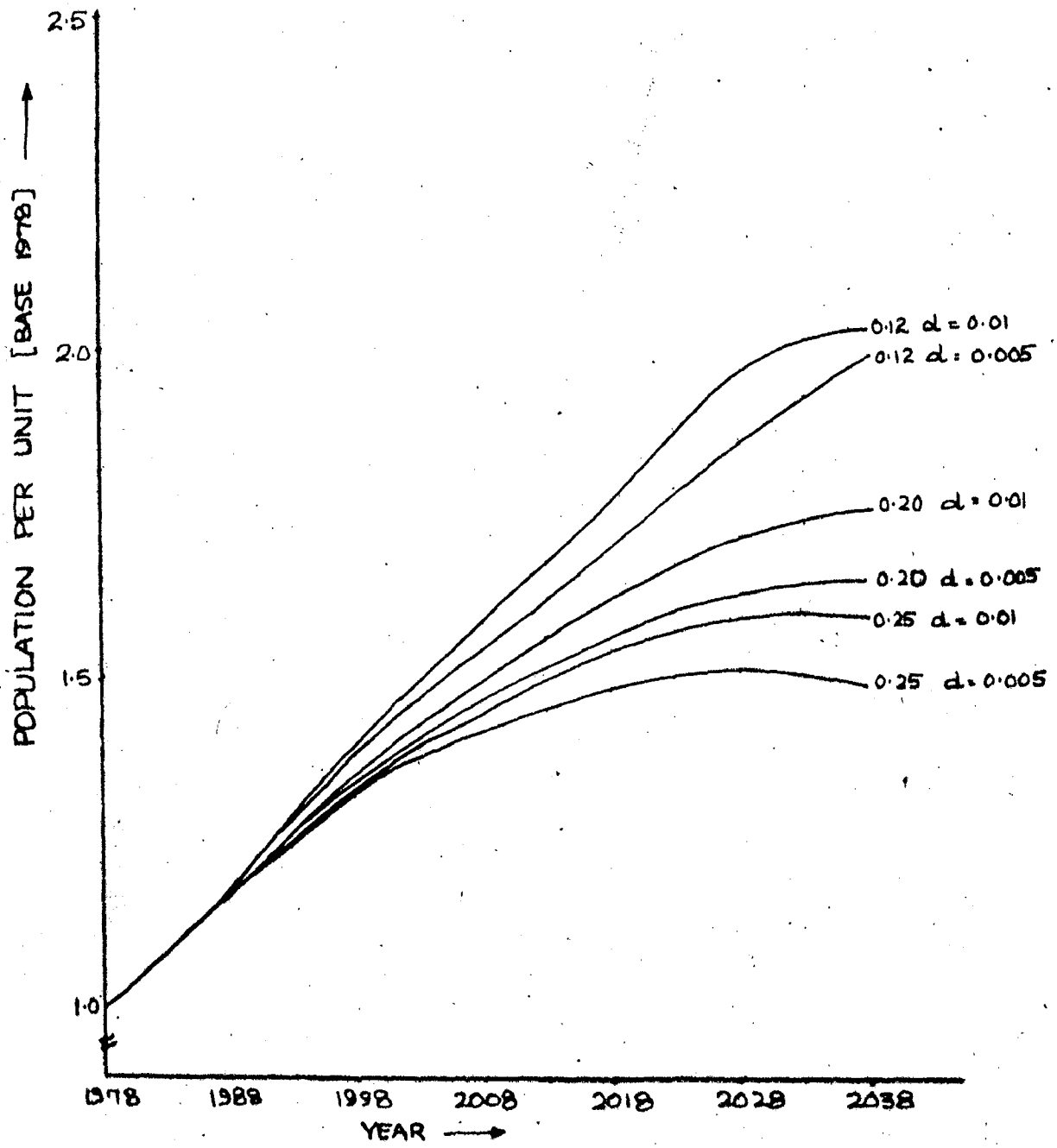
Fig. 4·20



GUJARAT

FAMILY PLANNING CONTROL ('A.M.')

Fig. 4·21

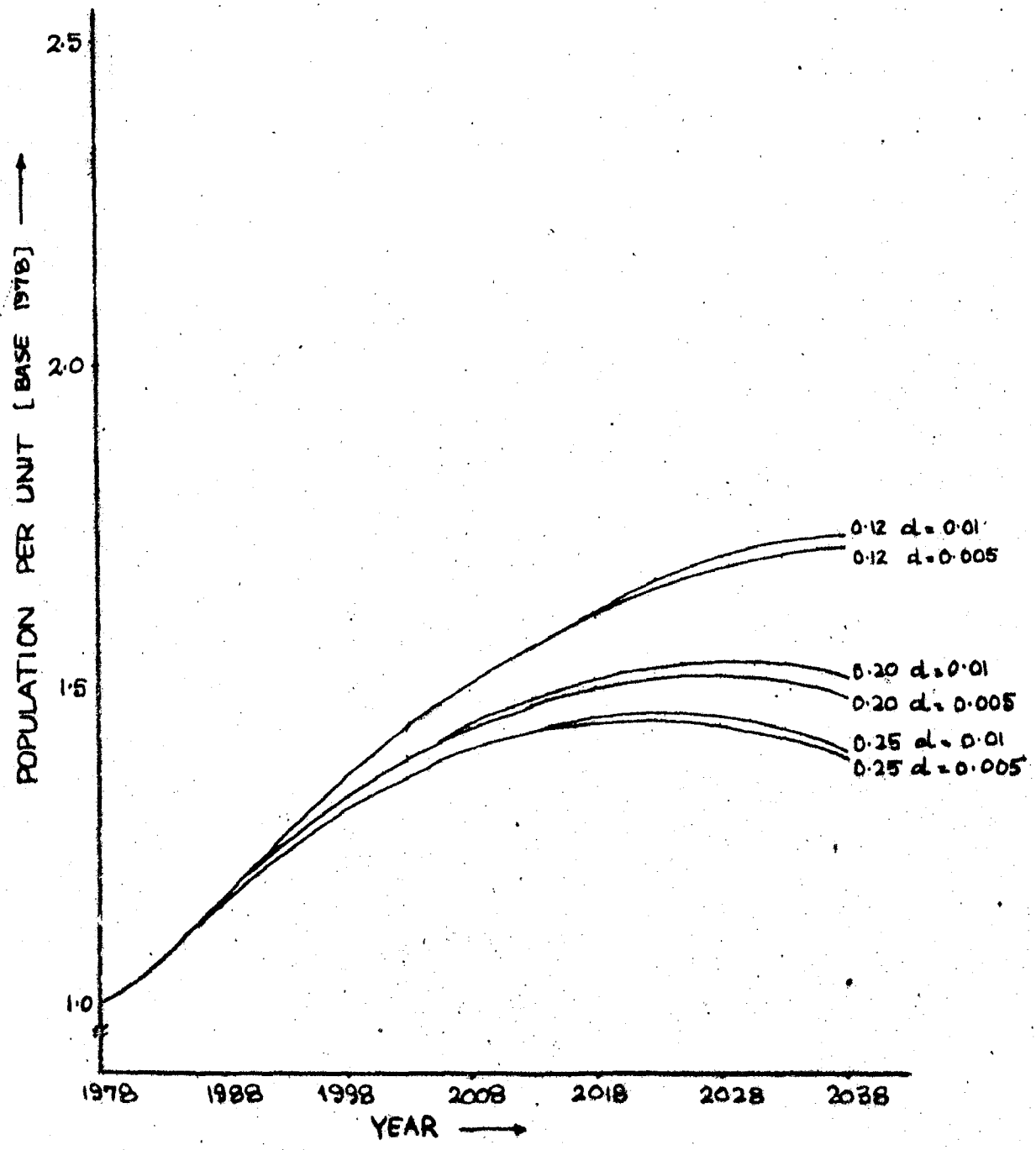


INDIA

FAMILY PLANNING CONTROL

CONSTANT AM

Fig 4.22

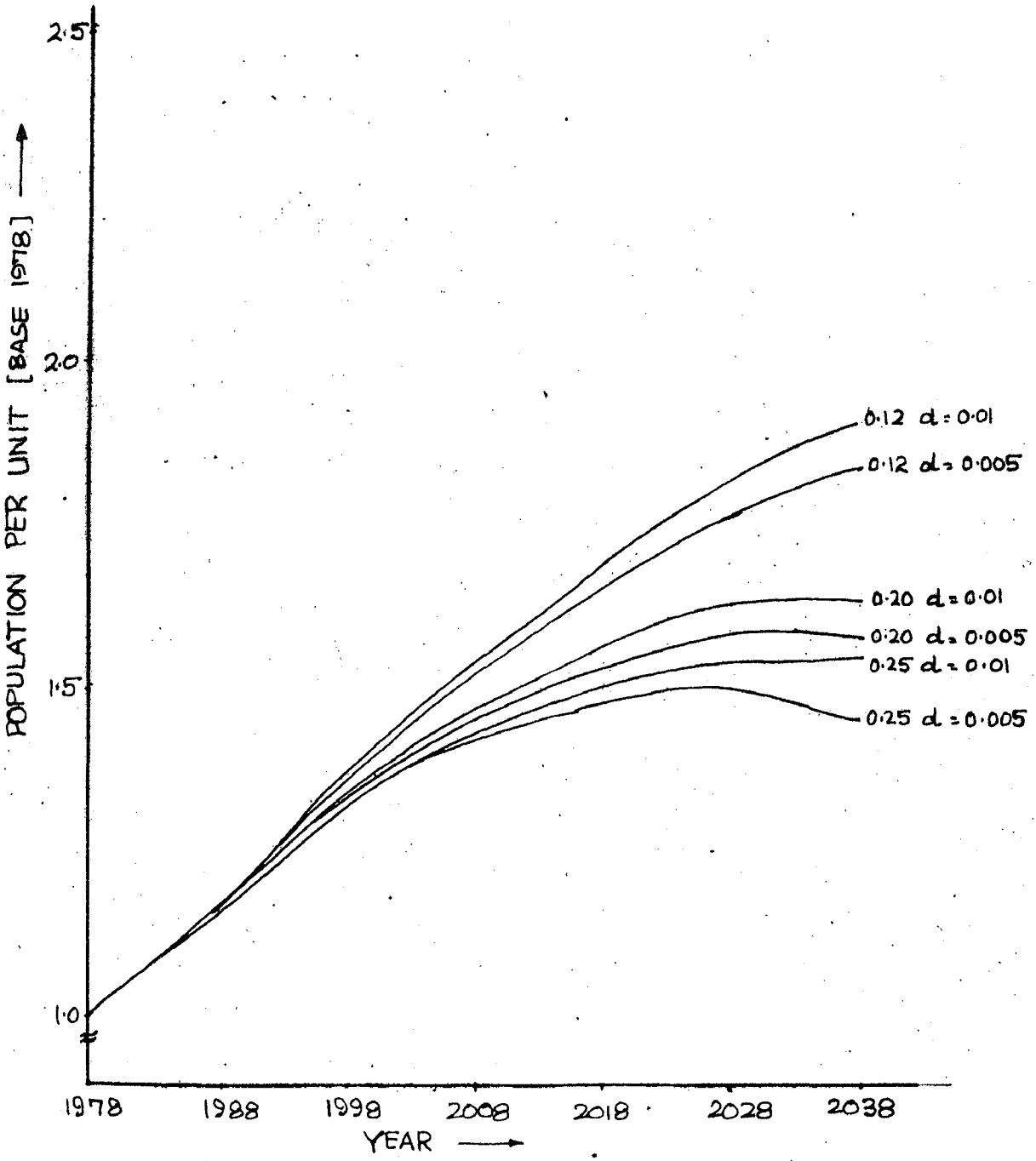


KERALA

FAMILY PLANNING CONTROL

CONSTANT A·M.

Fig. 4·28

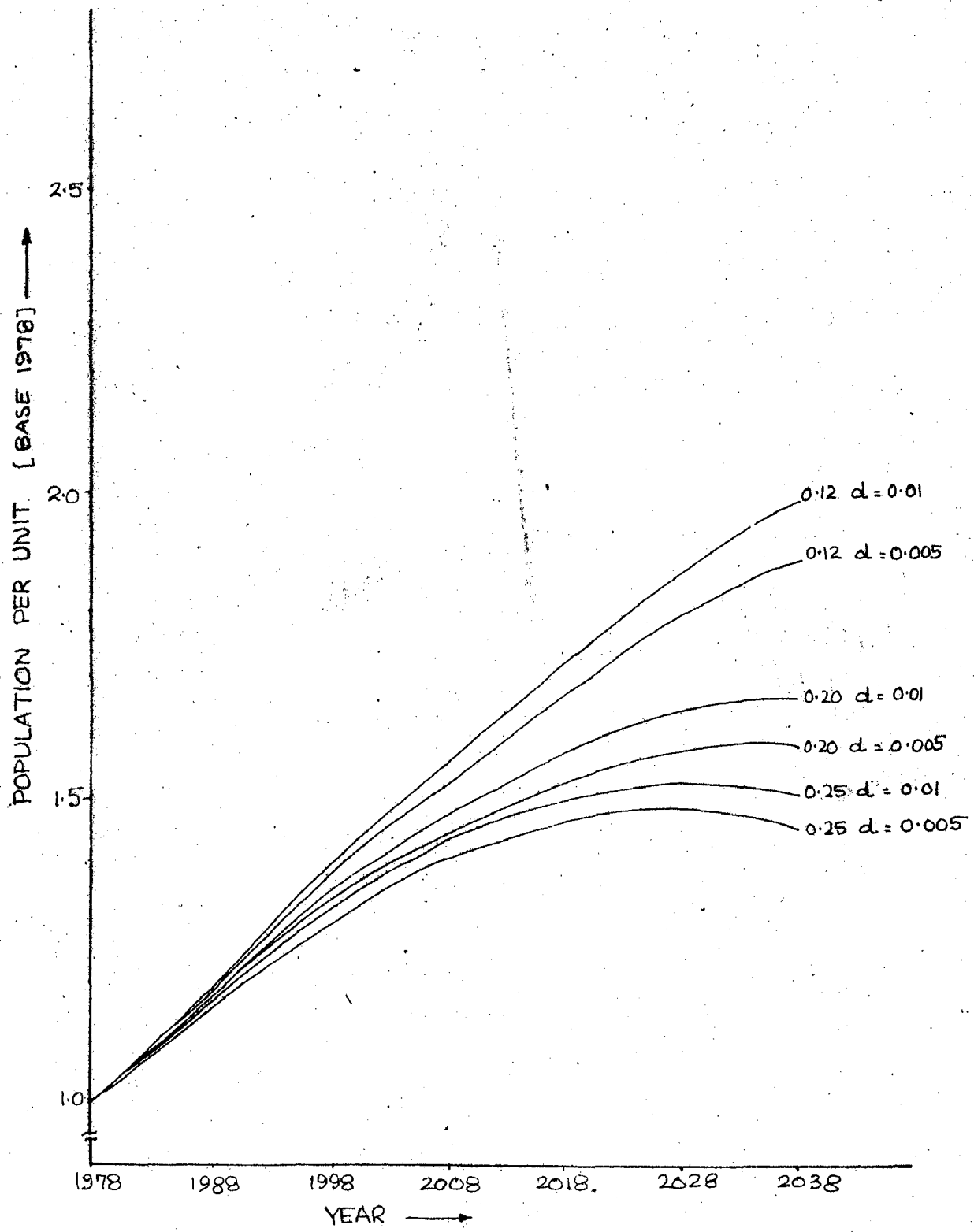


MAHARASTRA

FAMILY PLANNING CONTROL

CONSTANT A.M.

Fig. 4.24

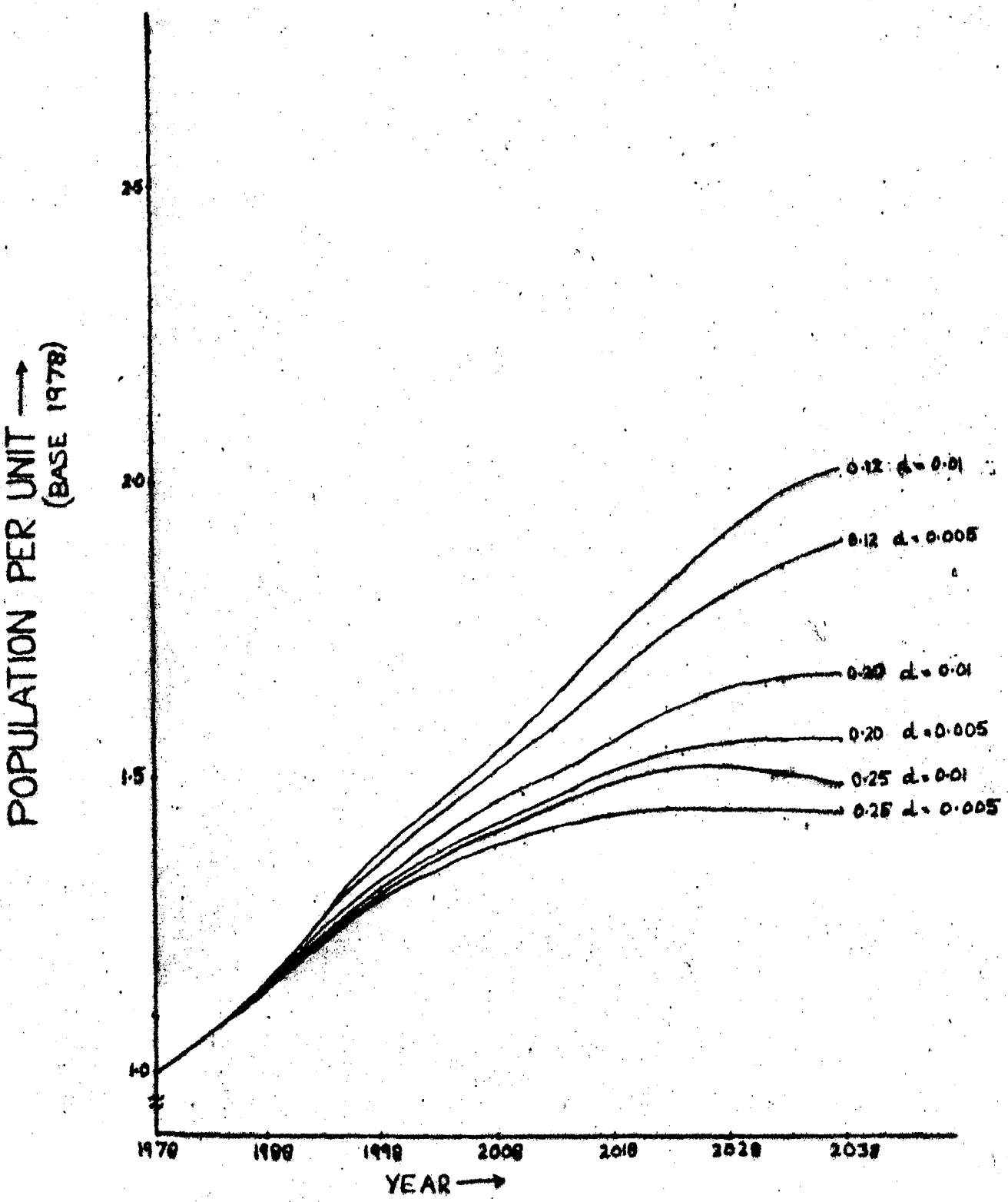


PUNJAB :

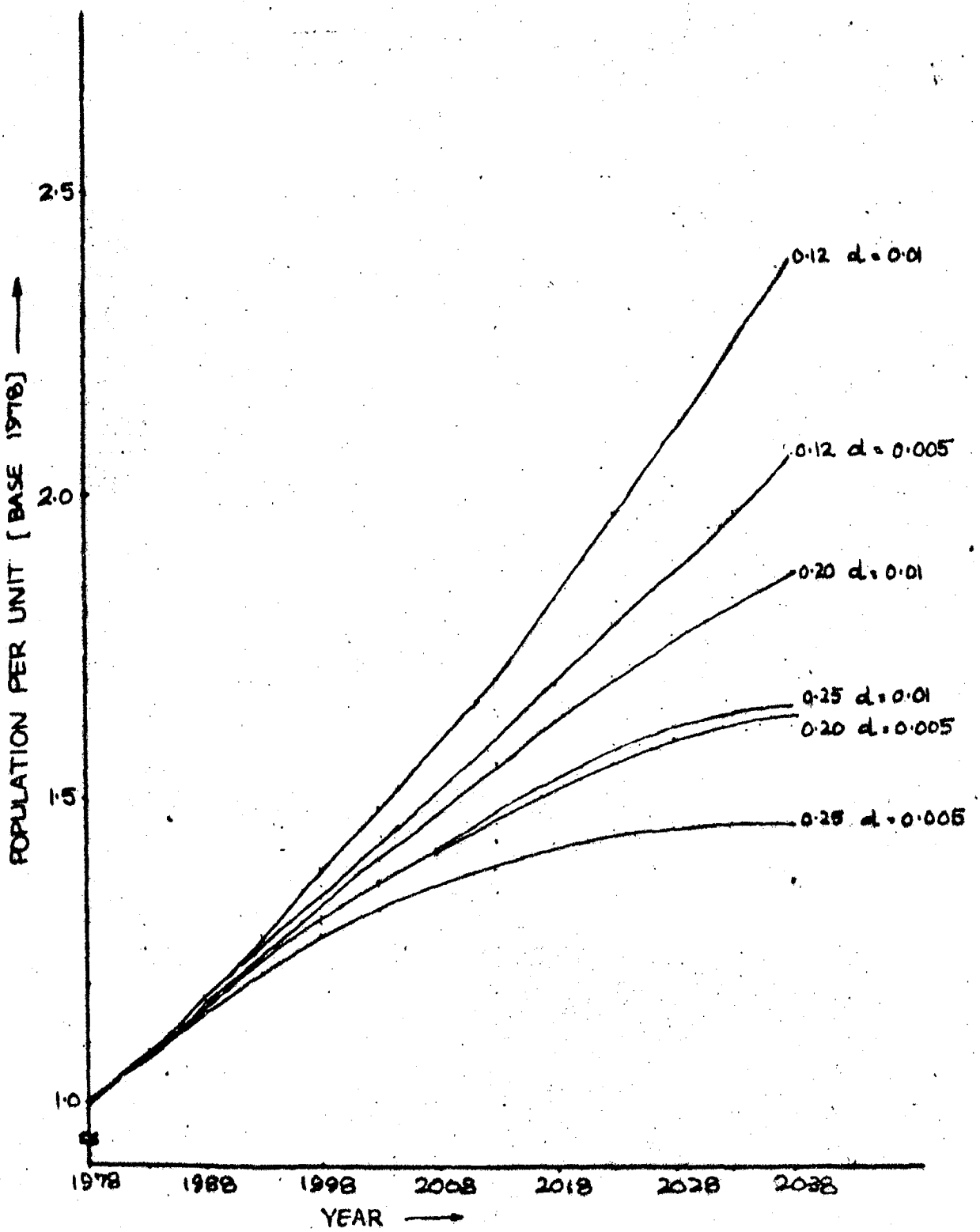
FAMILY PLANNING CONTROL

CONSTANT A·M

Fig. 4·25



ORISSA
FAMILY PLANNING CONTROL
CONSTANT 'a m'
Fig. 4·26

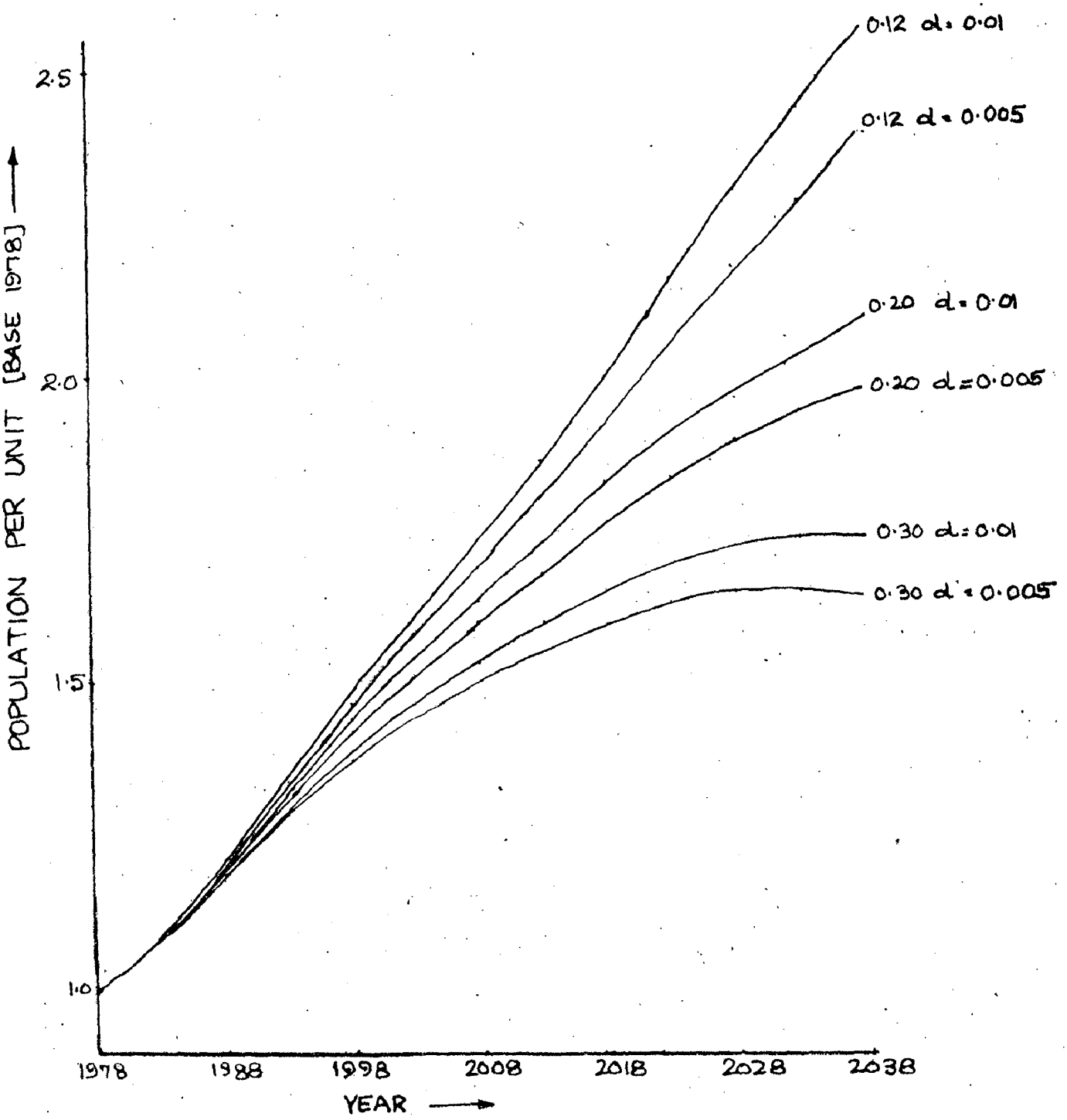


U.P.

FAMILY PLANNING CONTROL

CONSTANT A.M.

Fig. 4·27



GUJARAT

FAMILY PLANNING CONTROL

CONSTANT A.M.

Fig. 4·28

Fig. 4·29 AGE STRUCTURE OF POPULATION

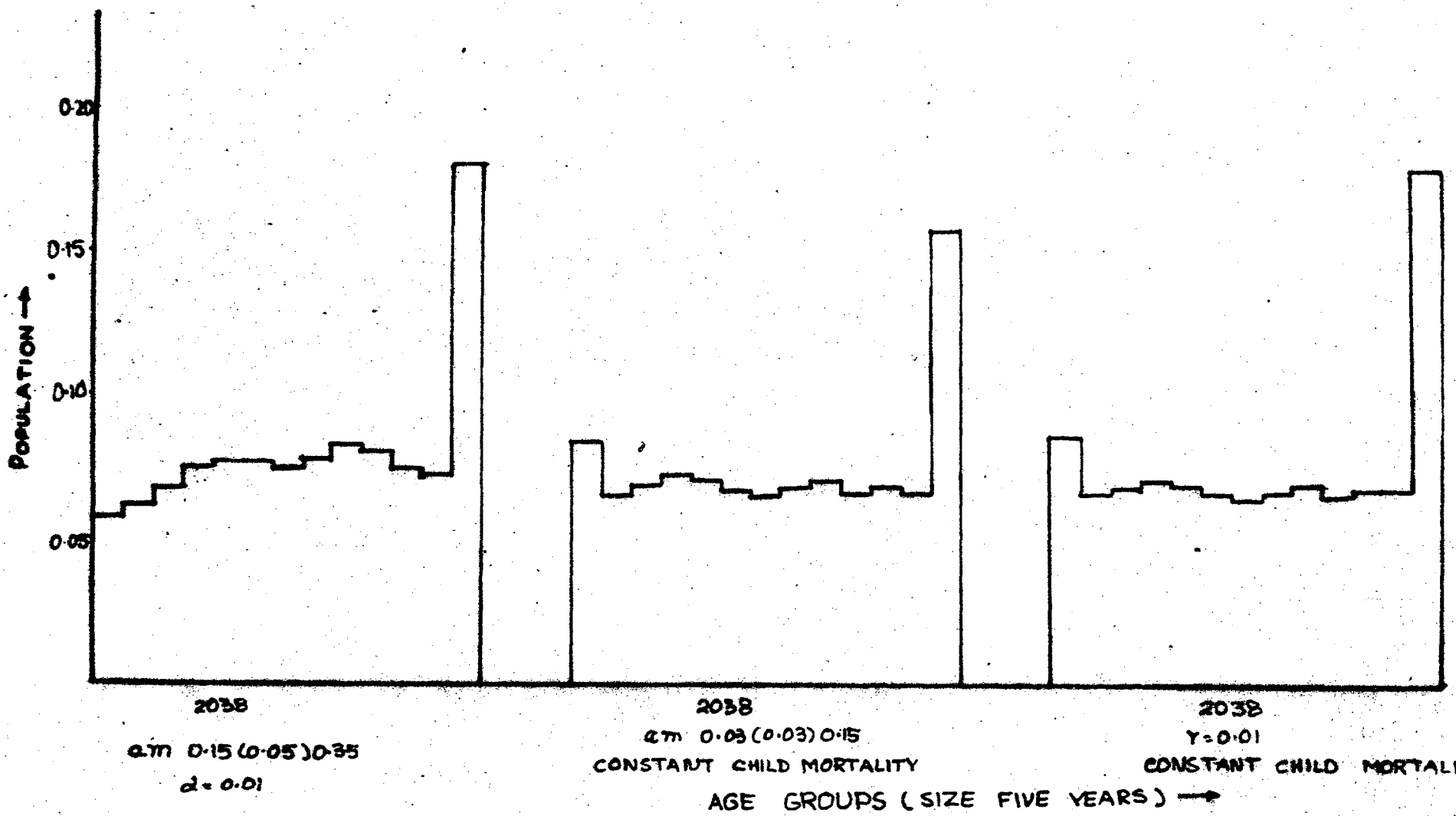


Fig. 4·30 AGE STRUCTURE OF POPULATION

CHAPTER FIVE

CONCLUSION

"There is no going back.
For standing still means death, and life is moving on
Moving on towards death.
But sometimes standing still is also life".

John Ashberry
'The Double Dream of Spring'

5.1 DISCUSSION OF RESULTS :

The acute importance of reduction in the growing number can not be over-emphasised as is pretty evident from previous discussion and simulation of results for different methods of fertility control. If we consider the bearing capacity of land to be about 1200 million, our aim would be to keep the population within this level in future. This means that the per unit population in future (base 1978) should be within 1.8.

From simulation results, some conclusion can be drawn, about the level of population control required for India.

1. In case of arbitrary control of fertility pattern a control effort of 0.010 i.e. a decrease of 9.5 per cent per decade gives a per unit population of 1.64 in 2038. If child mortality rates are also decreased simultaneously with a factor of 0.005 (decrease of 4.5 per cent per decade), an increased control effort of 0.015 i.e. a decrease of 14 per cent per decade is required for population of 1.86 in 2038.

2. For Family planning efforts, the value of control effort 'cm' of 0.10 gives a per unit population of 1.759 in 2038. If child mortality rates are also reduced simultaneously with control factors of 0.005 and 0.010, 'cm' required becomes 0.18 and 0.20 respectively giving per unit population of 1.70 and 1.75 respectively. Family planning is introduced in steps, the control factor has to be increased from 0.04 to 0.20 in five yearly steps of 0.04 and then held constant at 0.20 for achieving a per unit population of 1.74 in 2038. Introduction

TABLE 5.1

Suggested Control Efforts for States

Method of Control	Control Effort and Per unit population of 2038 (base 1978)					
	Kerala	Maharashtra	Punjab	Orissa	U.P.	Gujarat
Arbitrary with child mortality decline factor d= 0.005	0.010 1.73	0.012 1.79	0.015 1.84	0.013 1.83	0.022 1.76	0.022 1.75
Family planning in steps.	0.03(0.03)0.15 1.80	0.04(0.04)0.20 1.76	0.04(0.04)0.20 1.76	0.03(0.03)0.15 1.80	0.02(0.02)0.10 1.80	0.10(0.04)0. 1.84
Family planning constant 'am'	0.08 1.79	0.10 1.78	0.10 1.77	0.10 1.70	0.07 1.71	0.16 1.862
Family planning in steps with d=0.005	0.10(0.03)0.22 1.69	0.10(0.03)0.22 1.79	0.10(0.04)0.26 1.77	0.10(0.04)0.26 1.75	0.10(0.05)0.30 1.78	0.25(0.05)0. 1.70
Family planning in steps d=0.010	0.1(0.05)0.30 1.76	0.10(0.04)0.26 1.79	0.10(0.05)0.30 1.79	0.10(0.05)0.30 1.79	0.15(0.05)0.35 1.85	0.25(0.05)0. 1.80
Family planning constant'am' d=0.005	0.12 1.70	0.14 1.77	0.16 1.73	0.16 1.71	0.18 1.73	0.25 1.79
Family planning constant 'am'd=0.010	0.12 1.73	0.16 1.76	0.18 1.74	0.18 1.75	0.25 1.65	0.30 1.73

of a decline in child mortality rates at d = 0.005 raises the effort to an increase of five yearly steps of 0.05 from an initial control factor of 0.10 to 0.30 and then the effort is held constant at 0.30. This gives a per unit population of 1.76 in 2038. An increase in d to 0.010 increases the level of effort to an initial value of 0.15 increased to 0.35 in steps of 0.05. This gives a per unit population of 1.74 in 2038.

Table 5.1 shows the respective control efforts desired for the six states.

5.2 CONCLUSIONS :

The following conclusions have been made on the basis of this work :

1. Child mortality rates and fertility rates are strongly correlated. Therefore for any realistic study, a decline in future child mortality rates has to be assumed together with decline in future fertility rates. The mortality tends to increase population levels. This means that a higher birth control effort is required than that for the case of constant mortality rates, a fact which is supported by results obtained.

2. Surprisingly, no definite negative correlation was established between level of education and fertility, a finding which raises some eyebrows. The data used for this study was from Census 1971 fertility tables.

3. The studies of different socio-economic groups considering a state as a homogeneous group has brought out

large variations in population growth pattern from state to state for same control effort.

4. The population increase is considerably high for some states, typically Gujarat for a moderately high control effort. Uttar Pradesh also exhibits the same tendency when child mortality rates are also decreased. This points out to the magnitude of population problem confronting us.

5.3 FUTURE SCOPE OF WORK :

The Herculean task of population control has to be taken up earnestly and with a sense of devotion. It is known that more modernised women-literature, urban and belonging to a higher socio-economic group - have a lower fertility than those who are less educated, live in rural areas, belong to the poorer sections of the society and are more traditional in their outlook. But the task of educating the vast illiterate masses would take couple of decades. The little progress made is eaten away by the growing population. Technical assistance, political stability, strong leadership, greater consciousness among the masses and viable social and economic policies, etc. are some factors which contribute to more rapid economic and social progress.

Thus concentrated efforts are required, both in field work and also in the area of analytical studies.

A point to be borne in mind while undertaking future work is that the input data used should be extremely reliable, it should be cross-checked for possible errors. Some suggested

areas of future work are :

1. The lack of data for the marital fertility and percentages of married, widowed and divorced females on a state wise basis precluded the study of the effect of raising minimum age at marriage on population levels. This can be a subject of future work. The raising of minimum age at marriage alters the fertility pattern and exercises a controlling influence on population.

2. Population pattern can be studied by having a larger number of more homogenous groups. For example, within a state, the population projections can be undertaken for urban and rural areas. Another way is to study population growth for different income groups.

We can do a great deal to make our future more comfortable and less dangerous or we can turn our backs hoping the problems will go away leaving us untouched. They will not.

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